Lighting Global:
Solar Irrigation System End-User Subsidy Reference Guidelines

September 2021

LIGHTING GLOBAL
Catalyzing markets for modern off-grid energy
AN INNOVATION OF WORLD BANK GROUP
THE WORLD BANK IBRD • IDA
IFC International Finance Corporation

In Partnerships with
IKEA Foundation
ESMAP Energy Sector Management Assistance Program
Dalberg Advisors

Authors

Lighting Global

Lighting Global is the World Bank Group's initiative to rapidly increase access to off-grid solar energy for the 789 million people worldwide living without electricity. Lighting Global - managed by the International Finance Corporation (IFC) and the World Bank - works with manufacturers, distributors, governments, and other development partners to build and grow the modern off-grid solar energy market. Lighting Global programs are funded with support from the Energy Sector Management Assistant Program (ESMAP), The Public - Private Infrastructure Advisory Facility (PPIAF), The Netherlands' Ministry of Foreign Affairs, The Italian Ministry for the Environment, Land, and Sea (IMELS), and the IKEA Foundation.

Dalberg

- Dalberg Advisors is a strategic advisory firm that combines the best of private sector strategy skills and rigorous analytical capabilities with deep knowledge and networks across emerging and frontier markets. We work collaboratively across the public, private and philanthropic sectors to fuel inclusive growth and help clients achieve their goals.
- Our global perspectives are firmly rooted in local realities. We have 26 offices across the world and have served clients in more than 90 countries. By combining local knowledge and international experience, our strategies blend the best global ideas and innovations with the local practicalities and partnerships needed for effective implementation.

Acronyms & Abbreviations

- **AC:** Alternating Current
- **DC:** Direct Current
- **GLOBAL LEAP:** Global Lighting and Energy Access Partnership
- **PAYGo**: Pay-as-you-go
- **PULSE**: Productive Use Leveraging Solar Energy
- **SHF**: Smallholder Farmer
- **SIS**: Solar Irrigation System
- **SWP**: Solar Water Pump

Context and Overview

Context & Background

- **IFC's Climate Finance Program aims to support financial intermediary lending to clean and resource-efficient projects** as well as renewable energy investments & climate smart agriculture in emerging markets
- **As part of this program, the IFC seeks to develop the decision-making toolkits to improve SWP subsidy** design and implementation. This would allow the roll-out PULSE and off-grid tools in a way that benefits SHFs and generates positive market growth and development
- **This publication aims to arm policymakers and other stakeholders with a framework to help them consider the design of an appropriate end-user subsidy for solar irrigation.** IFC and Dalberg used a combination of research methods to inform this report including a literature review of prior lessons from programmes in Asia and Africa, guidelines on subsidies across sectors, and interviews with ~38 policymakers, distributors, manufacturers, farmer groups, non-profits and financiers who are active in the solar water pump industry.

Overview of the report sections

- **Executive summary** – The main insights of the study
- **Solar irrigation market in SSA** – The market overview
- **The role of SI subsidies** – How subsidies can contribute to addressing affordability of SIS, to catalyze market-led growth
- **Subsidy design framework** – Considerations when designing a subsidy
- **Subsidy design tool** – A guide to using the accompanying Excel-based design tool
- **Appendix** – Additional resources

These guidelines highlight key areas of consideration when designing a solar irrigation end-user subsidy

What this guide is

- ✓ An overview of the current solar water pump market in sub-Saharan Africa and its scalability potential
- ✓ A guide on why, where, when and how to design a SI subsidy for SHF
- ✗ A detailed guide on market projections or trends
- ✗ A guide to selection of a SIS for an individual farmer
- ✗ An exhaustive guide to all potential models for solar irrigation

See the resources section in the annex for further materials

Target groups

- ✓ **Policymakers** – To determine whether a subsidy is applicable, to support the design and assess impact
- ✓ **Manufacturers & Distributors** – To support policy engagement on the topic of end-user subsidies
- ✓ **Investors/Private financiers & Banks** – To assess the potential impact of a subsidy to support impact on farmer incomes or carbon targets

There are different steps to develop a SI end-user subsidy; and this framework is particularly relevant for certain parts of the process

DEFINE

Whether the subsidy is needed with a market assessment

- The first step is to understand if the subsidy is suitable and needed in a specific country/region
- Additionally, the objective of the subsidy needs to be defined
- A market assessment should also be considered to understand farmer ability to pay and purchasing behavior

DESIGN

The features of the subsidy

- The key features of the subsidy need to be designed, including beneficiaries, pumps, financial terms, delivery channels, payment terms, and exit plans
- The objective of the subsidy will influence the design of the subsidy (e.g., if the goal is to reduce carbon emissions, then farmers using diesel pumps should be targeted)

QUANTIFY

The costs and impact

- Based on the subsidy parameters defined, the cost (total cost, cost per farmer, etc.) and the impact of the subsidy (emissions, production, income) need to be quantified
- It is crucial to check that the projected impact is aligned with the objective defined in the first step

IMPLEMENT

The subsidy program

- The implementation phase of the subsidy includes finding the right partners, collecting the funds, and preparing the deployment processed and communication of the program
- A pilot to test the subsidy uptake and willingness to pay could be launched as part of this step before scaling the program

REFINE

The parameters based on real-life experience

- Finally, the subsidy parameters will be adjusted based on real-life experience and market evolution
- In particular, the subsidy rate will need to be adjusted based on the market reaction to the subsidy

GUIDELINES (DESIGN)

EXCEL TOOL (QUANTIFY)

Source: Dalberg analysis and interviews

Table of contents

LIGHTING GLOBAL
Catalyzing markets for modern off-grid energy
AN INNOVATION OF WORLD BANK GROUP
THE WORLD BANK IBRD • IDA
IFC International Finance Corporation

EXECUTIVE SUMMARY

SECTION ONE

Executive Summary (1/10)

CONTEXT TO SOLAR WATER PUMP SUBSIDIES

- **Solar Irrigation Systems (SIS) can increase agricultural productivity, yields and boost profits for small holder farmers (SHFs), while maximizing environmental benefits by providing efficient and sustainable access to water.** SIS are increasingly well-established globally and are beginning to make inroads in SHF segments in SSA. Evidence suggests that the use of irrigation systems can improve yield and resilience for existing crops, but the largest impact on farmer incomes occurs when irrigation enables farmers to transition to high value crops growing in shorter time periods (e.g., transition to horticulture). Irrigation can also enable the sale of crops off-season (at higher prices), increase the proportion of land owned that is cultivated, and reduce the water collection time, mostly for women. Farmers using diesel pumps benefit from a higher net income due to savings in fuel while eliminating harmful emissions.
- **SIS uptake faces a range of challenges.** To successfully take advantage of a SIS and increase their income through irrigation, farmers must have access to quality inputs, education on how to grow higher value crops, and have access to a reliable market. To be able to access a SIS, there must be a distributor they can reach, they need to be aware of the potential of a SIS, and be trained in to use it. In the industry as a whole, there is inconsistent regulation, and no standard set of quality standards. Finally, many farmers may have unreliable access to water.
- **Affordability remains one of the most significant constraints to widespread SIS uptake.** The high upfront costs of SIS technology (typically a minimum of $600+) represents a barrier for wider uptake, especially when diesel water pumps start at ~$200. Further, banks seldom have specific credit lines for solar-powered irrigation and have limited information on solar-powered irrigation for them to design adequate credit products. Many financial institutions consider solar-powered irrigation a high-risk investment, making it difficult to access loans. PAYGo models have helped address the affordability challenge, but many farmers still cannot afford these payments, and SIS PAYGo is not yet scaled either within countries or across the continent as a whole. Distributors also face a crunch in liquidity, as PAYGo models are typically financed by the distributors themselves (rather than financiers).

Executive Summary (2/10)

- **There is increasing consensus and interest from policymakers, donors and distributors in exploring demand-side subsidies as part of a wider basket of interventions.** Supply side subsidies to innovators (e.g. capital subsidies or grants/RBFs) are already established. Governments have provided tax breaks for solar irrigation products. A demand side subsidy (e.g., “end-user subsidy”) mainly works to reduce the high up-front costs for SIS, that has been the biggest barrier to adoption by farmers. Globally, SIS end-user subsidies have been shown to catalyse uptake. In India, for example, farmer adoption for SIS has been rapid, growing by over 3,000% between 2012 and 2019. Recent experience from SSA is also promising. Rwanda and Togo have government-subsidized irrigation programs in place for 50% of the cost of a pump. However, the scale of those programs remains small for solar products. In Rwanda ~470 farmers access the scheme annually, and since 2014, just 925ha has been covered by solar irrigation (average subsidy of $1000/farmer). A much larger number purchases other forms of irrigation equipment. In Togo they aim to have sold 5000 solar pumps with the subsidy by the end of 2021.
- **A series of conditions are combining to make SIS end-user subsidies more feasible.** Mobile money allows subsidies to be paid immediately to farmer or distributor, and on an ongoing basis as the pump is used. Remote monitoring of pumps allows for live verification. RBF models have been shown to be a high-potential model for smart subsidies. Investors and financial institutions are seeing the potential of financing these assets (e.g., through tools such as the UNDP Climate Aggregation Platform; or through local banks providing finance to farmer SACCOs for productive assets, such as SIS). Universal quality standards for SIS are in progress, which will allow the deployment of subsidies promoting reliable products that will not damage customer perceptions of SIS. The Global LEAP Awards Solar Water Pump Competition, which tested over 30 pumps in 2019, represented an important first step toward benchmarking quality and energy performance. Higher current and future global oil prices (up to $74/b from a low of ~$24/b) also means the benefit of switching away from diesel and/or petrol-based irrigation pumps is higher.

Executive Summary (3/10)

- **Deploying end-user subsidies comes with significant risks, and must only be considered in combination with other interventions to catalyze the market.** SIS requires water availability, knowledge, market linkages, proper water management and crop rotation to ensure a financially viable business model. Therefore, a set of market conditions are needed before launching a SI subsidy to ensure that farmers will benefit from the use of the pump. Some of the interventions required to enable the market development include tax exemptions, consumer protection through quality standards, consumer awareness programs, capacity building, access to market, agronomic support, water management programs, financing for the SIS, and financial & technical support for distributors.
- **Designing an end-user subsidy should be conducted with care; with these guidelines, the IFC seeks to support policymakers' development process, with a design framework and associated Subsidy Design Tool.** The process end to end includes steps such as assessing suitability, design of the programme, costing, implementation, and adjusting subsidy parameters based on real-life experience. The tools developed (i.e. the guidelines and design tool) are particularly relevant for the program design phase, as well as to quantify cost and impact. The tools should aide the design and implementation of SI subsidies in a way that benefits SHFs and generates positive market growth and development. Extensive country-specific consultations are needed to design an end-user subsidy; these guidelines aim to provide a set of considerations for programme design, but not replace a detailed country-specific assessment.

Executive Summary (4/10)

KEY FINDINGS & FRAMEWORKS FOR CONSIDERATION

- **Market distortion is likely to be minimized in countries that have certain pre-conditions.** Careful consideration is required of the market suitability, before launching a subsidy; as well as ensuring there is a stated aim of catalyzing the market for private sector actors. The priority should be upon countries where there is the greatest likelihood of success (feasibility plus potential for impact/need) – And these guidelines focus on those countries. End-user subsides *could* be deployed elsewhere, but other (e.g., supply-side) interventions should be considered first; and in this case there is a greater risk of dissuading private sector investment.
- **This paper categories suitable countries as those with 'high feasibility' and 'high potential impact'; in practice a detailed country-specific assessment would be required.** Countries with "high feasibility" would typically have a) existing distributors in place who could invest in selling SIS and have capabilities to deliver good after-sales service b) be relatively straightforward to do business; c) have low(er) levels of diesel subsidies, and where solar irrigation is aligned with government priorities. Countries with high potential for impact/need are those where there is a large potential pool of farmers who could benefit from a SIS; characterized by a) a high percentage of the population working on agriculture, b) the rural population has low electricity access rates c) there is water availability, and d) there is evidence that low-income farmers are willing to invest in SIS (i.e., a significant number of farmers above the subsistence income level)
- **This paper proposes a set of criteria that should be considered during SI subsidy design.** In practice, there is no 'one size fits all', and these will need to be tailored to local requirements.

Executive Summary (5/10)

WHO TO INCLUDE?

- **Beneficiaries – SHFs are best placed to receive and drive value from subsidies, especially if market linkages are also present.** This is because (i) They can partially afford SIS (especially through consumer financing models), and (ii) They are most likely to reap the benefits of additional productivity and income from better irrigation, than subsistence farmers. Farmers can either afford these pumps through future increased income ("Unstructured" farmers having greater yield on existing crops and starting to grow higher value crops); or through diverting existing spend on diesel/petrol pumps ("Multi crop" and "Horticulture" segments). The Togo program shows there is high willingness to pay when there is ability to do so ($15/month subsidized payment on an average $56/month income). These guidelines are focused on the purchase decision that an individual farmer may make (the "farmer ownership model"). In practice there are many hyper-localized models for accessing irrigation, such as community ownership or paying for irrigation as a service, that are outside the scope of this report.
- **Targeting – Targeting to specific farmer criteria is hard and complex to achieve.** Universal subsidies have certain inefficiencies built in, but are more straightforward to manage in the long term. Most existing irrigation subsidies are universal, with some geographic targeting through 'top up' of the subsidy by local govt. authorities (e.g., in Rwanda, India). Trying to target 'poorer' farmers (e.g., size of farm, income level, crop type) is difficult and open to manipulation and leakages. **"Smart" ways to target are emerging and have the potential to be more efficient** (GPS-based geographic, community-based, indicator-based, or pump-size based). In general, there is a connection between pump profile and farm size – Which can then be the basis of smart targeting (i.e. a higher subsidy percentage is applied to lower-sized pumps). Other ways to do targeting are dependent on data availability.

Executive Summary (6/10)

WHICH EQUIPMENT?

- **Pump profile – Pumps must meet standards for quality and after-sales service, to be selected for subsidy.** Apart from the size, certain features such as the type of pump (submersible vs surface), the motor, the flow rate, and the water head define the pump profile. There is a high risk of damaging consumer confidence if low quality pumps are sold. In addition, there must be an aftersales support network in place for repair and maintenance, which is not guaranteed with all pumps. Pumps must meet certain quality standards (e.g., the work in progress CLASP/VeraSol standard) to protect consumers. These standards include might include 'technical components' (e.g., durability, system quality, health & safety) and 'soft components' such as truth advertising, customer information and guarantees. The specific requirements of the pump profile should be set in partnership with local farmer groups and distributors, to account for local agronomic conditions and needs.

Executive Summary (7/10)

HOW TO PRICE?

- **Pricing – There are two approaches to subsidy pricing; either set by implementer, or bidding by distributors. Either way, subsidy pricing depends on the maturity of the market and should evolve as the market matures.** It is administratively easier if the implementer sets the subsidy rate consistently for all distributors. In a nascent market with few competitors, this is a standard, easily understood subsidy that is most likely to change investment behavior. The implementer (e.g., the government) can offer a certain percentage of subsidy based on their own approximations of ability to pay. The level of the subsidy should also be reduced over time, with adequate notice, to avoid a price shock when the subsidy scheme closes. Alternatively, a reverse auction allows distributors to make 'bids' for the price point or level of sales they could achieve with a given level of subsidy – And the most efficient 'bids' are granted the subsidy. However, this can also appear opaque to other actors and could lead to favoritism of a narrow set of larger suppliers. The key principle is that subsidy pricing should reflect beneficiary ability to pay, and allow the maximum number of farmers to purchase who couldn't previously afford to do so.
- **Financial component – Supporting farmer financing models (i.e., PAYGo or repayment of a loan) are essential to solve the affordability challenge.** Smallholders who can afford to purchase the pump fully upfront often already have other sources of income (e.g., a white-collar job). Crucially, shifting to monthly repayments can make the pump more affordable, as farmers benefit from a higher income once the pump is installed (and thus can afford the repayments). Farmers are often reluctant to take a loan if they are new to irrigation (and cannot be certain of the benefits); in these cases, a PAYGo model is likely to be more suitable. There are some limited but emerging examples of traditional finance covering the loan books of distributors: in Kenya, two major banks have signed an MoU with a distributor whereby the banks will lend into a SACCO, for the purposes of farm assets (including SIS). In this group-based financing model, farmers serve as guarantee to each other, so repayment rates are high – But a SIS is a more expensive asset then is usually financed. Secondly, another SIS distributor reported some banks were providing finance directly for SIS (and using a SIS as collateral), but not yet for the smallholder category of pumps.

Executive Summary (8/10)

HOW TO DELIVER?

- **Delivery Channel – End user subsidies could be administered directly to the beneficiary, or through suppliers. As long as market preconditions are met (e.g., existing commercial interest), routing through suppliers could be more catalytic.** Farmers often require support to access the subsidy (e.g., education on the benefits, usage, as well as how to apply for the subsidy); and distributors are well placed to provide such support. To deliver through distributors, this should be on a 'result-based financing' basis, through clear post-sales verification of the SIS being used. This could be complemented with supply-side RBFs to support distributors to perform market development activities such as awareness and training. In a mature market with a high level of awareness and choice, a farmer voucher scheme could also work effectively.
- **Distributor Selection – A curated set of high-performing distributors should be chosen through a competitive process**. All potential distributors can apply to be empaneled, with the option of future onboarding for those that did not make the initial cut (e.g., Ignite, the largest SIS distributor in Rwanda's scheme, needed support to be onboarded). If a company does not specialize in all aspects of the distribution value chain, it could partner with others. Distributors will be assessed for credit worthiness, quality of products, data sharing capabilities, and business model robustness. Then, the curated set of distributors will be supported in their use of the scheme. Ideally, these distributors should also be provided with working capital financing to support their growth (e.g. Angaza, which enables PAYGo tech, has its own 'distributor financing fund' for this purpose). The process of approving these distributors must be simple and transparent, with clear accountability and a grievance redress mechanism.
- **Subsidy disbursement – A mix of prefinance, point of sale payment & post verification payment will allow distributors to have sufficient liquidity to invest in stock, as well as incentivize after-sales service**. Usually, a combination of the three payment timings is needed. At each stage, the subsidy disbursement should be linked to performance indicators to mitigate deployment risks. The optimal mix will depend on the liquidity needs, and the quality of after-sales support of the curated set of distributors, the cost of verification and the perceived fraud risk by implementors (for example, in the SHS subsidy in Rwanda, verification on a sample of customers takes place before each disbursement). Additionally, when the subsidy is designed, it should be linked to fixed timelines that are communicated clearly to manage

Executive Summary (9/10)

- **Subsidy disbursement – A mix of prefinance, point of sale payment & post verification payment will allow distributors to have sufficient liquidity to invest in stock, as well as incentivize after-sales service**. Usually, a combination of the three payment timings is needed. At each stage, the subsidy disbursement should be linked to performance indicators to mitigate deployment risks. The optimal mix will depend on the liquidity needs, and the quality of after-sales support of the curated set of distributors, the cost of verification and the perceived fraud risk by implementors (for example, in the SHS subsidy in Rwanda, verification on a sample of customers takes place before each disbursement). Additionally, when the subsidy is designed, it should be linked to fixed timelines that are communicated clearly to manage distributors and beneficiaries' expectations. When a PAYGo system is supported, providing subsidy on a month-by-month basis aligns the incentives of the distributor to ensure the system is serviced and functional. The critical aspect of the disbursement schedule is that the approach is clear (verifiable), fully understood and agreed upon, and consistent (payments are provided when they are supposed to). This allows the distributor to manage its cash flows and build its business plan to fit to these payments.
- **Support Programs – End user subsidies can only be a component of the overall package to catalyze the market.** Supply side financial support (e.g., working capital financing), technical assistance and market development activities are also required. These support programs are key enablers for the subsidy to be a success. An awareness campaign could grow the market for all distributors – E.g. Uganda's micro irrigation subsidy invested $1.5m in awareness creation before disbursing any SWP. Capacity building is required at all levels, and could be as a public good where possible – E.g., training on horticulture through farmer groups can reduce costs that might've otherwise been duplicated by multiple distributors. An off-taker program supports farmer income improvement. Favorable regulations (e.g., tax exemptions) will avoid the subsidy being absorbed by increased import costs. Ongoing water access initiatives will grow the potential market size, alongside initiatives on sustainable water management and borehole drilling campaigns.

Executive Summary (10/10)

- **Monitoring and evaluation of the subsidy is crucial to identify when the market is sufficiently mature to adjust the subsidy, alongside identifying any negative market behaviour.** A tracking tool should be used to help policymakers to identify early warning signs when the subsidy is not being well implemented. Some of the key metrics to monitor include budget spent; units sold, installed & running; beneficiaries per segment, increase in production & income per farmer, reductions in CO_2, changes in diesel pump prices & units sold, and gender & social inclusion impact. Given the nascent nature of SI subsidies, tight monitoring (quantitative and qualitative) should take precedence over 'evaluation', and the programme must be able to pivot as necessary to accommodate market dynamics. Close, collaborative stakeholder engagement throughout the monitoring process will help any project issues to come to light (and be adjusted) even before issues become apparent in the data.
- **There are also potentially significant risks to consider, on market distortion, water access, and effective implementation.** A short-term subsidy can create distortive customer behavior (e.g., set non-sustainably low prices in the market; reduce incentives to control cost base; encourage arbitrage across regions eligible). Any implementer should expect that farmers will act in their own interests to maximize their benefit from the subsidy – There are many examples of subsidies being applied incorrectly, e.g., to already-sold (and installed) pumps, or multiple subsidies being applied to the same pump. SIS expansion could lead to over-extraction of groundwater at zero marginal cost, reducing water tables and increasing subsistence. Anecdotal evidence from interviews suggests this is not a major issue (at present) – With appropriate farmer education, SHF apply the right amount of water for their own crops, and SIS are a small proportion of overall water use. For implementation, any programme with a public body as an anchor partner can be subject to political cycles, budgetary pressures, and local influence. A partnership between international funders, private donors and the public sector will be best suited to balance accountability to the public purse and to the farmer.

SOLAR IRRIGATION MARKET IN SUB-SAHARAN AFRICA

SECTION TWO

Water pumps enable farmers to access the most reliable and labor-saving irrigation methods

Water supplied by a water pump

DRIP

- Rubber or plastic pipes with small holes are placed to align with the base of the plants, to drip feed water. Specialist pipe is better; SHF often use locally available hosepipe instead
- Pros- Highly water efficient (so lower flow & lower cost pump can be used)
- Cons – Difficult and expensive to adjust the dripline spacing (e.g., if a different crops is grown.) Pipe can block.

"Proper drip pipe can cost $60 per [smallholder] farm – Many farmers buy local hosepipe instead as and when they need it" – SIS distributor

SPRINKLERS

- Sprinklers are attached to sections of hose pipe with connectors; water is supplied by a water pump
- Pros – Easy to set up and use, not labor intensive; can cover a large area. Some crops prefer overhead irrigation (rather than drip)
- Cons – Less water-efficient than drip (typically requires 2x the volume of water)

"When you have water in abundance, people use sprinklers" – SIS distributor

MIST

- Mist irrigation works by spraying a fine 'mist' of water onto the crops. It is similar in a way to drip, in that water is put through small holes or nozzles but at a higher pressure
- Pros – It allows to water quicker and a wider area. Some crops prefer overhead irrigation
- Cons – Less efficient than drip

"Once the farmer cultivates a few acres, manual irrigation can be very time consuming" – SIS distributor

FURROW OR FLOOD

- The soil is flooded around the plants, typically using furrows (troughs) between raised ridges where the plants grow
- Pros – Little education/knowledge required; no additional expensive equipment
- Cons – Manual effort of digging the furrows; if over watered roots can rot. Also the least water efficient of all methods.

"Our SHF pump can do the job of two people full-time watering" – SIS manufacturer

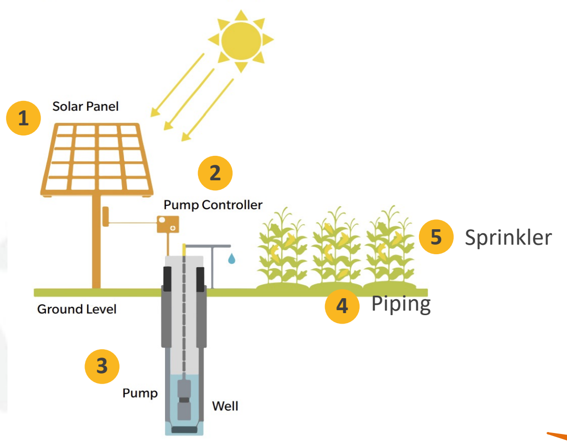
MANUAL

- Manual irrigation happens when the farmer moves water from plant to plant. This is very labor and time intensive and is usually done with a hose or bucket (hand or hip pumps also available)
- Pros – Cheapest option with easy access
- Cons – It is labor intensive, time consuming, not suitable for large areas and less efficient

Note: The cost is additional to the solar irrigation system (that included pump, panel, controller and pipe)
Source: Dalberg analysis, Interviews, FuturePump materials, Grekkon & D&S benchmarks for prices

A SIS typically comprises a panel, pump, pump controller, and piping/sprinkler; they can be deployed above or below the water surface

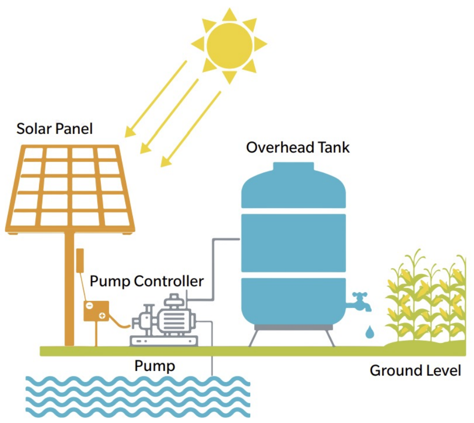
Submersible water pump



- **Submersible pumps work in wells and boreholes at depths at and above 100 meters**, require more horsepower and larger solar installations, and tend to be more expensive
- **They are more prevalent in areas where more water is needed** or where water is only available at greater depths
- **More cost-effective micro-submersible pumps use similar technology** at less depth and can lift to ~20-65 meters

"Those pumping from a Well can start with a solar pump – We're seeing that become the default"
– *Kenya SIS distributor*

Surface water pump



- **By contrast, surface pumps are installed next to a water source** such as a lake or stream and can pump from a maximum depth of ~5-10 meters
- **Micro-submersible and surface pumps are more prevalent on smallholder farms** due to their lower cost and easy installation

"Those with surface water on their farm will almost always first start irrigating with an engine (petrol/diesel) pump, before they consider solar"
– *Kenya SIS distributor*

Source: CLASP, FuturePump, Dalberg Analysis

A range of factors determine a farmer's SIS choice; size of pump, which is closely linked to price, is typically a main decision point

	Definition	
Motor	• **AC/DC**: Water pumps are driven by electrical motors on alternating (AC) on direct (DC) current. AC pumps require an inverter to convert the solar power to the motor; whereas DC motors are typically less powerful but can avoid the cost of an inverter. • **Horsepower:** In Asia pump size is typically measured by horsepower (e.g., 2 or 5hp); in SSA flow rate or water head is commonly used instead (smallholder pumps can be <0.25 hp)	**The "pump"** ($600-$1000)
Water performance	• **Flow rate**: The flow rate for a SWP is typically slower than a diesel pump; although SWP tend to have better pumping height	
Pump performance	• **Water head**: Positive displacement pumps are suitable for lower flow rates and medium to high pumping heads (30–250 m), whereas centrifugal pumps are suitable for high flow rates and lower pumping heads (10–120 m)	**The "kit"** ($150-200) *Often sold combined with the pump; may either be pre-wired or require local installation*
Water output	• **Sprinkler/Drip**: A broad set of potential water distribution methods are possible; the pump choice should match to the required output method	
Solar input	• **PV panel:** The solar photovoltaic (PV) cell directly converts solar radiation into electric current. • **Controller:** The solar pump controller controls the circulating pump to harvest as much heat as possible from the solar panels, and it also protects the system from overheating	

There is no 'one size fits all' with SIS selection; direct comparisons to assess the most suitable pump for a farmer depend on very local conditions and may require an in-field assessment

Source: Dalberg Analysis

SIS have the potential to increase SHFs' productivity and income, while maximizing environmental benefits

BENEFITS OF IRRIGATION

For farmers starting to irrigate

1. **Yield increase –** In SSA, studies found that irrigation could boost maize yields by 141–195%, and high value crops up to 300% per year[1]
2. **Price increase** – SIS allow farmers to adjust growing cycles, in some cases enabling them to harvest at off-peak times of year when prices are higher; or to grow on pre-set schedules as required by commercial buyers
3. **Ability to sell higher value crops –** SIS technology allows farmers to plant more diverse crops (including high value crops) and can increase the number of planting seasons (typically up to three a year), thereby diversifying revenue streams
4. **Improve resilience –** 25% of all economic damage caused by climate related disasters is linked to agriculture, and drought causes 84%of that damage. SIS enable farmers to offset some of the risks of low or unpredictable rainfall with an additional water source[1]
5. **Reduce water collection time –** Women are more likely to be responsible for water collection. Solar water pumps can provide savings of effort, especially if they are used not just for agricultural purposes but also as a water source for the household, as is commonly the case

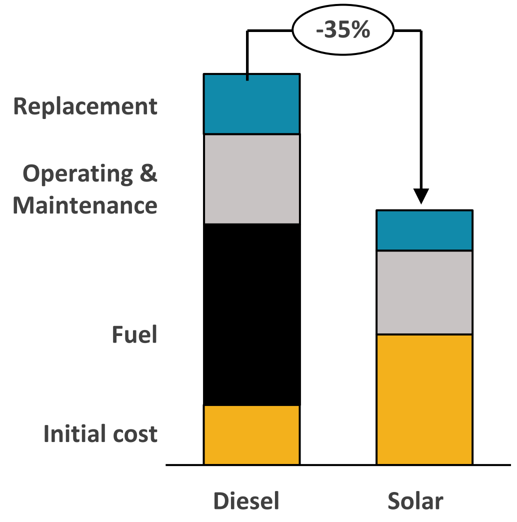
"I haven't seen any solutions that create more stable, higher incomes for farmers than solar irrigation today"
– SIS distributor

BENEFITS OF SOLAR IRRIGATION

For farmers converting from fuel pumps

1. **Cost savings** – Farmers switching to solar water pumps from a diesel pump save on ongoing fuel costs. Those using a small solar water pump report saving USD 268 per acre per year[1] after the switch to solar irrigation
2. **Longer lifetime of pump** – SWPs in general have a lifetime of 10+ years, whereas diesel pumps last 5 years[1]

While the initial cost of a typical solar water pump system is higher than that of a diesel pump, when accounting for fuel costs, and longer lifetime value the solar water pump costs 35% less over a pump lifecycle[1]



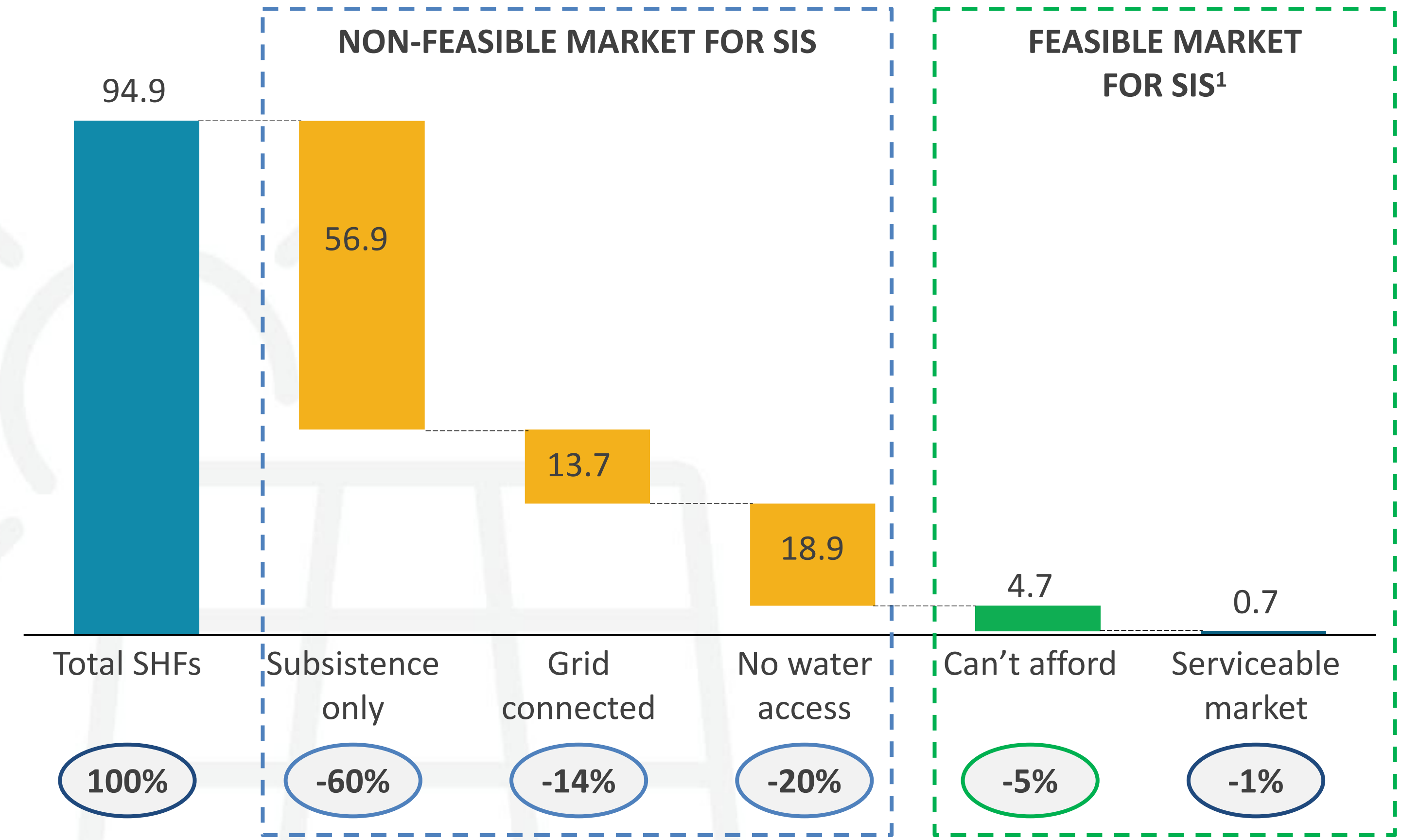
Benefits for donors and governments committed to achieve the SDGs

- **SDG2: "Zero Hunger"** – Irrigation plays a key role in improving the resilience of farmers, guaranteeing food security in dry seasons
- **SDG13: "Climate Action" –** By encouraging farmers to convert from fuel to solar energy, SIS also play a key role in reducing carbon emissions

Sources: (1) Efficiency for access, 'Solar Water Pump Outlook', 2019, Dalberg Analysis

SIS could be feasible for ~5.4 million farmers in SSA, of which about 90% are unserviceable today because of affordability

Total SSA serviceable market breakdown (2018) – MM SHF Households



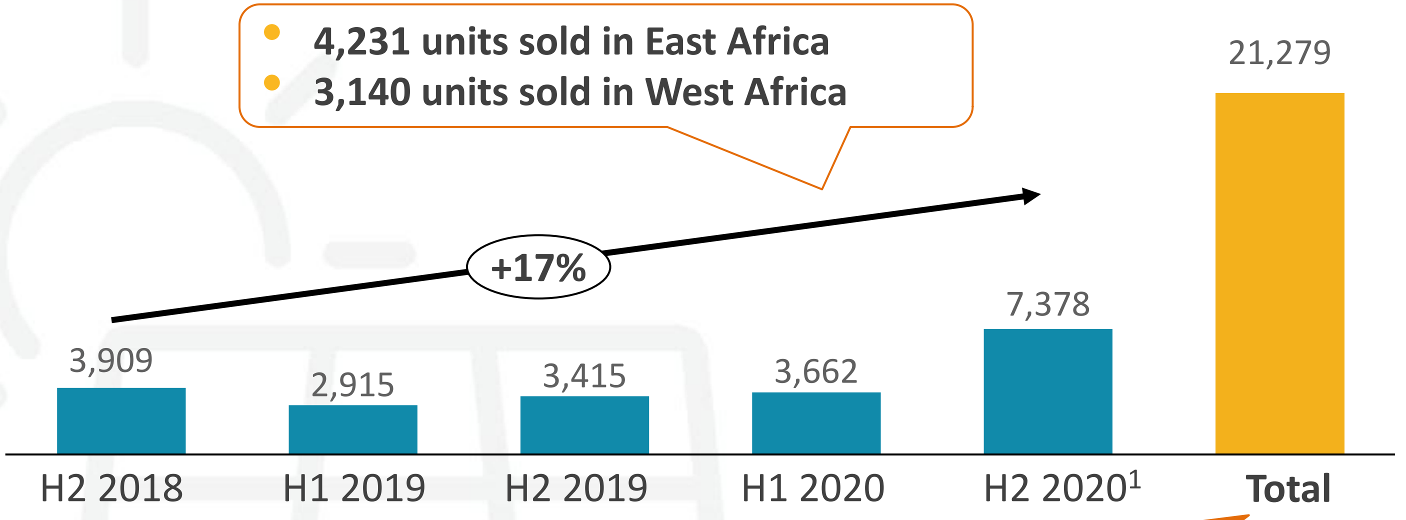
- The current serviceable market in SSA only contains **701,000 farmer households**
- However, if affordability could be addressed, the **total serviceable market** would rise to **5.4 million farmer** households
- Therefore, the **serviceable market could increase five times by introducing initiatives to boost affordability** and consumer financing for SIS

Source: Efficiency for access, 'Solar Water Pump Outlook', 2019
Notes: (1) Potential market when addressing affordability constraints & incentives to substitute diesel pumps

Current SIS penetration in SSA is approximately 3% of the total serviceable market, highlighting a nascent industry

Solar water pumps – Units sold in SSA

Figures are based on self-reporting from a limited number of vendors and are likely to be an underestimate



"Only 4% of farmers irrigate in Africa and only 15% of our farmers previously had a diesel or petrol pump"

– SIS distributor

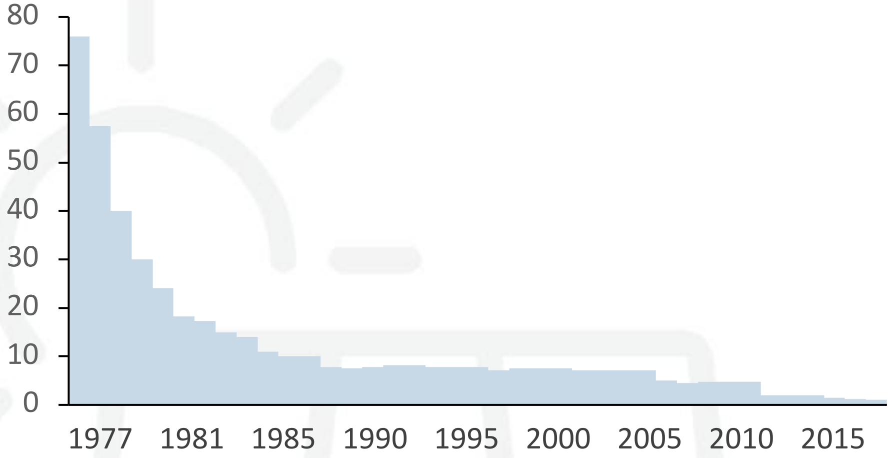
- **Accumulated sales are only 3% of the serviceable market**; affordability, alongside access, education and financing are key constraints
- **PAYGo is a potential solution for this barrier** since it brings the upfront cost down. **PAYGo sales represent the largest number of SIS** sales based on available data, although many cash sales are underreported
- **80% of SIS reported in 2020 were sold together with the power system kit** (i.e. solar panel and associated parts), and this larger investment may require consumer financing

Source: Lighting Global & GOGLA, 'Global Off-Grid Solar Market Trends Report', 2020; 60 Decibels, "Uses & Impact of SWPs", 2021; Dalberg Analysis,
Note: (1)The increase in total sales in H2 2020 may be driven by the improvements in reporting. (2) According to a recent report from 60decibels, the main factor that affects the purchase of irrigation technology is the cost and affordability

Changing market fundamentals suggest that component costs will fall and incomes/awareness will rise, causing greater SIS demand…

On cost

PV panel cost is reducing over time ($/watt)[1]



Increase in **number of manufacturers and suppliers**

On demand

- **Products are improving** over time motivated by the quality and energy performance benchmarking efforts (e.g., The Global LEAP Awards Solar Water Pump Competition). However, equipment malfunction and technical issues remain to be the main challenges customers face, according to 60 Decibels consumer research.[2]
- **Governments are making efforts to encourage the switch** (to avoid expensive fuel subsidies & to reduce emissions)
  - CIZO scheme in Togo
  - Solar Irrigation in Rwanda (SIR) program
  - The Kenya Off-Grid Solar Access Project (KOSAP)
  - Off-Grid Market Development Fund (OMDF) subsidy for solar power companies in Madagascar
  - Micro-Scale Irrigation Program in Uganda
- **Increased awareness of SIS**
  - The presence of government programs is helping to raise awareness of solar irrigation systems
  - Greater variability in climate conditions mean irrigation is of greater importance to farmers
  - Growth of solar home systems is also supporting growth in productive use: in East Africa, 64% of solar water pump customers owned a solar lighting product before purchasing a solar water pump

Sources: (1) World Bank, 'Solar Pumping: The Basics', 2018; (2) 60 Decibels, 'Use and Benefits of SWPs', 2019; Dalberg Analysis
Notes: (2) According to the research, 55% of customers with challenges reported technical issues

..but critical industry barriers must be addressed to allow the market to scale

Main barriers for SIS uptake

- Farmers must have access to water through e.g., a dam, water pan or river. Digging boreholes/wells can be very expensive if not already available
- There is a lack of awareness of the existence of the products themselves, how to use them, the benefits and the availability of financing options, such as PAYGo
- In some rural regions, there is no presence of SIS distributors, and farmers don't have access to purchase the product; as well as few repair/maintenance options

Source: (1) 60 Decibels, 'Use and Benefits of SWPs', 2019; Dalberg Analysis

..but critical industry barriers must be addressed to allow the market to scale (cont'd)

Main barriers for SIS uptake

- Before installing the pump, famers often do not have the ability to pay for the total SIS upfront cost
- This leads to working capital requirements and can be prohibitive for distributors to sell SIS, thus reducing their presence and reach
- For example, a One Acre Fund study assessed that their SHF could pay a maximum of $300; yet there are no SIS at that price point

- SIS technology has been improving in the past few years. However, the top-cited challenge among SIS customers is equipment malfunction
- These challenges could be due to early stages of product development, mismatched customer expectations, lack of after-sales support and customer misuse[1]

- There are few examples of banks offering loans to SHFs directly for the purposes of purchasing SIS, using the SIS as collateral. As such distributors end up financing on their own balance sheets

"Pumps were quite an affordable product and now are close to being a luxury product because of the increase in taxes in Kenya."
– Distributor

- Regulations such as VAT on solar products and duty on imports, will directly affect the price of the SIS. For example, in 2020 Kenya removed the tax exemptions on solar products producing a consequent price increase
- The application of regulation is also a challenge – Rules can be applied inconsistently and waiver approvals can be difficult to achieve

Source: (1) 60 Decibels, 'Use and Benefits of SWPs', 2019; Dalberg Analysis

LIGHTING GLOBAL
Catalyzing markets for modern off-grid energy

AN INNOVATION OF WORLD BANK GROUP
THE WORLD BANK IBRD • IDA
IFC International Finance Corporation

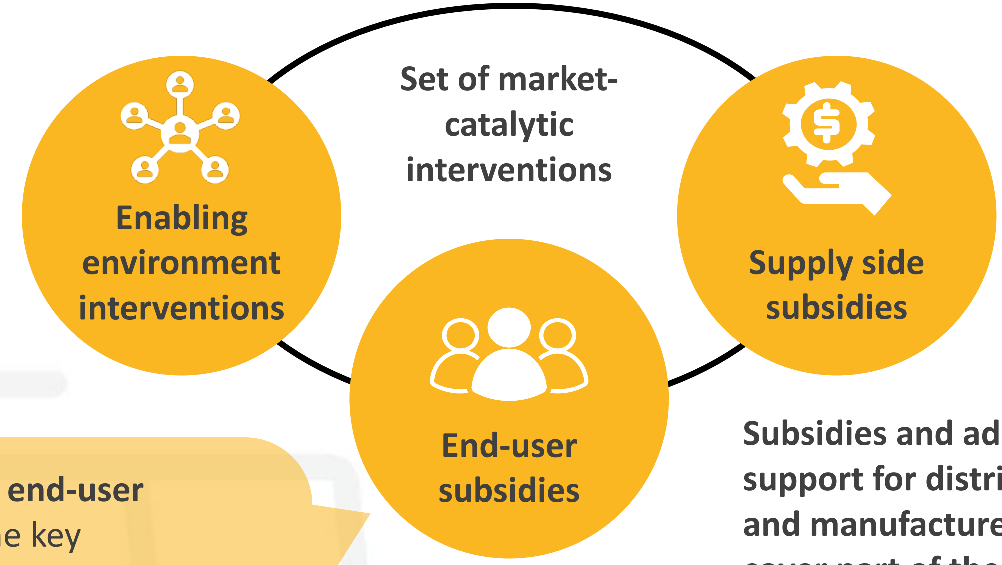
THE ROLE OF SI SUBSIDIES

SECTION THREE

These guidelines focus on the tradeoffs that should be considered when designing an end-user subsidy

Intervention areas to address affordability of SIS

Interventions that enable the market development



This study **focuses on end-user subsidies** as one of the key interventions to unlock the market potential. However, end-user subsidy in its own is not enough, and **a combination of the three interventions is needed to develop the market**.

Subsidies and additional support for distributors and manufacturers to cover part of the market entry costs

"The discussion doesn't start with subsidies – We are yet to determine if this is the most efficient use of funding to achieve these outcomes"

– SIS distributor

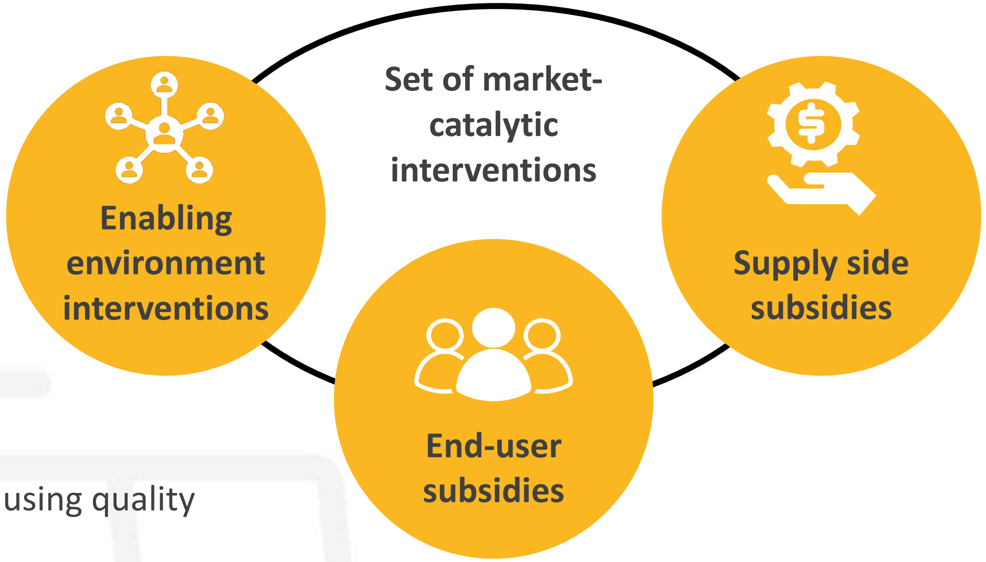
End-user results-based financing, other subsidies paid through companies, direct-to-consumer subsidies via cash or voucher

- End-user subsidy schemes provide a clear way to **address the affordability challenge** for poorer households
- It is critical they are **market catalytic** – Aimed at bringing in buyers who are nearly but not quite able to afford the product
- In time, **creating a larger market for the products should promote competition**, reduce costs and ultimately remove the need for subsidy

Source: GOGLA, "Discussion Paper: How End-User Subsidies Can Help Achieve Universal Energy Access", 2021, Dalberg Analysis

However, they need to be considered alongside supply-side subsides and enabling ecosystem interventions, which may often come first

Intervention areas to address affordability of SIS



Interventions that enable the market development

1. Tax exemptions
2. Consumer protection using quality standards
3. Consumer awareness programs
4. Capacity building
5. Access to market/Offtaker support
6. Agronomic support
7. Water management programs
8. Third party financing

Subsidies and additional support for distributors

1. Grants
2. Financing facilities
3. Supply side results-based financing (RBF)

> "When VAT was removed, we were able to reduce price by 26%, which increased our addressable market by 100%"
> – SIS distributor

Source: GOGLA, "Discussion Paper: How End-User Subsidies Can Help Achieve Universal Energy Access", 2021, Dalberg Analysis

Subsidies have shown some success in catalysing solar products; SI subsides have been limited to date

Examples of subsidy programmes in Africa

Uganda

- **End-user** subsidy for SIS
- The government paid between **25% and 75% of farmers' irrigation equipment**, including solar pumps, sprinklers and drip systems
- Part of the **Micro-scale Irrigation Program** supported by World Bank

Togo

- **End-user** subsidy for SIS
- **5,000** beneficiaries and **50%** subsidy
- **Tax exemptions** on import duties and VAT on water pumps
- **Pay-as-you-go** (PAYG) model
- Partners include **Bboxx, EDF Togo and SunCulture**

Madagascar

- **Supply-side** subsidy for SIS
- **12 companies** will collectively receive US$2.5 million upfront
- **Results-based financing incentivizes solar distributors to test models to improve affordability for customers**, like PAYGo and equipment rentals
- The main partner is the **World Bank**

Rwanda

- **End-user** subsidy for SIS
- **1,450** beneficiaries and **50-70%** subsidy
- The affordability challenge was met with a **mix of subsidies and loans**
- The **loan component had low uptake**[2], only about 3% of the farmers supported through loans (although more were supported using a PAYGo model)
- The main partner is **Energy for Access**

Source: Energy for impact, "Solar Irrigation Rwanda", 2021; ESI Africa, "Partnership cultivated to deliver solar-powered farming in Togo", 2020; GSMA, "Smart subsidies and digital innovation: Lessons from Togo's off-grid solar subsidy scheme", 2021; Dalberg Analysis

A series of conditions are combining to make SI subsidies more feasible to administer and execute

Policies are promoting renewable energy
Donor governments are incentivizing the uptake of renewable energy by removing taxes for solar products (e.g., Senegal) or shifting subsidies for diesel towards renewable energy

Mobile money allows subsidies to be paid immediately to farmer or distributor, and on an ongoing basis as the pump is used. Customers make a payment through mobile money, the mobile operator checks if the customer qualifies for the subsidy, and then tops up the customer's payment with the subsidy. This model has its limitations, since the Telco becomes a project implementor in addition to a payment facilitator – Which they not be suited for.

Remote monitoring allows for live verification
It allows the implementer to verify that the SIS is installed and working before paying the subsidy to the distributor. GPS technology can be used for verification purposes. However, physical verification may be required in many countries since this is not only about if the system works but also the water flow & management

Results Based Finance models are now shown to be a high-potential model for smart subsidies
Alternative price setting mechanisms can also be used to assess the level of subsidy. E.g. a reverse auction could be used to allocate funds via RBF where suppliers bid for levels of support

Source: Dalberg Analysis

A series of conditions are combining to make SI subsidies more feasible to administer and execute

Investors and financial institutions are seeing the potential of financing these assets
For example, through tools such as the UNDP Climate Aggregation Platform or through local banks providing finance to farmer SACCOs for productive assets, such as SIS

Universal quality standards for SIS are in progress
Although the SIS market is one of the most nascent PULSE markets, and there is a great deal of innovation in progress, quality standards are being developed to act as a benchmark. It is essential to ensure subsidies promote quality, reliable products to avoid damaging perceptions of SIS

Higher current and future global oil prices (Up to $74/b from a low of ~$24/b)
With some movement away from fuel subsidies and increasing global oil prices, the benefit of switching away from diesel/petrol-based irrigation pumps will continue to rise

Increasing focus on climate smart agriculture
The increasing focus on CSA and reducing the carbon footprint from donors, governments and international organizations have also facilitated the mindset shift and the promotion of SIS

Source: Dalberg Analysis

However, SI subsidies may be premature or unfit for some contexts

What are issues to be addressed prior to subsidy launch?

Markets with low quality & durability of SIS, and poor after-sales services might not be ready to launch initiatives to promote SIS. For example, in SSA, 34% of customers had experienced challenges with SIS, and 42% had not had their challenge resolved[1]. Unresolved challenges can encourage negative word-of-mouth and detract from positive impact. Therefore, companies should prioritize resolving customer issues, such as:

1. **Faulty technology –** There is something wrong with the product. This is best addressed through discussions with manufacturing
2. **Mismatched expectations –** The customer says the product/service isn't working because they expected it to work differently, but it is working as intended. A review of marketing materials or sales pitches may be useful here
3. **Misuse –** The customer isn't using the product properly, often not deliberately. Installation guidance or training may help reduce these issues

When should a subsidy not be launched?

Markets with water scarcity might be inappropriate to implement SI subsidies. Therefore, a careful assessment of water availability and the potential negative impact of the subsidy on the water table should be done before designing the subsidy. In those cases, a more centralized solution than a farmer-ownership subsidy could increase the government capability to control and track water management.

Markets that have very low penetration of SIS (e.g., without existing private sector actors) would benefit first from other approaches. Consumer awareness/farmer education, financing of SIS, and a supportive enabling/regulatory environment should already be in place.

Source: (1) 60 Decibels, "Uses & Impact of SWPs", 2021; Dalberg Analysis

SUBSIDY DESIGN FRAMEWORK

SECTION FOUR

When is a subsidy appropriate?

To be most catalytic, end-user subsidies are best applied in countries that have a high need and a baseline level of feasibility

Sub-Saharan African Countries

- Better candidates are those countries where a subsidy is at least likely to be **feasible** (not necessarily easy) **and have some potential for impact[1] (the green box)**
- There is a checklist to assess whether the country has a high level of feasibility and need **(on the following slide)**

Source: Dalberg analysis and interviews

Eight criteria provide an indication on suitability; but a detailed market assessment is needed before a SI subsidy is deployed

Strong potential and feasibility

Feasibility

- **Presence of distributors –** Countries with a low density of distributors might not have the minimum level of demand and supply to launch a subsidy
- **Relatively high level of "ease of doing business" –** Countries with adverse conditions (macroeconomic crisis, corruption, civil conflicts) might not attract investment or have access to finance
- **Low level of diesel subsidies –** In countries with high fuel subsidies, there may be little incentive to switch away from diesel pumps
- **Alignment with government priorities –** Commitment to increasing farmer productivity and supporting clean energy and climate smart agriculture/"resilient agriculture" (as shown by supportive govt. policies)
- **Access to finance –** The presence of banks with a history of lending to SHFs is needed to offer financing to farmers based on their credit scoring
- **Presence of aggregators –** If there is a lack of off-takers, it will make it difficult for the farmers to obtain a return on investment from the SWP since they can not sell the extra produce

Impact

- **High percentage of agriculture employment –** Low agriculture employment rates mean that a large part of the population could not benefit from the subsidy
- **High percentage of unelectrified population –** If most rural communities have access to electricity, they may already have the means to run the water pumps without the need for solar
- **Water availability –** In arid areas with no small reservoirs or groundwater availability, there are limited water sources to pump the water from
- **Low-income farmers willing to invest –** A cadre of farmers is needed who are active market players, and willing to invest in increasing output. If most farmers are pure subsistence, other types of support will be needed first (e.g., fertilizers, inputs, access to market)

There need to be additional interventions in place to address other barriers such as awareness & capacity building. These interventions enable efficient use of end-user subsidies and help to ensure sustainability.

Source: Dalberg analysis and interviews

For other countries, there are other interventions that may be more appropriate than launching an end-user subsidy

	Feasible, but little potential for impact	Low feasibility and potential for impact	High potential for impact, but challenging feasibility
Description	• The solar irrigation market and agriculture value chain are developed • Higher income countries may already be able to afford pumps; there may also be little smallholder market that could be attractive to distributors	• The solar irrigation market is not developed (e.g., lack of distributors), and the agriculture value chain is unstructured (e.g., lack of offtakers) • Most of the population are subsistence farmers that need to access essential inputs before buying SIS	• The solar irrigation market is not developed (e.g., lack of distributors) • However, there is a potential for impact since low-income farmers have the willingness to invest in the pump
Suggested Activities	• In those types of countries there is no need for a subsidy in the short or long term. An intervention may risk distorting the existing market	• Other interventions (access to inputs, links with offtakers, agronomic support, etc.) should be implemented first to improve farmers productivity • As a result, subsistence farmers can increase their income and have a minimum willingness to pay for pumps. Once that is achieved, an end-user subsidy could be implemented to develop the solar irrigation market	• Earlier-stage market development activities (e.g., supply-side subsidies to support distributors, enabling environment reforms, market assessments) should be employed first • In the medium term, when the solar irrigation market is more developed, an end-user subsidy could be implemented to catalyze the market

Source: Dalberg analysis and interviews

What are the key design parameters for a SI subsidy?

The subsidy guidelines are based around a nine-part framework

Focus of the section

SI Subsidy

Design

1 Timelines, objectives & context

- What is the objective of the end-user subsidy? What are the different phases to design and implement a subsidy? What are the different models and stakeholders involved?

2 Beneficiaries & targeting

- Which farmer segments should be targeted?
- How to promote gender & social inclusion?
- Which farmers benefit most from SIS?
- What is their ability to pay for a pump?
- What are the water and land resources they have?
- What would they need beyond the subsidy?

3 Pump profile

- Which SIS map best to segment needs?
- What other technical factors must be considered?
- What should the approach to pump eligibility be?
- Which quality standards should be required?

4 Pricing & financial component

- What are the models?
- What are the main ways the cost of the pump can be covered? In what ways can the pumps be offered on finance?
- What are the main considerations when defining subsidy levels?
- Which ways could the subsidy be allocated?

5 Delivery & disbursal

- What is the appropriate channel to deploy the subsidy?
- What is the optimal payment (disbursement) approach? And the optimal verification mechanisms?
- How should distributors be selected?

6 Exit strategy

- What are the main strategies to develop an exit plan?
- What are the implications of a poorly implemented subsidy exit plan?

Source: Dalberg analysis and interviews

The subsidy guidelines are based around a nine-part framework (cont'd)

Focus of the section

SI Subsidy

Support & monitoring

7 Risks & mitigation

- Which are the main risks associated with SI Subsidies? (e.g., negative impact on the water table, poor quality of services and after-sales support, lack of distribution and in-country logistics support)
- How can those risks be mitigated?

8

- **Value chain actors & support programs**
- Who are the main value chain actors to engage (e.g. distributors, dealers, cooperatives)? How should each actor be engaged?
- What are the associated technical assistance programs that will support an increase in uptake? Which segments require them?

9

- **Monitoring & evaluation**
- Which KPIs should be monitored to measure the success of the program?
- Which are the 'early warning' metrics that the decision maker should look at to identify when the program is performing poorly?

Source: Dalberg analysis and interviews

An SIS end-user subsidy could have one or multiple objectives depending on the stakeholder that is supporting the initiative

Ministry of Agriculture

- **By increasing the total production of farmers**, employment and income, the subsidy could be launched as an initiative to increase agriculture GDP (i.e. total production)

Ministry of ICT

- **By developing the market ecosystem**, the subsidy could be promoted to build inhouse technological capabilities to enable the scalability of solar energy in the country

Donors

- **By increasing the access to irrigation and, therefore, the resilience of SHFs**, the subsidy could be put in place to increase the food security of remote communities during dry seasons
- **By increasing the shift from diesel to solar pumps**, the subsidy could be launched to decrease carbon emissions

Ministry of Energy

- **By increasing the access to power**, the subsidy could be put in place to develop the RE sector and increase the awareness and use of solar energy in remote communities

Source: Dalberg analysis and interviews

To catalyze the solar irrigation market and improve farmer incomes, multiple cross-sector stakeholders must work together

Value Chain

Manufacturer
Most of the SWPs are imported, and there are also some local manufacturers

SunCulture, Futurepump, LORENTZ

Technology adapter
The SWP technology needs to be adjusted to allow distributors to unplug the product due to the lack of payment in the PAYGo model

angaza, solar now

Distributor
Several distributors in the region bring the product to the community to be sold. Distributors are also in charge of after-sales support

Bboxx, Davis & Shirtliff, Ignite

Financer
Banks and other financial institutions provide loans either to distributors or directly to farmers

Juhudi Kilimo, Stanbic Bank

Farm engagement
Field agents and cooperatives have a crucial role in the value chain since they build awareness and support farmers training

SACCOS, One Acre Fund, DigiFarm

Other key stakeholders

Government
Government is a crucial actor to coordinate different initiatives towards the promotion of solar irrigation (tax exemptions, end-user subsidies, supply-side subsides, support programs, etc.)

National Irrigation Authority

Organizations
Different organizations support the market development building studies, defining quality standards or even as subsidy program implementers

clasp, Mercy Corps, GOGLA, SNV, Energy4Impact, VeraSol

Funders
Investors and funders that promote food security and climate are crucial to provide financial support and close the funding gap to scale the subsidies

IKEA Foundation, World Bank

Source: Dalberg analysis and interviews

Additionally, different models can be promoted when designing and implementing a subsidy; we will focus on the farm ownership model

Focus

MODEL	DESCRIPTION
Farm ownership	***Asset Financing* – Farmers purchase the pump upfront with a loan** • From the farmethe affordability barrier is high since they must pay part of the SWP upfront before getting the benefits of it • From the business's perspective, the rs perspective, risks is of defaulting on the loan repayments; so typically collateral (car ownership papers or title deeds) are required; given a SIS is infrequently accepted as collateral ***Pay-as-you-go* – Farmers pay for the monthly fees to have the SWP on the farm and use it, and the business receives a regular income stream** • From the farmers perspective, the affordability barrier is lower since they don't have to pay the high upfront cost • From the business's perspective, the risks are that this model requires a significant upfront investment, repossessing the product can be expensive and challenging, and assets and demand must be carefully balanced to avoid retaining ownership of the products
Community ownership	**Group of farmers purchase the pump upfront** • From the farmers perspective, they can share the risk of buying a high-cost product • From the business's perspective, a company can take advantage of the collective buying power of the group who could not afford the product/service individually while reducing the time and energy needed to travel to individual farms
Service provision	**Farmers only pay for the service provided (i.e., irrigation),** and the business receives income when the farmers want to irrigate (e.g., pay per use or renting for a limited period) • From the farmers perspective, they are paying to obtain a service when needed • From the business's perspective, they can not ensure a regular income stream. Service providers can suffer shifts in the demand making the business model risky, which might also be reflected in prices. This model requires local entrepreneurs to purchase and then let out the product.
Large-scale government irrigation schemes	**Farmers receive access to irrigation as part of a government program** • Farmers in these schemes pay operation and maintenance fees that go towards maintenance of the primary irrigation system, including cost of energy in case of pump abstraction • The government pays for the infrastructure, pumps and installation costs

Source: Dalberg analysis and interviews

Smallholders are the focus of these guidelines; within smallholders, there are further sub-segments of interest

Recommendation

Farmer Archetypes – *There is still a wide range of behavior within these categories*

		Smallholders			
	Subsistence Farmers	**Unstructured farmers**	**Multi crop farmers**	**Horticulture Farmers**	**Large Farmers**
Land size	Less than 0.5 acres	Average 1 acre	Average 1.5 acres	Average 2.5 acres (up to 10 acres)	More than 10 acres
Monthly Income (usd)	Less than $40	$40 - $100	$100 - $200	$200 - $500	More than $500
Crops	Low-value crops	Low-value crops	All crops	High-value crops	High-value crops
Links with offtakers	No	No	Yes	Yes	Yes
SI Subsidy case	Farmers need another type of support first (e.g., inputs, access to market, etc); subsidy would need to be near 100%	With access to irrigation and offtakers, these farmers can increase productivity and income.	Access to irrigation can help farmers to shift from low to high value crops increasing their income	This segment has almost 100% diesel pump penetration, and access to SIS can increase farmers income due to savings in fuel	Large farmers often have the ability to pay the full price of the solar irrigation kit or can access finance

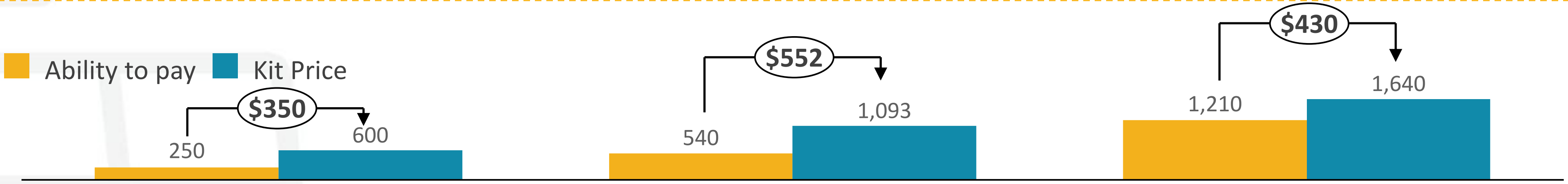
Source: Dalberg analysis and interviews

Sub-segments can strongly benefit from SIS, and have different abilities to pay

Ability to pay per farmer – Calculations based on Kenya, Rwanda and Togo case studies

	Unstructured farmers	Multi crop farmers	Horticulture Farmers
Average Monthly Income (usd)[1]	• Pre-subsidy: $70 • Post-subsidy: $181(+158%)	• Pre-subsidy: $150 • Post-subsidy: $299 (+99%)	• Pre-subsidy: $350 • Post-subsidy: $574 (+64%)[4]
Ability to pay [2]	• Upfront: $70 • Monthly payments: $180 • Total: $250	• Upfront: $150 • Monthly payments: $390 • Total: $540	• Upfront: $350 • Monthly payments: $860 • Total: $1,210
Average SIS[3] **kit price**	• $600	• $1,093	• $1,640

Affordability gap (usd)



% of price that the farmer can afford	Unstructured	Multi Crop	Horticulture
	42%	50%	77%
	Third Phase	**Second Phase**	**First Phase**

Starting with farmers that have a smaller affordability gap, allows the program implementor to gradually extend the programme to poorer segments over time

Source: Dalberg analysis and interviews

Notes: (1)The differences in income pre and post subsidy are explained by the savings in diesel and increases in productivity. (2) Ability to pay upfront is computed as one month of income pre-subsidy. Ability to pay loan is computed as a percentage of the monthly income post-subsidy (12% unstructured, 15% multi crop, 18% horticulture) for a loan tenure of 10 months; (3) Solar Irrigation System selling price, it does not include maintenance costs; (4) The increase in income is relatively lower due to the high penetration of diesel pumps in this segment

Targeted subsidies are more efficient, but are administratively complex; a universal subsidy is easier to budget and administer

Options	Description	Pros and cons	Suitable in..
A Universal	• **Single, consistent subsidy rate across different beneficiary segments**	✓ It is **simple to implement** and doesn't need additional data on target beneficiaries ✗ It can **over subsidize richer** or better-educated farmers	• Countries where the **implementation capacity** of the government is **low**, there is a **lack of farmer data** to segment, or the **income level** of farmers is **homogeneous** between segments (e.g., often in poorer agricultural settings)
B Targeted	• **Subsidy rates vary for each target segment based primarily on affordability** (or proxies for affordability)	✗ Accurate beneficiary targeting is hard and complex under current conditions in most SSA countries due to the lack of data and capabilities for a smart subsidy deployment ✓ However, segmenting a subsidy might have cost efficiency benefits since the funds are targeted according to the farmers need ✗ A detailed survey could be possible to implement a segmented rate in countries without data. However, key issues are likely a) cost; b) effective targeting (e.g., many of those interviewed may not be eligible) c) accurate data (farmers are incentivized to downplay their income) d) statistical significance – E.g. one PAYGO provider decided their detailed scorecard was not actually a predictor of likelihood of payment, so they abandoned it. It could also be hard to communicate why a farmer was eligible or not.	• Countries where the **implementation capacity** of the government is **high,** and there is **farmer data** to segment (e.g., Rwanda's income level system) • The more **heterogeneous the income level** of farmers is, the most appropriate the segmentation choice will be

Source: Dalberg analysis and interviews

Several means of targeting can be employed; targeting on the basis of pump size is likely to be feasible in most settings (1/2)

Options	Description	Pros and cons	Suitable in..
A **Geography based**	• **Based on the location of the farmer** (e.g., higher subsidies for remote locations that have low presence of SIS distributors to incentivize the market competition & supply)	✓ It allows **local governments to increase** the subsidy for their farmers ✗ **New technology** integration is needed, and **arbitrage** can happen between geographies ✗ A subsidy only based on only geography might be **favorable for rich farmers**	• **Large countries with devolved administrations** with different needs and farmers profiles per region
B **Community-based**	• Community-based targeting relies on local **authorities or community representatives to select beneficiaries/farmer groups**	✗ It can be ineffective due to **political favoritism** ✗ **Local information about the beneficiaries** that often is unobservable can be brought into the selection process	• Countries with **autonomous local authorities** that manage other subsidies

In Ethiopia, a study showed that the most suitable locations for irrigation subsidies (with the highest potential benefit and need) are in remote rural areas with low population density

Source: Dalberg analysis and interviews; IFPRI, “Instruments to target agricultural subsidies to desired beneficiaries”, 2012; EconPaper, “Who benefits from farmer-led irrigation expansion in Ethiopia?”

Several means of targeting can be employed; targeting on the basis of pump size is likely to be feasible in most settings (2/2)

Options	Description	Pros and cons	Suitable in..
C **Indicator based**	• **Based on indicators** (e.g., low-income, specific crops)	✗ Targeting based on existing subsidies or welfare programs (e.g., the income categorization system in Rwanda) has **implementation challenges** because of the **lack of reliable data** in SSA ✓ However, when there is available data from existing programs, it might be **most efficient and clear way** to segment the subsidy	• Countries with **good data** on farmers income, crops, location, etc.
D **Pump-size based**	• **Based on the size of the pump** (e.g., higher subsidies for smaller pumps)	✓ It is **easy to communicate** ✓ When farmer segments can be mapped well to SWP requirements, especially in terms of size, it makes the **implementation of the program feasible** ✗ **Can incentivize inefficient behavior** (e.g., one big farmer buying multiple small pumps)	• Countries where the **SHFs require small pumps**, and these need the highest levels of subsidy • **Farmer segments can be mapped well to SWP requirements**, especially in terms of size

In Malawi, IFPRI assessed a fertilizer subsidy program and determined it should have used indicator-based targeting[1], as it would have been more cost-efficient than the universal coverage that was employed[2]

"When you segment the subsidy by product type, it is important to include a price cap on the total subsidized amount to avoid price inflation"
– NGO

Generally, a pump size-based subsidy percentage is the easiest way to target an SI subsidy at lower-income groups, with the lowest risk of leakage and misuse, since most countries don't have good data or welfare systems to leverage.

Note: (1) subsidized fertilizer would be provided to beneficiaries based on their household characteristics. (2) Leakage (the proportion of beneficiaries who are not intended to benefit from the subsidy) would be reduced by more than half, leading overall to efficiency gains
Source: Dalberg analysis and interviews; IFPRI, "Instruments to target agricultural subsidies to desired beneficiaries", 2012

A higher subsidy percentage can be applied to lower-sized pumps to target most in-need segments

Illustrative example of the type of pumps that *could* be suitable for 1, 2 and 3 acre farmers – In practice, these would vary based on local requirements, water table, and crop type.

	1 acre	2 acres	3 acres
Details	• Indicative price: $600 • Output: 1,800 liters/hour • Max hours of operation: 7 • Maximum total vertical lift: 15m • Horizontal discharge: <500m • Self installation, no maintenance	• Indicative price: $1,000 • Output: 3,600 litres/hour • Max hours of operation: 7 • Maximum total vertical lift: 15m • Horizontal discharge: approx. 500m • Self installation, no maintenance	• Indicative price : $1,600 • Output: 2,800 litres/hour • Max hours of operation: 9 • Maximum total vertical lift: 40m • Horizontal discharge: 500m+ • Self installation, no maintenance
Examples[1]	***Unstructured farmers*** 	***Multicrop farmers*** 	***Horticulture farmers*** 
Farmers	"The small pumps can have a very simple installation mechanism – 'Plug and play.' – If they are pre-wired they can be installed by farmers." – Distributor		"We are working on a prototype solar water pump that could retail for $300.. But quality is the issue" – Large farmer group

In practice, SIS suitable to irrigate one acre could have a higher subsidy, lowering the affordability constraint of unstructured farmers

Source: Dalberg analysis and interviews, Futurepump, Lorenz

Case study: Subsidies have different targeting strategies; gender-based targeting has been tested in Nepal with promising results

Case study : Gender-based targeting strategy in SI Subsidy in Nepal

Subsidy Design & Impact

- **In Nepal, women cultivate most of the land, but** female land ownership is very low. In the Saptari district, only 3 percent of the land is owned by women.
- **The government addressed this issue by offering an additional 10 percent for solar irrigation system (SIS) grants if the application was submitted by a woman** and provided, she owned the land on which the SIS would be used.
- **Out of 65 applications, 77 percent were from women.** In most cases, the land was transferred before farmers applied. This transfer would not have happened if there had not been a women directed subsidy. The programme demonstrated that structural inequities can be reduced through segmented SI subsidies.

Lessons Learned

1. **The need to transfer legal ownership of land to women was not seen as an impediment** to availing the additional discount
2. **Market challenges for SIS in Nepal included limited options for manufacturing**, relatively few suppliers and limited access to finance
3. **Information and understanding about SIS among farmers was inadequate**, as they hesitated to change farming practices
4. **Once SIS were installed, they could serve multiple uses**, making water supply more cost-effective and efficient (e.g., by reducing the time that women spend collecting water for non-agricultural use)

Source: Dalberg analysis and interviews; FAO, “The benefits and risks of solar powered irrigation”, 2017

Case study: Subsidies have different targeting strategies; universal subsidies can end up targeting certain groups unintentionally

Case study : SI Subsidy in India

Subsidy Design & Impact

- **In 2014, the government announced a budget to supply a minimum of 100,000 solar water pumps per year**. In Rajasthan, a subsidy was provided of up to 86% of the cost (in Gujarat this was 80%)
- **The high subsidies rates did not reach the very poor; specific barriers were difficult for smallholders.** In Rajasthan, for instance, it is expected that the farmer should: (i) own at least 0.5 ha of land; (ii) have a water storage structure on or near the land; and (iii) have installed a drip irrigation system.
- **This is a clear example of how a 'universal' subsidy can indirectly target certain segments by including a set of requirements.** In this case, the eligibility criteria were favorable for large and medium scale farmers. However, a similar approach could be used to target small farmers – Greater local flexibility (e.g., where all rural workers have a landholding) could have been put in place.

"Distributors told us after a 90% subsidy, the market is ruined – "We are not going to touch it"

– Financier

Lessons Learned

1. **The subsidy was not available for small-scale farmers** due to the specific requirements on land size and infrastructure
2. **There was a need to optimize and decentralize technical parameters** of the scheme based on target beneficiaries at the state level (e.g. 2 HP pump can be sufficient for farmers in Bihar, but not in other regions)
3. **There was a need to improve the technical capacity of farmers** and local institutions to maintain pumps since proper maintenance of solar pumps can help extend the product age
4. **Integrating solar water pumps with more appropriate water distribution technology** can reduce over-extraction of ground water[1] and to improve the farm-level outcomes of solar pumps

"In India, the subsidized pumps have gone mostly to richer farmers. The scheme has had unintended consequences- If the manufacturer knows that there is a 90% subsidy, there is no incentive to drive down costs."

– NGO

; Sources: FAO, "The benefits and risks of solar-powered irrigation", 2018; Dalberg and Shakti Foundation "Technical and Policy recommendations for solar pumps program in India", 2017

Case study: In Rwanda, a geographic segmentation was used where regional authorities could top up the national subsidy

Case study : SI Subsidy in Rwanda

Subsidy Design & Impact

- **Beneficiaries:** End-user subsidy; target of 1,000 beneficiaries per year (470 reached)
- **Costs:** Cost per farmer $1,000; budget of $1,000,000 per year
- **Financial terms:** Upfront payment is 10-15%, subsidy is 50% (local governments can top up the national subsidy), monthly payments of $30, loan tenor 12-15 months
- **Channel:** Farmers fill out a physical form and send them to the district authorities to get the confirmation; distributor was heavily involved
- **Additional details:** Distributor primarily worked through a cooperative to retrieve PAYGo payments and to provide additional farmer support
- **Partners:** Energy for Access and Ignite

Lessons Learned

1. **Lack of awareness was one of the main barriers for uptake** – For that reason, a set of demo farms were given a 100% subsidy to increase uptake
2. **Farmers with higher ability to pay are those using petrol/diesel pumps** - the subsidy was targeted to smallholder farmers, with "the vast majority" originally using petrol water pumps
3. **Payment post-verification ensures a high quality after-sales support** – The subsidy was paid to distributors quarterly after checking that the SIS were functioning
4. **The loan component had low uptake since farmers preferred to borrow money from their family/friends** – Only about 3% of the farmers elected to take up a bank loan (most on PAYGo or cash)
5. **If the government has delays in paying the subsidy, then a third party might be needed to cover the liquidity gap** – E4I covered the 50% of subsidy with the proof of sale and then got repaid when the government paid the distributor
6. **Long and bureaucratic application processes might put off providers** – Distributors had to heavily support farmers during the application process

"Once you have the first farmer in the village using a SWP, then the neighbors will follow."
– Rwanda Distributor

"We intentionally did not get involved in the Rwandan program- it was a mess."
– Distributor

"We spent 1.5 years trying to use the Rwanda subsidy scheme directly but failed, due to the bureaucracy."
– SWP Manufacturer

Relevant Links: Solar Irrigation Rwanda – Developing a new Market for smallholder farmers; Off-Grid Solar Market Assessment Rwanda
Note: (1) It can be difficult for a PAYGo distributor to turn off a pump remotely
Source: Dalberg analysis and interviews

A small selection of pump profiles is better in non-mature markets since it will support after-sales ecosystem development

Options	Description	Pros and cons	Suitable in..
A Large selection of pump profiles	• **All pumps that meet the quality criteria and the after-sales support presence in the targeted areas are eligible for the subsidy** • In **Rwanda**, all pumps can be eligible for the subsidy (although the pump set up must be approved by a local govt. extension worker)	✓ A large selection of pumps **widens the options for the farmers** to choose the most appropriate pump ✗ Without any supporting ecosystem, a large selection of pumps can be subject to a **poor after-sales ecosystem** because of the lack of technicians with the know-how or spare parts to fix the pumps	• **Large countries** with very diverse pump needs • **Mature markets** with a developed after-sales ecosystem
B Small selection of pump profiles	• **Only two or three eligible pumps for each farm size (one, two and three acres)** • **Under this model, only certain pump size/type that meet the quality standards and the selected sizes are eligible** • In **India**, the SIS specifications were set centrally and not tailored at a state level – This generated a mismatch between specifications and SHF need	✓ The selection of **no more than two/three pumps/pump types**, largely driven by the size of the pump and six big quality standards (more details on the next slide) should ensure that only pumps that have a strong **after-sales ecosystem** can be included ✗ In the long term, it can be **detrimental to the consolidation of a competitive market.** That is the reason why it is recommended only for nascent markets or pilots for a short period of time.	• **Smaller countries** with similar pump need between regions • **Nascent markets** with few players (most of them, new entries) and a weak after sales ecosystem • **Pilots** that are launched to test the end-user subsidy potential before scaling the initiative

Generally, the key feature is the equality assurance framework in place to subsidize good quality products. Preselecting distributors (‘winners’) is detrimental to the consolidation of a competitive market.

Source: Dalberg analysis and interviews

Subsidized pumps must be long lasting and of high quality; industry-wide standards need to be set

Why focus on quality?

- A high-quality pump needs to meet technical standards (quality, durability, health and safety) and customer trust standards (truth advertising and consumer information (see next slide)
- At present, even highly educated farmers cannot easily compare and contrast the different pumps available to make an informed decision

Why are standards important?

- Quality pumps can last up to 10-20 years and so produce much better long-term economic return
- Experience with solar home systems shows that poor quality products can distort the consumer perception across the whole industry

How can they be standardized?

- There is no generally accepted set of standards to discern SIS quality
- VeraSol[1] has already been working to create a universal set of standards; finalizing these in partnership with industry is required
- Quality marks must be approved internationally. Otherwise, individual countries may set their own standards, leading to a proliferation of different approaches

"The product should be simple and robust, to allow the farmer to be able to fix and service it themselves (e.g. with 3-5yr warranty)"
– Distributor

"As well as ensuring overall quality in the market, strong standards can help to avoid the long-term consequences of allowing low quality products to enter the market, negatively impacting farmers and damaging perceptions of the overall solar water pump space"
– SWP Outlook Report

"The SWP market is quite nascent, and therefore there is a lot of innovation going on - that makes it difficult to define the right set of quality standards"
- NGO

"The Global LEAP Awards Solar Water Pump Competition, which tested and compared over 30 pumps, represents an important first step toward benchmarking quality and energy performance"
– SWP Outlook Report

Source: Energy for access, 'Solar Water Pump Outlook', 2019; Dalberg analysis and interviews; (1) VeraSol is managed by CLASP, an expert in appliance energy performance and quality, 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 (supported by the Netherlands Ministry of Foreign Affairs and the Italian Ministry for the Environment, Land, and Sea), the United Kingdom's Foreign, Commonwealth & Development Office, the IKEA Foundation, Good Energies Foundation, and others.

Some of the criteria used by Lighting Global to assess SHS quality can be applied to SIS while industry-wide standards are being developed

For over a decade, **Lighting Global has operated a quality assurance program** for the off-grid solar industry.
The **VeraSol Quality Standards by CLASP** address the following **critical aspects** related to product quality and consumer trust:

Soft component | Technical component

- **There should be consumer-facing information and a warranty available**; the required warranty duration varies by product type
- Main metrics include a user manual, component specifications and replacement methods, and minimum warranty terms

"It is about having basic quality standards but also that producers and distributors communicate the right specifications"
– NGO

- **Products must include a mechanism to prevent irreversible damage to the system and the user**
- Main metrics include circuit and overload protection, AC-DC charger safety, wiring and connection safety, hazardous substances ban

"The SHS standards have withstood the test of time and haven't quashed innovation in the sector. Avoiding prescriptive requirements allows further innovation in the sector"
– NGO

- **Advertising and marketing materials must accurately reflect tested product performance**
- Main metrics include manufacturer, product, name and model no., performance claims, PAYGo metering, and functionality

- **The product must be appropriately protected** from water exposure and physical ingress, has durable switches and connectors and, if portable, survives being dropped
- Main metrics include having a switch, gooseneck, moving parts, and connector durability and strain relief
- The product maintains consistent output after 2,000 hours of operation

- **The product passes a visual wiring and assembly inspection**
- Main metrics include PV overvoltage protection, miswiring protection, physical ingress protection, water protection, soldering and electronics quality, cable specifications

"The subsidy should be for everyone that has been verified and not the only five big players. For example, if you're verified by global LEAP, you can access it"
– Distributor

Source: Dalberg analysis and interviews; (1) Lighting global, "Our standards", 2021
Note: These standards are taken form the SHS specifications, the SWP specifications are being developed

SIS cost can be covered by (1) upfront farmer payment, (2) farmer loans, (3) the subsidy; farmer affordability is the underlying driver

Financial terms

	Term	Definition	Quotes
1	**Upfront payment**	The farmer's upfront cost is the amount of money that the farmer pays at purchase for the SIS	"Farmers could pay 3 months' of income for a pump" – Kenya Farmer Group "The upfront payment is 2 or 3 months' of the monthly PAYGo payment.. If they can afford the upfront payment, they can afford the monthly payment" – SWP digital platform provider
2	**Loan**	The loan is the amount of money that is going to be **financed and paid back on a monthly basis** by the farmer	"Farmers that don't want to take a loan are mainly overindebted customers or customers having losses from lack of market (i.e. they do not want to have a loan they cannot repay)." – Financial institution
3	**Government subsidy**	The subsidy is **provided by the government or other donors** to the total price of the solar irrigation system	"Farmers in Kenya would not wish to pay more than 5% of their income from the prior season if they don't see an immediate (first year) benefit of the SIS; if they do, it could be up to 50%." – NGO

Note: affordability levels used above are intended as a starting point for the policymaker to model the subsidy, not a firm recommendation – Local analytical work with farmers would be required to determine the optimum price point.

There are two main models of financial terms for SI subsidies; farmer financing models are more complex but enable lower subsidy

Options	Description	Pros and cons	Suitable in..
A **Grant & up-front farmer payment**	• **The farmer pays a percentage of the total price upfront, and the government pays the rest of the SIS cost** • In **Rwanda**, it was challenging to ensure uptake of loans to purchase SIS, since most farmers still preferred to borrow from family and friends rather than the banks	✓ **Farmers that don't want to take a loan** can afford the pump when accessing the subsidy ✗ The **cost of the subsidy per farmer needed to be higher** to overcome the affordability barrier ✗ This approach may provide **incentives to distributors to increase price**	• Only in markets where the **financial sector is not developed** and **farmers are not willing to take credit**, financial terms without a loan component are recommended
B **Grant & upfront payment & farmer financing**	• **Part of the price of the pump financed to the farmer via loans or PAYGo model** • Some finance providers in SSA are attempting to enter the market, but actual deals are scant. For example, Juhudi Kilimo is in discussions with several distributors to provide a SIS financing product • Some programs offer multiple choices. In **Bangladesh**, they offered farmers three financial options: a grant model, a grant-loan model, and a grant PAYGo model	✓ The financial component is crucial to **unlocking market potential** – The farmers' income will rise once the pump is in place, thus improving affordability ✗ It is important to **support distributors with the liquidity** needed to provide loans/PAYGo ✓ The **total cost of the program per farmer is lower**, and therefore more farmers can be reached with a certain budget when adding the financial component ✗ This approach can create **downstream complexity for the subsidy disbursement schedule**, because designers have to navigate how customer non-payment/default is handled	• Markets with **certain levels of financial inclusion,** presence of players that finance farmers, and farmers willing to take loans "It is important to have incentives for the distributors to maintain a healthy loan portfolio once they receive subsidy support" – Financial institution

Source: Dalberg analysis and interviews

Financing can be via a PAYGo model, as a direct loan from a bank, or through an intermediary (e.g., a SACCO)

The subsidy can be paid either through farmer or distributor. Additionally, the program can provide financial support for farmers following different models:

Description, Conditions & Examples

PAYGo

- **Farmers pay a monthly fee to use the SIS**
- If the farmer stops paying, the distributor is in theory able to shut the pump so the farmer is not able to continue using it
- PAYGo allows farmers to test out a SIS and may help avoid the stigma of a bank loan
- The total cost to the farmer is likely to be higher than a direct loan
- This also typically implies a streamlined distribution approach, where one company is handling all aspects of the business

"Usually, banks don't want to lend money to small-scale farmers given the perceived risk (the problem is broader than just for SWP). Additional incentives or support is required (first-loss facility, banker training/assistance, guarantees, govt. backing, etc.)."
– Distributor

SunCulture

Consolidated bank loans

- **Banks provide financing to a group/SACCO, which can provide financing for pumps**
- Group based lending allows farmers to serve as a guarantee to each other – A good option where farmers don't have credit history. An MoU is signed with a distributor to provide the pumps and after sales support
- Consolidated bank loans are a good alternative when there is a willing farmer-focused SACCO[1]

D&S DAVIS & SHIRTLIFF know HOw through experience

Direct financing from bank

- **Banks provide direct financing for SIS**
- Those type of loans are only offered for large/commercial pumps (e.g., in the case of CAT) (or where other forms of collateral are provided beyond the pump itself)
- Direct financing from banks could work once there is a secondary market for SIS, and once there is loan officer experience to this segment

CAT Center of Alternative Technologies

"Repayments are high when a third party (e.g. cooperatives) play the role of guarantee of payment for farmers."
– Distributor

Source: Dalberg analysis and interviews
Notes: (1) SACCOS (Savings and Credit Cooperative Societies) are financial co-operatives that meet the financial needs of all members (2) solar irrigation program in Rwanda

Most solar irrigation systems are sold as PAYGo in SSA; private companies that offer this option need to have sufficient liquidity

Generic SHS/SIS PAYGo model step by step[1]

1. SMS — PAYGo customer receives a reminder to pay via SMS from the PAYGo operator
2. Customer gives cash to a mobile money agent, loads float onto their mobile wallet
3. Customer sends money to the PAYGo operator via a mobile money
4. PAYGo operator's server receives Payment confirmation, credits the customer's record in the CRM
5. AW7P — PAYGo operator's sends an SMS to the customer with a unique authorization code and the outstanding solar lease balance
6. AW7 — Customer types the authorization code into the PAYGo product's user interface
7. PAYGo product unlocks for an amount of prepaid days, allowing use of lights/productive use appliance
8. PAYGo product locks after prepaid days are used up, shutting off use of lights and appliances until the customer pays again

Return to Step 1
where the customer receives payment reminder via SMS again

9. PAYGo operator's CRM tracks ongoing payments. When customer's outstanding solar lease balance hits zero, PAYGo operator sends an SMS to the customer with one final authorization code
10. Customer types the authorization code into the PAYGo product's user interface
PAYGo product unlocks permanently giving the customer access to light and appliances for free for the remainder of the product's life
11. (OPTIONAL)PAYGo Operator`s data analytics identify the customer as having a good payment record, prequalifies the customer for access to a product upgrade, sends an offer via SMS and through the call center

PAYGo customer Accepts upgrade offer, starts a new lease.

Source: Dalberg analysis and interviews; (1) GOGLA, "PAYGo SOLAR: Lighting the Way for Flexible Financing and Services", 2017

Most solar irrigation systems are sold as PAYGo in SSA; private companies that offer this option need to have sufficient liquidity (cont'd)

- To pay cash upfront for SIS, **SHF would have to have many months' of savings in place**
- However, **when farmers have a SIS installed, they experience an increase in their income** due to an increase in productivity or savings in diesel
- That makes it easier for them to **afford the monthly payments of the PAYGo model**
- To provide PAYGo services, **distributors need to have the liquidity to afford the upfront cost** of the pump

Source: Dalberg analysis and interviews; (1) GOGLA, "PAYGo SOLAR: Lighting the Way for Flexible Financing and Services", 2017

To price the subsidy, it is administratively easier if the government sets the subsidy rate for all the distributors

Options	Description	Pros and cons	Suitable in..
A **Government setting the subsidy rate for all the distributors**	• First, **the government offers a certain percentage of subsidy** based on their own approximations of ability to pay • Then companies apply. **If distributors meet the eligibility criteria**, they have access to the subsidy • It is the most **common mechanism** used in SI subsidies[1]	✓ The standard mechanism is **easier to communicate and implement** ✗ However, it can **leave value on the table** since some companies might be taking a higher subsidy than needed, and the central government may not have enough information to identify those cases	• **Nascent markets** where there are **few distributors** • Countries where **distributors don't have the capabilities** and demand data to project the number of units sold at certain prices and the farmers ability to pay
B **Reverse auction mechanism** "Flexible deployment of subsidy funds allows you to both allocate the subsidy to the most efficient distributors and also pursue additional goals" – NGO	• First, the **government offers the maximum funds available** • Then, companies apply and **offer a certain number of units to be sold** (or offer to sell at a particular price point) **with a percentage of subsidy** required • **Distributors requiring the smallest subsidy win** and have access to the requested subsidy (each company could have different a subsidy %) • A similar mechanism was used for different PULSE appliances in SSA[2]	✓ When firms compete for subsidies in reverse auctions, they have an **incentive to compete to provide the best result for the least funds** ✓ This furthers the government's goal to **achieve maximum public policy impact with a minimum budget** ✗ However, it is the **most complex allocation to implement** since the government needs to choose the more attractive offer each cycle ✗ It might be **challenging to communicate and implement** a different subsidy percentage per distributor	• **Mature markets** with a **high density of players.** Reverse auction in a new market does not foster competition. • Countries where **distributors have the capabilities to estimate** the farmers affordability gap per segment "In nascent markets, the few players will talk to each other to coordinate bids" – NGO

At all maturity stages, the objective should be to build an inclusive portfolio that includes both international and local companies and supports both vertically integrated and unbundled supply chain. This approach will foster competition between different models which helps to drive efficiency in the market.

Notes: (1) Subsidies in Togo, Rwanda, India, Bangladesh and Nepal; (2) including TVs, refrigerators, etc.
Source: Dalberg analysis and interviews

Subsidies can be channeled via distributors or be delivered directly to farmers; routing through distributors can be more catalytic (1/2)

Options	Description	Pros and cons	Suitable in..
A **Directly to end user**	• **The subsidy is paid directly to the farmer (e.g. with mobile vouchers)** • In **India**, farmers were in charge of the application process. Tracking farmer application, installed pumps, and status of installed pumps was difficult due to long paper trails	✓ Subsidies distributed to end users might allow governments to **target exactly the desired segments** since the voucher is sent directly to the beneficiaries, if there is good data ✓ Digital vouchers have **proven highly effective during the COVID pandemic** as a way to support consumer purchases in other sectors ✗ However, managing a govt. subsidy can be **complex and time consuming for farmers**, resulting in low uptake rates ✗ Additionally, **messaging on the existence of the end user subsidy can get lost**, so government needs to invest in marketing and awareness raising of the subsidy and ensure companies adequately explain the discount	• In a mature market with a **high level of awareness and choice**, a farmer voucher scheme could work effectively • In markets where **pump sizes do not exactly match the farmer segments,** digital vouchers directly delivered to farmers could be a way to target beneficiaries • Countries with **high rates of mobile money penetration** where a digital voucher could be feasible

Source: Dalberg analysis and interviews

Subsidies can be channeled via distributors or be delivered directly to farmers; routing through distributors can be more catalytic (2/2)

Options	Description	Pros and cons	Suitable in..
B Via distributor	• **The subsidy is paid directly to distributors** • **In PAYGo models, this is the most common approach since the government top up the monthly payment from farmers to achieve the full cost of the service per month** • In **Bangladesh**, they provided concessional financing for the projects through a 50% grant and a 35% concessional loan, with 15% equity required by project sponsors	✓ Subsidies channeled via distributors might be **easier to implement** since the government has to deal with fewer stakeholders ✓ Additionally, the **uptake can be higher** if the farmers automatically receive the subsidy during the transaction without any paperwork needed beforehand ✗ However, the subsidy provider needs to **tie the payment to certain requirements/results** to make sure that the desired segment of farmers is being targeted ✗ If the government has delays in the subsidy payment, it might **affect the liquidity of the distributor,** reducing their ability to scale the program and reach more farmers. In those cases, a third party might be needed to cover the liquidity gap	• **Mature markets** where the **distributors have a presence in all the regions** and the delivery channel will not be a limiting factor for farmers to access the subsidy • Countries with **good tech capabilities and infrastructure**

"If you deliver the subsidy via distributors, you need to make sure they have the right digital tools to track eligibility"
– NGO

"The government provides 50%, but it can take six months till the govt releases the funds to the distributor. Farmers would provide their amount, but the remaining 50% would be released 6-7 months later."
– NGO

"Distributors would increase the price of the solar pumps because it took a long time to get the subsidy back from the government,. We covered the 50% from the government and then got repaid when the govt repaid the distributor."
– NGO

Source: Dalberg analysis and interviews

Case study: A close relationship between distributor and subsidy provider (Govt. Togo) has been essential to smooth implementation

Case study: SI Subsidy in Togo

Subsidy Design & Impact

- **Beneficiaries:** End-user subsidy with a target of 5,000 beneficiaries. Only 400 farmers have been reached so far (the program started at the end of 2020 and is experiencing some technical issues). All farmers are eligible.
- **Costs:** Cost per farmer $700; budget of $3,500,000 (total program)
- **Financial terms:** Upfront payment is 2-3 monthly payments, subsidy is 50%, Monthly payments of $15, loan tenor 36 months
- **Channel:** Pay-as-you-go (PAYGo) model. Mobile operator checks if the customer qualifies for the subsidy and then tops up the customer's payment with the subsidy
- **Additional component:** Tax exemptions on import duties and VAT on water pumps
- **Partners:** BBoxx, Sunculture, EDF

Lessons Learned

1. **The subsidy needs to be communicated once it is ready to be launched** – If it is communicated to the beneficiaries in advance in can distort the market
2. **The affordability assessment for PAYGo can be greatly simplified from industry norms** – Every farmer in Togo is eligible, and if they are able to make the upfront payment (3 months' of monthly repayment) they are considered a good credit risk. A previous detailed credit scoring methodology was proven to not be statistically significant
3. **A well-defined sales channel is needed to generate uptake** - A list of farmers was provided by govt. as a target list, which have been targeted through via a call center – But local presence and sales channels are needed to drive uptake
4. **Integration of the required partners and technologies can impact customer experience – Connecting govt. payments with farmer payments and usage of the pumps has been challenging –** Some farmers have purchased with the subsidy promised but not yet delivered to them.

"People were being told there was a subsidy coming, but 'not yet' – So there was a drop in sales"

"You can get a lot of support from local authorities in the county. However, you should not take them as program implementers because this could slow the process."

"The subsidy delivery mechanism is not working smoothly yet"

Relevant Links: Smart subsidies and digital innovation: Lessons from Togo's off-grid solar subsidy scheme; Partnership cultivated to deliver solar-powered farming in Togo; Pre-feasibility Report for implementation of solar pumps scheme in Togo

Source: Dalberg analysis and interviews

A curated set of distributors allows the subsidy provider to provide tailored financial and capability-building support

Options	Description	Pros and cons	Suitable in..
A All distributors	• **All companies in market are able to access the subsidy on a rolling basis**	✓ It promotes **competition and innovation** in the sector ✗ However, the **companies with poor performance and lack of liquidity can apply to the subsidy,** risking consumer protection and the positive awareness of the pumps	• **Mature markets** with high competition and good distributors performance
B Curated set of distributors	• **A curated set of distributors should be created through a competitive process, who will be assessed for credit worthiness and supported in their use of the scheme** • All potential distributors can apply to be empaneled, with the option of future onboarding for those that did not make the initial cut • **In Rwanda**, the preferred SIS distributor (Ignite) was not accredited for the scheme initially - SIR supported Ignite to gain accreditation for their pump on a later stage	✓ Fewer companies involved can **ease the implementation** of the subsidy and lower the bureaucracy of the application process ✗ However, it can **damage the competition** in the sector and prevent new players from entering the market	• **Nascent markets** with a few players, where the government needs to support them financially • It is **a good option for the initial development of the SIS market**. Once the market starts developing, an open application process will be more appropriate to promote competition

Depending on the capacity of companies in the market, the implementer can either use competition to work with the best of them, or provide financing alongside capacity building, to steadily improve the quality of products provided by companies over time. The selection criteria should evolve according to the market context.

Source: Dalberg analysis and interviews

Case study: The irrigation subsidy in Bangladesh illustrates a good example of the selection process for distributors step by step

Case study : Irrigation subsidy in Bangladesh (IDCOL) – Example of distribution selection process

	Phase 1 – Expertise	Phase 2 – Quality	Phase 3 – Test
Description	**Company documents & experience** in the relevant field check	**Technical assessment** and quality standards check	**Testing of pump functionalities** and performance validation
Requirements	1. Memorandum of Association of the Company/Proprietorship 2. Trade license, TAX & VAT certificate of the company 3. Audited financial report for last 1 year/bank statement 4. Experience of the company/technical personnel associated with the company in Solar PV/Pump/Power technologies	1. Memorandum of Understanding/Agreement/Contract between the supplier & manufacturer 2. Warranty documents from the manufacturer in favor of the supplier for major components i.e. pump controller & PV 3. Technical catalogues of all equipment 4. Test report of controller, pump & PV modules from IDCOL accredited testing centers	1. Installation of a demo SIPS project with the tested equipment. 2. Demo project to undergo IDCOL performance test 3. Results of the Performance Test to be compared with manufacturer data

Relevant Link: [IDCOL Solar Irrigation Program]
Source: Dalberg analysis and interviews; FAO

There are different subsidy payment schemes for distributors; a mixed approach can help balance government and private sector needs

Upfront payment

- **Pre-financing, so the distributor can get stock and to account for the effort to get approved for the subsidy**
- In **Kenya**, Angaza has a "distributor financing fund" that provides financing for distributors purchasing products for PAYGo

Payment with proof of sale

- **Payment with the proof of sale allow the distributor to have liquidity when needed and the government to ensure that the transaction has been made**
- In **Togo**, all farmers can access the 50% on SIS, and the distributors get the subsidy for each transaction made

Post-verification payment

- **Payment post verification (e.g. three months after instalment) to check if the crop is planted and selling**
- In **Rwanda**, payment post verification (three months after the sale has been made) was key to avoid product dumping

---

- A **mixed approach combines incentives and liquidity to offer the financial component upfront and also ensures a good quality after-sales** service if part of the subsidy is paid post verification
- It allows the government to **ensure the impact in terms of scale, target segments, or other outcomes** (climate, gender, etc.) once those outcomes are verified in the post verification payment step
- This scheme might be more time consuming and **complex to implement**, and resources need to be put in place to verify the results of the program prepayment
- Usually, a **combination of the three payment timings** is needed. The **optimal mix** will depend on the liquidity needs and the quality of after-sales support

> "You have to keep it simple by aligning the subsidy to when we get paid".
>
> – Distributor

Source: Dalberg analysis and interviews

Case study: RBF models are increasingly being shown to be effective; LEAP has used a reverse auction mechanism for SIS with success

GLOBAL LEAP AWARDS **Case study :** Global LEAP RBF use of reverse auction mechanism

Subsidy Design & Impact

- **Global LEAP results-based financing (Global LEAP-RBF) aims to catalyze the uptake of high-quality efficient appliances** by lowering the cost to procure large volumes of best-in-class off-grid appliances and facilitating new business partnerships for suppliers.
- **Incentives were allocated through a reverse auction in which participants submitted a bid** that laid out the amount of incentive funds requested, the volume of products to be procured, and national markets in which these products will be sold.

Lessons Learned

1. **When the subsidy can not be used to decrease the end user price, the affordability barrier is not being addressed** – Incentives were not tied to a change in consumer price, so they didn't support improvements in affordability
2. **Only supporting a limited subset of products can be justified** – The subsidies are available only to high-quality products that won a "LEAP award", with the aim of ensuring proliferation of the best performing products, and supporting their uptake
3. **Market KPIs can show you when the market does not need the subsidy any longer** – In time, subsidy was removed for solar TVs, as it became apparent that the market had started to grow of its own accord, and the subsidy was no longer required
4. **Due diligence on approved distributors is required** – One distributor was heavily supported, yet later became insolvent & the impact of the subsidy could not be verified

Source: Dalberg analysis and interviews; Open Capital, "A new approach to significantly scaling climate smart technologies", 2021; Global LEAP Awards "Global LEAP Results-Based Financing Program", 2019

Case study: RBF models are increasingly being shown to be effective; the new CLIPP platform improves the potential of RBF models

Climate Impact Payments Platform CLIPP

Case study : CLIPP platform improves the potential of RBF models

- **The Access to Energy Institute (A2EI) has developed a new platform for "Climate Impact Payments"**, complementing existing results-based financing (RBF) schemes to fund clean energy projects and to achieve substantial carbon mitigation
- **The processes embedded in the CLIPP use IoT and data analytics to validate installation, product and climate performance** drawing from detailed data reported automatically by the installed systems to CLIPP
- **Therefore, a real time verification and monitoring of the climate impact at a single system and at an aggregate level will enable the easy measurement of results** and the scalability of RBF
- **Funders can pay for a specific level of carbon offset,** as provided through the pumps
- **A2EI has partnered with five off-grid solar companies** - Bboxx, Engie Mobisol, Victron, SunCulture and Lorentz Pumps - to test the platform specifically for PULSE

bboxx SunCulture mobisol victron energy LORENTZ Sun. Water. Life.

Source: Dalberg analysis and interviews; Open Capital, "A new approach to significantly scaling climate smart technologies", 2021; Global LEAP Awards "Global LEAP Results-Based Financing Program", 2019

A 'smart subsidy' that adjusts the percentages over time is more complex, but can minimize the overall cost of the subsidy

Options	Description	Pros and cons	Suitable in..
A Constant rate	• **For the duration of the program, the financial terms for the farmer (% subsidy, % loan, % upfront) remain constant**	✓ It is a **clearer 'market signal', simpler message to communicate** and **easier to implement** ✗ However, it **does not allow a smooth transition to removal of subsidy**, and it might generate a price jump once the government decides to stop the subsidy ✗ Additionally, it **generates more costs than necessary** in the last years of the program	• Countries where the **implementation capacity of the government is low** and the adjustments can not be well communicated and implemented
B Adjustable rate	• **The subsidy financial terms are revised every couple of years, based on the adjusted price and ATP from farmers**	✗ It is more **complex to communicate and implement**. Therefore, the subsidy should be adjusted only infrequently, and the timelines should be clearly communicated upfront ✓ It is the **optimal configuration** since it adjusts the subsidy rate to market evolution. For example, when the market maturity increases, the efficient subsidy rate decreases. ✓ The price of pumps can also increase, and the subsidy rate needs to be adjusted upwards[1].It is particularly relevant to take this approach **in countries with foreign exchange rate fluctuations** since the pumps/pump components are usually imported ✗ It may be very difficult to **get accurate market data on the 'optimum' subsidy** ✓ Since under this mechanism, the subsidy decreases gradually, once the government stops the subsidy, there are **no market distortions**	• **Countries with a high level of implementation capacity** should go for the adjustable rate option, and conduct a review on an infrequent basis to assess if the program is over/under subsidizing the solar irrigation sector

"An alternative exit strategy is to bound the duration of the subsidy and communicate it as a 'special offer' or loyalty programs from distributors.. However, governments typically want to claim it as 'their' subsidy and get the credit for this"
– NGO

"Companies across the board are keen to see longer term, larger schemes, with clear market signals. However, this takes a significant commitment from a donor or a country"
– NGO

Note: (1) The price of pumps might increase in the following year due to the rise in raw material prices and transport costs due to COVID
Source: Dalberg analysis and interviews

In sum, there are different options and recommendations for the subsidy design that depend on the context of the county

Component	Decision	Recommendations
Beneficiaries & targeting	• **Target segments** • **Subsidy rate** • **Segmentation approach**	• **Smallholders** are the optimal segment for SI subsidies • Universal subsidies are easier to budget and administer but leave value on the table; **"smart" ways to target** are emerging • Targeting based on **pump size** is likely to be most feasible for SIS
Pump profile	• **Pump selection**	• A robust aftersales service network is the goal; selecting just a **small set of approved, quality pumps** could support this aim
Pricing & financial component	• **Financial components** • **Rate selection** • **Allocation**	• Supporting farmer **financing models** (i.e., PAYGo or repayment of a loan) are essential to solve the affordability challenge • To price the subsidy, it is administratively easier if the **government sets the subsidy rate for all the distributors** • Subsidy should be channeled as '**results-based finance'** – i.e., pay for results, via distributors
Delivery & disbursal	• **Selection process** • **Channel** • **Payment terms**	• A **curated set of distributors** allow the subsidy provider to make sure high-quality standards of eligible products are met • Subsidies can be delivered directly to farmers or be **channeled via distributors;** in a mature market with a high level of awareness and choice, a farmer voucher could work effectively • A mix of **prefinance, point of sale payment & post verification** payment will allow distributors to have sufficient liquidity to invest in stock, as well as incentivize after-sales service
Exit strategy	• **Evolution**	• A 'smart subsidy' that **adjusts the percentages over time** is more complex but can minimize the cost of the subsidy

"It is important to define the "problem statement" i.e. the objective carefully - Is it to accelerate the transition from diesel pumps to solar? Is it to maximize income & yield for farmers (who might not have a pump today)? These will guide the choices policymakers will need to make"

– NGO

Source: Dalberg analysis and interviews

There are significant risks with an end user subsidy – Primarily on market distortion, over-pumping, and under-subsidizing

Subsidy risks

1 Market distortions

- A short-term subsidy can create distortive customer behavior (e.g., set non-sustainably low prices in the market; reduce incentives to control cost base; encourage arbitrage across regions eligible for the subsidy)
- Subsidies can also be applied incorrectly: e.g. to already-sold pumps, or multiple subsidies to the same pump
- A subsidy through a pay-monthly/loan repayment model could be less distortive

"A short-term subsidy to the 'one off' price might distort the market; we prefer getting a subsidy through a pay-monthly/loan repayment model instead."
– Distributor

2 Over-pumping of groundwater

- SIS expansion could lead to over-extraction of groundwater at zero marginal cost, reducing water tables
- Farmer training and SIS digital monitoring can mitigate some of these risks

"There are concerns about a declining water table – but it's a long term [not immediate] concern"
– Distributor

3 Under-subsidizing

- If subsidies are not sufficient, especially in nascent markets, there's a risk that companies will not participate in SIS market development programs, and the status quo will remain
- More broadly, profitability might be at risk since companies might not be able to obtain the necessary density of customers they need to cover the significant investments they will need to make in, for example, after-sales service
- Therefore, it is important to ensure the overall 'offer' to companies is sufficiently attractive to secure their participation

Note: (1) Those are the regions where the targeted beneficiaries are often located
Source: Dalberg analysis and interviews

There are also potential implementation risks – Including product quality, lack of awareness forced exit, and lack of logistics support

Implementation risks

1 Poor quality products being sold

- If quality standards are not upheld as part of the subsidy, and there is a proliferation of varying standards, consumer perceptions could be affected
- Universally approved quality standards and an ability to directly compare pumps would aide farmer choice and enable high quality after-sales support

2 Lack of farmer awareness & education

- The lack of awareness of irrigation benefits, the long-term benefits of solar pumps, agronomic education and financial literacy is one of the main implementation challenges to ensure uptake
- There can also be a lack of awareness on the distributors side about the subsidy and the appraisal processes
- Support programs can mitigate this risk (next slide)

> "Level of knowledge and awareness of farmers is limited; there is work to do."
> – Government

3 Forced exit due to lack of funds or political decision

- It is important to avoid a sudden exit to the subsidy, which could affect all distributors go-to-market strategy, solvency, and liquidity (especially for companies offering the PAYGo services)
- Some strategies could be employed to reduce the cost of the subsidy to lessen the 'shock' – E.g. forward signaling, extending loan tenor of loans, providing 'bridge' funds from elsewhere

4 Lack of distribution and in-country logistics support

- In countries with poor logistics infrastructure, it can be challenging to deliver the SIS to farmers in remote communities[1] – Uptake of the subsidy can then be concentrated around urban settlements
- Geographic segmentation of the subsidy can focus on regional-specific distribution challenges

> "Small diesel pumps are available everywhere. But, for solar pumps, you really need to know where to get it."
> - Government

Note: (1) Those are the regions where the targeted beneficiaries are often located
Source: Dalberg analysis and interviews

Case study: Outside of solar irrigation, other subsidy schemes also experience familiar challenges – For example, in Sanitation

Case study Industry-wide Water supply & Sanitation Subsidies

Subsidies for water and sanitation have been a frequently used tool for governments, yet effective targeting and market distortion remains difficult. A World Bank meta-review concluded that subsidies can be powerful and progressive tools in delivering water and sanitation when they are designed in smart and targeted ways and implemented effectively.

Many existing subsidies are:

- **Pervasive:** In many cases, public officials use subsidies to manage political support. That is common across countries, irrespective of region or income level.
- **Expensive:** Governments spend around $320 billion per year (up to 2.4% of regional GDP).
- **Poorly Targeted:** An average of 56% of subsidies are captured by the wealthiest 20% of the population, while a mere 6% are captured by the poorest 20%.[1]
- **Non-transparent:** They can facilitate rent-seeking by governments and service providers.
- **Distortionary:** Contribute to inefficiency, threaten service sustainability, and encourage overexploitation of resources. By affecting prices, subsidies distort economic agents' choices.

With a better design & implementation, subsidies can be:

1. **Smart**
   - A **better balance to support both water and sanitation**, rural and urban, and different types of service can make subsidies work better
   - Subsidies can also encourage better operational efficiency through **performance incentives**
2. **Targeted**
   - Measures to make water supply and sanitation **affordable for those in need** can ensure that no one gets left behind
   - Effective targeting is increasingly possible through **technological innovation**
3. **Implemented Efficiently**
   - A **communications strategy** is essential to build local support and to enable successful implementation
   - **Understanding the institutions**, incentives, and interests is key to have supportive political coalitions
   - When a subsidy is temporary, an **appropriate exit strategy** must include some form of support for the most vulnerable
   - **Complementary policy** measures can make scarce public resources go further

Relevant Link: Doing More with Less - Smarter Subsidies for Water Supply and Sanitation
Source: World Bank, 'Doing more with Less', 2019; Dalberg analysis and interviews
Note: (1) Percentages from analysis of 10 developing countries – more details on the cited report.

Alongside the subsidy, a set of associated market development programmes are prerequisites to a subsidy project (1/2)

The following programs are not the focus of this study but are crucial to ensure the success of a SI Subsidy. Without them, there may be low uptake, returns and impact of the intervention.

1 Awareness campaign

- Raise farmer awareness of the potential of solar irrigation (e.g., demonstration sites, meetings with SHFs, education events, and radio shows)
- Key stakeholders include cooperatives, farmer associations, digital agriculture platforms, and distributors

> "Most of the distributors were not interested in SWP because there was a lack of awareness from the farmers and the distributors themselves"
> – NGO

> "Every community has extension services agents/cooperatives/SACCOS that can help you to tailor the awareness campaign to the specific community you are working on."
> – NGO

2 Capacity building

- Build the capacity of farmers to use solar irrigation systems
- Key stakeholders include content providers, digital agriculture platforms, cooperatives, farmer associations, and distributors

3 Offtaker support

- ***It is only needed when the target beneficiaries do not have access to market*** (e.g., unstructured farmers)
- Strengthen links between farmers and off-takers, e.g., access to platforms, quality assurance, guaranteed prices, supporting with eligibility programmes
- Key stakeholders include offtakers, cooperatives, digital agriculture platforms, extension workers

> "There needs to focus on the whole agriculture scheme, not just irrigation. The end point is to increase production for farmers, and irrigation does not increase production by itself if the inputs or off-takers are not involved."
> – NGO

4 Agronomic support

- Support farmers to maximize the productivity increase once the pump is installed will help them have a greater return. For example, by appropriately rotating crops and investing in soil testing.
- Key stakeholders include extension workers and agronomists

> "For it to work, we need to think about the complete chain... E.g., if we don't think about the marketing of produce, it may not be a good idea to pursue"
> – Government

> "Forward and backwards integration is very important for catalyzing the SWP market. Whilst the subsidy can be for equipment, it's impossible to ignore education/extension workers, inputs, the ecosystem for repair, maintenance, etc. Policymakers need to understand that these things need to be fixed gradually, together."
> – NGO

Source: Energy for Impact, Dalberg analysis

Alongside the subsidy, a set of associated market development programmes are prerequisites to a subsidy project (2/2)

5 Third-party financing
- Address system affordability through third-party financing
- Key stakeholder include local banks, MFIs, SACCOS, cooperatives and distributors

6 Favorable policy and regulation
- Create favorable policy and regulatory frameworks (e.g., tax exemptions)
- A key stakeholder is the government

"Pumps were quite an affordable product and now are close to being a luxury product because of the increase in taxes in Kenya."

– Distributor

7 Support to distributors
- Support distributors with technical assistance and working capital support, since many distributors are cash- and resource-constrained
- Key stakeholders are the government & distributors

8 Water Management
- Build incentives to avoid over-pumping groundwater since it can cause water tables to fall and subsidence
- Strengthen capacity on monitoring of water tables, use of water, siting of boreholes etc.
- Key stakeholders are the government and farmer groups

9 Quality standards dissemination
- Work with suppliers to finalize quality standards and comparison criteria
- Key stakeholders include manufacturers and international organizations (e.g., Lighting Global)

Source: Energy for Impact, Dalberg analysis

Case study: The micro-scale irrigation program in Uganda shows the importance of an awareness program to ensure uptake

Case study : Micro-scale irrigation subsidy in Uganda

Subsidy Design & Impact

- **Beneficiaries:** End-user subsidy with a target of 10,000 beneficiaries. 18,000 applications submitted since last year
- **Costs:** Cost per farmer $6,500 (75% to pay the cost of the equipment, up to a maximum of $5,000 per farmer, plus 25% for support activities). Total programme budget of $65 million
- **Financial terms:** Government pays between 25% and 75% of the total cost of the irrigation equipment, with a maximum contribution of $2,000 per acre depending on the nature of the farm and the irrigation equipment that farmers choose
- **Channel:** Farmers complete an expression of interest, then the district officers perform a farm visit and based on that the subsidy percentage is defined
- **Additional component:** The farmer receives complementary services such as extension support in irrigated agriculture. All micro irrigation equipment (including diesel pumps) is eligible for the scheme
- **Partners:** World Bank

"Over 75% of farmers are choosing solar irrigation"
– Government

Lessons Learned

1. **Start with an awareness program to ensure uptake –** They started building awareness in the first year to make sure that the farmer understands the irrigation benefits, before any SIS were provided
2. **Use e-tools available to improve the agility and transparency of the program –** They use a bespoke Play Store app to collect data, determine the subsidy percentage and provide farmers training
3. **Partner with different stakeholders from the very beginning –** They have been designing the program in partnership with all stakeholders, from the start, to get all the relevant perspectives into account

"The use of technology has been very beneficial for this program"
– Government

Relevant Link: Micro-scale irrigation program
Source: Dalberg analysis and interviews

Monitoring of subsidy delivery and impact is critical, to allow adjustment to the programme as it is implemented (1/3)

	KPI	Value	Metric detail	Warning sign/rationale
Subsidy delivery[1]	Investment	100% (green) 80-75% (amber) 0-75% (red)	Ratio government investment per month vs. projected investment	If the actual investment is below the projected one, then there is a lack of subsidy uptake
	Subsidy payment schemes	100% (green) 80-75% (amber) 0-75% (red)	Ratio funding allocated on each milestone vs. funding disbursed on each milestone	If the funding allocated per milestone is not aligned with the funding disbursed, it might be a payment delay
	Units sold	100% (green) 80-75% (amber) 0-75% (red)	Ratio units sold vs. target	If the units sold are below target and the investment is on target, then there are distributors obtaining the benefit and instead of selling pumps
	Units installed	100% (green) 80-75% (amber) 0-75% (red)	Ratio units installed vs. units sold	If the units installed are less than the units sold, then the installation part of the value chain is failing
	Units running	100% (green) 80-75% (amber) 0-75% (red)	Ratio units running vs. units installed	If units running are less than units installed, then the after-sales service may be underperforming
	Beneficiaries per segment & gender	100% (green) 80-75% (amber) 0-75% (red)	Ratio farmers reached vs. target (Per segment & gender)	If there is a deviation in the actual beneficiaries vs target per segment and gender, then the incentives are not aligned to promote social inclusion and gender equality

Source: Dalberg analysis

Note: (1) The subsidy delivery KPIs are focused on the SWP appliance per se. KPIs around the enabling environment are detailed on the next slide.

A tracking tool will help policymakers to assess the performance of the subsidy vs the projected impact (2/3)

	KPI	Value		Metric detail	Warning sign/rationale
Impact on income, climate and gender	**Increase in production per farmer**	+50% 50-0% -0%	Green Yellow Red	Ratio average farmer production after using the SIS vs. before (Per segment)	If there is no increase in production, then there might be a lack of training for farmers on how to use the pump
	Increase in produce sold	Increase Constant	Green Yellow Red	Ratio average farmer produce sold after using the SIS vs. before (Per segment)	If there is no increase in produce sold, then farmers have no access to market to sell the additional produce
	Increase in income per farmer	+50% 50-0% -0%	Green Yellow Red	Ratio average farmer income after using the SWP vs. before (Per segment)	If there is no income increase (and a production increase), then farmers might not have market access or the offtaker is not offering a competitive price.[1]
	Reduction in CO_2	+50% 50-0% -0%	Green Yellow Red	Ratio average emissions per farmer after using the SIS vs. before (Per segment)	If there is no reduction in CO_2, then the farmers are not shifting from diesel pumps to SWPs
	Water collection time	Decrease Constant Increase	Green Yellow Red	Hours spend per day on water collection	If there is no reduction in hours spend on water collection, then the farmers are not shifting from diesel pumps to SWPs
	Water used per pump vs. benchmarks[2]	Lower Equal Higher	Green Yellow Red	Liters of water used per pump per year vs. best practices	If the water used per pump is higher than best practices, then a module of farmer training and water management incentives is missing in the subsidy scheme. In those cases, the subsidy could potentially have, in the short or long term, a negative impact on the water table.

Source: Dalberg analysis

Note: (1) Assessing farmer income is difficult – Case studies may have to be used rather than a quantitative assessment; (2) In the mid/long term water table level should also be monitored

A tracking tool can also include KPIs from other markets to assess the performance of the subsidy (3/3)

	KPI	Value	Metric detail	Warning sign/rationale
Other markets	Change in diesel pumps price	Increase (green) Constant (yellow) Decrease (red)	Ratio diesel pump price after subsidy vs. before	If the price of diesel pumps decrease, it could be that there is less demand or that the suppliers are decreasing the margins to gain some market
	Change in diesel pumps sold	Positive (green) Constant (yellow) Increase (red)	Ratio monthly diesel pump sales after subsidy vs. before	If the units sold increase, then it might be in line with the diesel suppliers decreasing the price, or farmers might not be perceiving that the ROI of SIS is higher than the diesel pumps

Source: Dalberg analysis

Note: (1) Assessing farmer income is difficult – Case studies may have to be used rather than a quantitative assessment

Additional impact metrics could be considered, based on the local context and the objectives of the subsidy

Additional metrics to be considered

Environment	• Ton of CO_2 emissions avoided • Sustainable water practices • E-Waste management
Economic	• Change in expenditure due to pump use ($) • Change in job opportunities (# of jobs created) • # of farmers with increased yield • Average increase in yield per farmer (%) • # of women with increased income
Social and Health	• Evidence of increase in food security • # of people enjoying from better access to sanitation & hygiene services due to pump • Evidence of increase in free time • # of women benefiting from more free time • # of people enjoying from an increase in food security • # of women spending more time on their own education due to pump

Source: Efficiency for access, “Solar Water Pump Technical Working Group”, 2021

SUBSIDY DESIGN EXCEL TOOL

SECTION FIVE

SUBSIDY DESIGN EXCEL TOOL

Overview of the Design Tool

The 'Design Tool' is designed for a policymaker to assess the impact of a subsidy in their country, through adjusting a set of key inputs

Inputs

1

- **Country**
- **Number of beneficiaries** per segment (#farmers)
- **Loan tenor** per segment (number of months over which the loan is repaid)
- **The interest rate** for farmers[1]

Outputs

2

Total cost

- Total cost of the subsidy (USD)
- Total cost per farmer (USD)
- Financial terms (% loan, % upfront, % subsidy)
- Financial terms (USD)

3

Cashflow

- For the program implementer (subsidy & operational costs)
- For the finance provider (new loans, repayment & interests)
- For the farmer (additional income, savings in diesel & monthly payments)

4

Impact

- Productivity & resilience
- Income
- Emissions

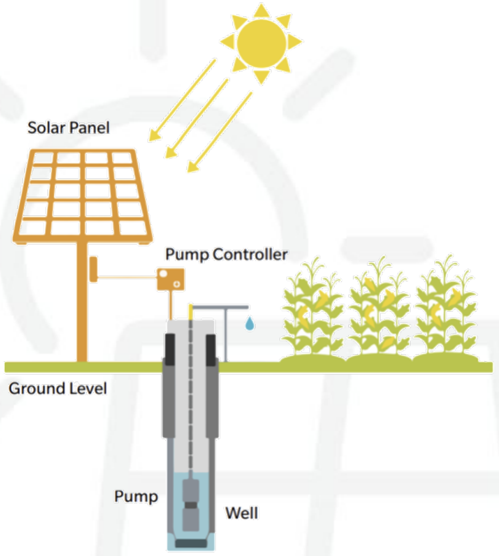
Source: Dalberg analysis

Notes: (1) This input should not me considered in some countries where private sector/distributors are not allowed to charge interest rates on loans (e.g. Ethiopia)

The cost of a pump can be covered by the farmer upfront payment, a portion covered by financing (either loan or PAYGo), and a subsidy

Market price of the pump

Price of SIS



Financial terms

Upfront payment (18% - $180)

Smallholder farmer ability to pay	= 3 months of total income p.a.
Farmer yearly income pre subsidy	= $720
Farmer monthly income pre subsidy	= $60
3 months of income	=$180
Upfront price	**= $180 (Output)**

Loan (25% - $255)

Loan tenor	**= 17 months (Input)**
Monthly ATP	= 20% of monthly income post subsidy
	= 20% * $72
	= $15
Total loan	**= $255 (Output)**

Government subsidy (56% - $565)

Subsidy	= SIS Price – Upfront Payment - Loan
	= $1,000 - $180 - $255
	= $565
Subsidy %	**= 56.5% (Output)**

SUBSIDY DESIGN EXCEL TOOL

Walkthrough on how to use the Design Tool

This section provides a step-by-step walkthrough on how to use the Design Tool

Input Output

Content of the section

1 Main choices

- Main five choices of the tool – Country, beneficiaries, loan tenor and interest rate for farmers

2 Total cost

- The total cost of the program and each component (direct subsidy, operational cost and financial requirement)
- Cost per farmer per segment

3 Cash flow

- Cash flow from the program implementer, finance provider and farmer perspective

4 Impact

- Impact on productivity, income, emissions, hours spend on water collection and resilience

5 Dashboard

- Summary of all the tool results in a visual way

Source: Dalberg analysis

When the policymaker uses the model, the main inputs to adjust are beneficiaries, loan tenor and interest rate for farmers

Model snapshot

1. Scope	
Country	**Rwanda**
Number of total beneficiaries	**5,000**
Unstructured Farmers	**2,500**
Multicrop Farmers	**1,500**
Horticulture Farmers	**1,000**
2. Design	
Loan Tenor (Months)	
Unstructured Farmers	**12**
Multicrop Farmers	**9**
Horticulture Farmers	**6**
Interest rate for farmers	**20%**

Input to be completed by policy maker

Rationale & comparison with ongoing subsidies

- The decision maker will be able to set the **number of farmers that will be targeted** across a 10-year period, **per farmer segment**
- The decision maker will be able to adjust the **loan tenor,** to take into account the likely ability of distributors and financiers to extend capital (a good proxy will be to include the typical tenors for other rural asset loans)
- Finally, the policy maker will also be able to adjust the **interest rate for farmers**, impacting the profitability of the finance provider. A good proxy for this will be other rural asset loans from microfinance institutions or SACCOs
- The **model assumptions** are currently set within the parameters of **ongoing subsidies –** All assumptions can be adjusted to reflect a variety of scenarios.
  - Total beneficiaries: 5,000 (Togo)
  - Loan tenor: 9-15 months (Rwanda)
  - The interest rate for farmers: 20% (Juhudi Kilimo, Kenya)

Source: Dalberg analysis

The Design Tool will show the total cost of the program, cost per farmer and the appropriate financial structure

Model snapshot

Outputs - Subsidy Cost & Impact

1. Total cost

Total cost of the program

	Total program	Subsidy	Operational	Financing req
Unstructured	$ 1,688,477	$ 1,009,258	$ 400,000	$ 279,219
Multicrop	$ 1,395,035	$ 981,850	$ 210,000	$ 413,186
Horticulture	$ 1,217,926	$ 898,368	$ 140,000	$ 319,558
Total cost	**$ 4,301,438**	**$ 2,889,476**	**$ 750,000**	**$ 1,011,963**
% of total		**67%**	**17%**	**24%**
Total cost per farmer				
Unstructured	$ 675	$ 404	$ 160	$ 112
Multicrop	$ 930	$ 655	$ 140	$ 275
Horticulture	$ 1,218	$ 898	$ 140	$ 320
Total cost	**$ 860**	**$ 578**	**$ 150**	**$ 202**

Financial structure

Financial terms	% Upfront	% Loan	% Subsidy	
Unstructured	15%	18%	67%	
Multicrop	16%	24%	60%	
Horticulture	26%	19%	55%	
Financial terms	**$ Upfront**	**$ Loan**	**$ Subsidy**	**Monthly payment**
Unstructured	$ 88	$ 108	$ 404	$ 9
Multicrop	$ 171	$ 267	$ 655	$ 30
Horticulture	$ 431	$ 310	$ 898	$ 52

Rationale & comparison with ongoing subsidies

- The three sources of cost of the program are the **subsidy** (% of pump cost paid by the government), **operational costs** (subsidy delivery and offtaker program), and the **financing requirements** (loan extended to farmers to purchase the pump/monthly payments in a PAYGo model)
- The **model parameters** can be compared with data from **ongoing subsidies:**
  - Total costs: $1,000,000 (Rwanda), $3,500,000 (Togo)
  - Cost per farmer: $1,000 (Rwanda), $700 (Togo)
  - % Operational costs: 20% (Rwanda)
  - % Upfront: 10-20% (Rwanda)
  - % Subsidy: 50% (Rwanda & Togo)

Source: Dalberg analysis, Interviews

The Design Tool will show the total cost of the program, cost per farmer and the appropriate financial structure

Model snapshot

Outputs - Subsidy Cost & Impact

1. Total cost

Total cost of the program	**Total program**	**Subsidy**	**Operational**	**Financing req**
Unstructured	$ 1,688,477	$ 1,009,258	$ 400,000	$ 279,219
Multicrop	$ 1,395,035	$ 981,850	$ 210,000	$ 413,186
Horticulture	$ 1,217,926	$ 898,368	$ 140,000	$ 319,558
Total cost	**$ 4,301,438**	**$ 2,889,476**	**$ 750,000**	**$ 1,011,963**
% of total		**67%**	**17%**	**24%**
Total cost per farmer				
Unstructured	$ 675	$ 404	$ 160	$ 112
Multicrop	$ 930	$ 655	$ 140	$ 275
Horticulture	$ 1,218	$ 898	$ 140	$ 320
Total cost	**$ 860**	**$ 578**	**$ 150**	**$ 202**

Financial structure

Financial terms	**% Upfront**	**% Loan**	**% Subsidy**
Unstructurec	15%	18%	67%
Multicrop	16%	24%	60%
Horticulture	26%	19%	55%

Financial terms	**$ Upfront**	**$ Loan**	**$ Subsidy**	**Monthly payment**
Unstructurec	$ 88	$ 108	$ 404	$ 9
Multicrop	$ 171	$ 267	$ 655	$ 30
Horticulture	$ 431	$ 310	$ 898	$ 52

Rationale & comparison with ongoing subsidies

- The three sources of cost of the program are the **subsidy** (% of pump cost paid by the government), **operational costs** (subsidy delivery and offtaker program), and the **financing requirements** (loan extended to farmers to purchase the pump/monthly payments in a PAYGo model)
- The **model parameters** can be compared with data from **ongoing subsidies:**
  - Total costs: $1,000,000 (Rwanda), $3,500,000 (Togo)
  - Cost per farmer: $1,000 (Rwanda), $700 (Togo)
  - % Operational costs: 20% (Rwanda)
  - % Upfront: 10-20% (Rwanda)
  - % Subsidy: 50% (Rwanda & Togo)

Source: Dalberg analysis, Interviews

Cash flow is viewed from the perspective of the program implementer, financial provider and the farmer themselves

Model snapshot

2. Cash flow											
Program implementer	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Subsidy costs	$ (57,790)	$ (809,053)	$ (866,843)	$ (577,895)	$ (288,948)	$ (144,474)	$ (57,790)	$ (28,895)	$ (28,895)	$ (28,895)	$(2,889,476)
Operational costs	$ (15,000)	$ (210,000)	$ (225,000)	$ (150,000)	$ (75,000)	$ (37,500)	$ (15,000)	$ (7,500)	$ (7,500)	$ (7,500)	$ (750,000)
Cash flow	$ (72,790)	$ (1,019,053)	$ (1,091,843)	$ (727,895)	$ (363,948)	$ (181,974)	$ (72,790)	$ (36,395)	$ (36,395)	$ (36,395)	$(3,639,476)
Finance Provider	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
New loans	$ (20,239)	$ (283,350)	$ (303,589)	$ (202,393)	$ (101,196)	$ (50,598)	$ (20,239)	$ (10,120)	$ (10,120)	$ (10,120)	$(1,011,963)
Repayment	$ -	$ 17,881	$ 250,338	$ 268,219	$ 178,813	$ 89,406	$ 44,703	$ 17,881	$ 8,941	$ 12,591	$ 888,774
Interest	$ -	$ 3,576	$ 50,068	$ 53,644	$ 35,763	$ 17,881	$ 8,941	$ 3,576	$ 1,788	$ 2,518	$ 177,755
Cash flow	$ (20,239)	$ (261,892)	$ (3,183)	$ 119,471	$ 113,379	$ 56,690	$ 33,405	$ 11,338	$ 609	$ 4,990	$ 54,566
		$ (282,131)	$ (265,075)	$ 116,287	$ 232,850	$ 170,069	$ 90,094	$ 44,743	$ 11,947	$ 5,599	
Accumulated portfolio	**$ 20,239**	**$ 303,589**	**$ 607,178**	**$ 809,570**	**$ 910,766**	**$ 961,364**	**$ 981,604**	**$ 991,723**	**$ 1,001,843**	**$ 1,011,963**	
Farmer (single farmer level)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Unstructured	**$ (144)**	**$ 739**	**$ 739**	**$ 739**	**$ 739**	**$ 739**	**$ 739**	**$ 739**	**$ 739**	**$ 739**	
Add income for production	$ 74	$ 739	$ 739	$ 739	$ 739	$ 739	$ 739	$ 739	$ 739	$ 739	$ 6,727
Savings in Diesel	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Upfront payment	$ (88)	$ -	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ (88)
Monthly Payments	$ (130)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (130)
Multicrop	**$ 161**	**$ 1,782**	**$ 1,782**	**$ 1,782**	**$ 1,782**	**$ 1,782**	**$ 1,782**	**$ 1,782**	**$ 1,782**	**$ 1,782**	
Add income for production	$ 491	$ 1,620	$ 1,620	$ 1,620	$ 1,620	$ 1,620	$ 1,620	$ 1,620	$ 1,620	$ 1,620	$ 15,071
Savings in Diesel	$ 162	$ 162	$ 162	$ 162	$ 162	$ 162	$ 162	$ 162	$ 162	$ 162	$ 1,620
Upfront payment	$ (171)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (171)
Monthly Payments	$ (321)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (321)
Horticulture	**$ 169**	**$ 1,567**	**$ 1,567**	**$ 1,567**	**$ 1,567**	**$ 1,567**	**$ 1,567**	**$ 1,567**	**$ 1,567**	**$ 1,567**	
Add income for production	$ 630	$ 1,225	$ 1,225	$ 1,225	$ 1,225	$ 1,225	$ 1,225	$ 1,225	$ 1,225	$ 1,225	$ 11,659
Savings in Diesel	$ 342	$ 342	$ 342	$ 342	$ 342	$ 342	$ 342	$ 342	$ 342	$ 342	$ 3,420
Upfront payment	$ (431)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (431)
Monthly Payments	$ (372)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (372)

Rationale

- The cash flow from the **program implementer** perspective includes **subsidy and operational costs** of the program
- The cash flow from the **finance provider** perspective includes the **new loans, repayment** (assumed to be 93% according to real-world benchmarks), and the **interest** (a model input)
- The cash flow from the **farmer** perspective computes all the changes in income that the farmer experiences vs baseline, including **additional income** from the productivity increase, **savings in diesel**, and loan **monthly payments**

Source: Dalberg analysis

Impact metrics are also computed, on additional value of production, improvement in farmer income and reduction in emissions

Model snapshot

3. Impact

Impact per farmers	Production Increase Range Kg/yr.		Range %		Income Increase Range dollars/yr.		Range %		Emissions Decrease Range CO2 kg/yr.		Range %	
Unstructured	1,595	1,677	98%	103%	$722	$756	137%	144%	0	0	98%	100%
Multicrop	3,867	4,066	63%	67%	$1,580	$1,660	71%	74%	-520	-547	98%	100%
Horticulture	1,951	2051	13%	13%	$1,196	$1,255	21%	22%	-842	-885	98%	100%

Total impact (in 10 years)	Total	Per beneficiary
Productivity - Additional Production (kg)	90,422,912	18,085
Income - Additional Income (USD)	$55,239,684	$11,048
Climate - Reduced emissions (CO2 kg)	-12,496,832	-2499

Total impact	Total	Per beneficiary
Gender - Time saved in water collection per day (I	6,750	1.35
Resilience - (Kg production that is assured/yr.)	582,628	117
Resilience - (USD production that is assured/yr.)	$ 197,940	$40

Rationale & comparison with ongoing subsidies

- The differences in income per segment are driven by the **penetration of diesel pumps**, and the **access to market**
- For example, **unstructured farmers** have a low current diesel pump penetration (close to 0%), and are assumed to have little formal access to market before the program. As a result, they have a l**ow impact on emissions, a high impact on productivity and an even higher impact on income** since the subsidy allows them to access better prices through the offtaker program – But additional investment is required (and factored in) for this group to have them market-ready.
- The **model parameters** can be compared with data from **ongoing programmes:**
  - Production increase: up to 300% (Horticulture, Kenya)
  - Income increase: up to 100% per year (Kenya)

Note: the actual increase in production and income as a result of irrigation can be highly variable, based on other inputs, topography, farmer knowledge, and access to markets.
Source: Dalberg analysis, Interviews

A dashboard provides a visual overview of the key outputs of the model itself, including cost, impact and financial structure

SUBSIDY DESIGN EXCEL TOOL

Design Tool country comparison outputs

This section shows a comparison of model results between Kenya, Togo and Rwanda

Content of the section

Input Output

1 Inputs for the exercise

- Selection of the five key choices of the tool (homogeneous for all the countries to enable the comparison)

2 Total cost

- The total cost per country
- Cost per farmer per country

3 Financial terms

- Financial terms (% upfront, % loan, % subsidy) per country per segment

4 Cash flow

- Cash flow from the program implementer, finance provider and farmer perspective per country

5 Impact

- Impact on productivity, income, emissions, hours spend on water collection and resilience[1]

Explanation of main drivers that generate differences between countries

Source: Dalberg analysis

Note: (1) An advanced version of the tool should capture how much water is likely to be abstracted over a given development area and part of the water accounting framework

Kenya has a lower subsidy cost, a higher loan component, and a greater impact on income than other countries (Togo & Rwanda)

The Design Tool includes scenarios for subsidies being rolled out in three countries: Kenya, Togo and Rwanda, to assess cost and impact. All inputs can be varied by the user. The outputs have been benchmarked against real-world data for ongoing subsidies in Rwanda, Togo, India, Nepal and Bangladesh.

Inputs

Total Beneficiaries (farmers) 5,000

- Unstructured – 2,500
- Multicrop – 1,500
- Horticulture – 1,000

Loan tenor (months)

- Unstructured – 12
- Multicrop – 9
- Horticulture – 6

Interest rate for farmers

- 20%

Outputs

Total Cost

Cost per farmer

- Kenya: $566
- Rwanda: $860
- Togo: $883

Benchmarks:
Rwanda: $1,000
Togo: $700

Financial Structure

Subsidy %

- Kenya: 0-13%
- Rwanda: 55-67%
- Togo: 55-71%

Benchmarks:
Rwanda: 50%
Togo: 50%
India: 80-90%
Nepal: 60-70%
Bangladesh: 50%

Impact

Increase in productivity

- Kenya: 24-103%
- Rwanda: 13-100%
- Togo: 37%-103%

Benchmark:
Kenya: 100-300%
Conservative assumptions used

Decrease in emissions (per year)

- Kenya: 1,148 tons
- Rwanda: 1,247 tons
- Togo: 1,013 tons

Benchmark:
Bangladesh: 1,000 tons

Source: Dalberg analysis

The different levels of subsidy are driven by a set of key country parameters, including farmer income and SIS prices

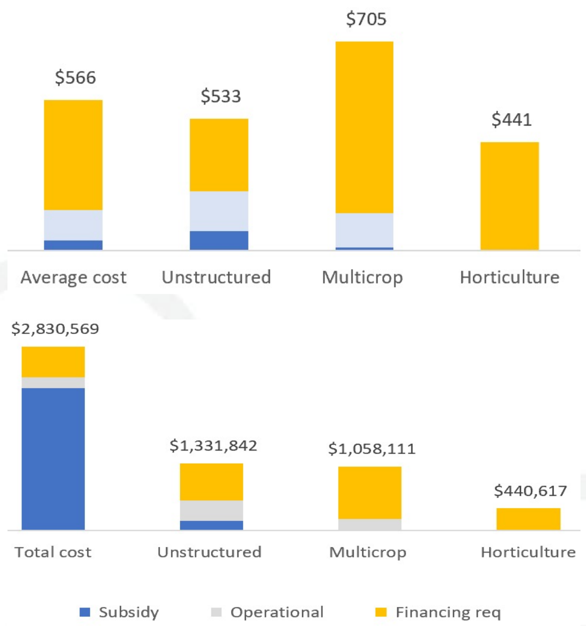
	Description	Differences between countries
Farmer income	• **Farmer income is a crucial parameter since it determines the farmer ability to save** and, therefore, the amount that the farmer can pay upfront and per month (loan) • **The lower the income is** (given a certain SIS price), **the higher the subsidy** will need to be to overcome the affordability barrier • **Since income data is difficult to find**, it is estimated based on crop shares (% of each crop type for low and high-value crop farmers), productivity (tons per acre) and prices (usd per ton) reported by FAO	• **Kenya has farmers with the highest incomes.** This is driven mainly by the high productivity per acre. Therefore this is the country with the lowest subsidy levels. • **Togo has farmers with the lowest incomes** driven by low productivity and prices. Therefore, this is the country with the highest subsidy levels. • **Rwanda has farmers with income slightly higher than those in Togo**, and the main difference is that those farmers have better prices but still a significantly low productivity
SIS Prices	• **SIS is also a crucial parameter because it determines how costly it will be** for the farmer to irrigate the fields with solar power • **The higher the SIS price is** (given a certain income), **the higher the subsidy** will need to be to overcome the affordability barrier	• **Prices of SIS are quite homogeneous** between countries • **The main differences in prices are driven by taxes and transportation** costs

"Price is going to be the same - apart from transport, VAT and import taxes. It does not change much between countries."
- Distributor

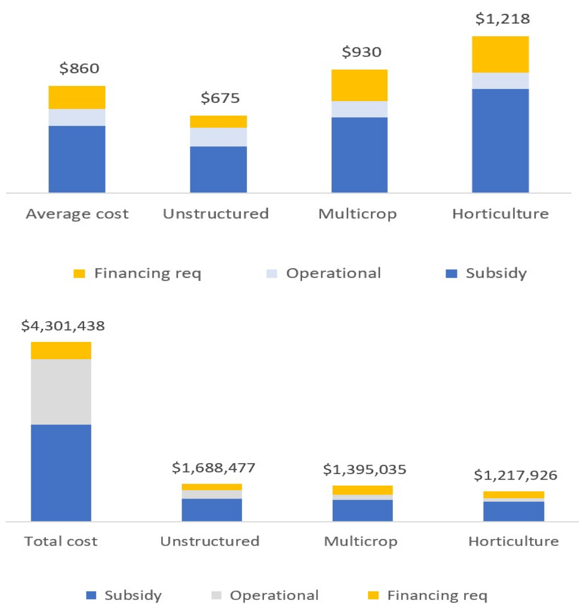
Source: Dalberg analysis

Kenya has the lowest subsidy cost per farmer vs other countries due to the highest relative income of their farmers

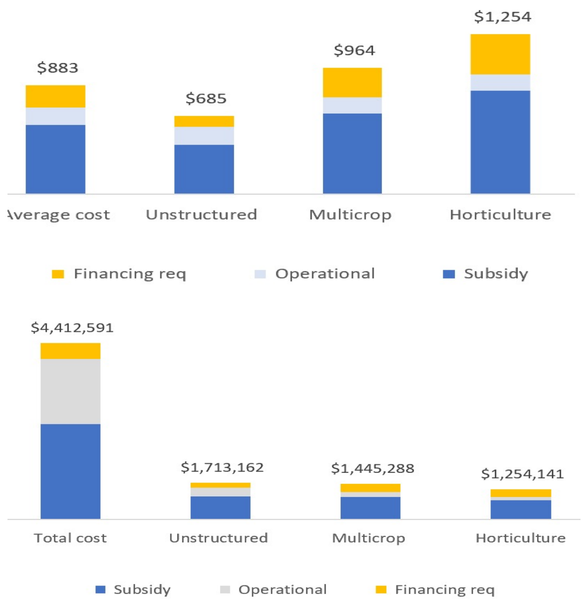
Kenya



Rwanda



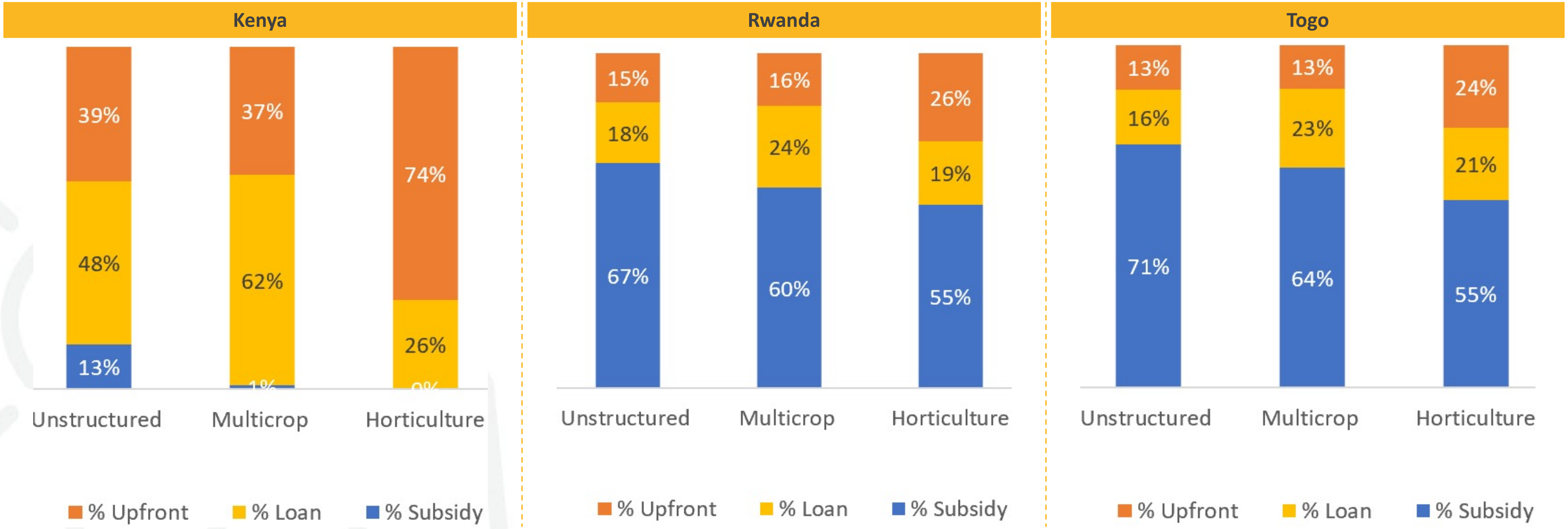
Togo



- In Kenya, the subsidy cost per farmer is lower ($566), and most of the upfront expenditure is on financing of the pumps. Therefore, a big part of the total cost will be recuperated when farmers pay back
- Rwanda and Togo have similar farmer profiles based on the data for farmers who use SWP. As a result, they have a significantly higher cost per farmer ($860-$883) and a larger proportion of direct subsidy and related operational costs.
- In general, the larger the acreage of the farmer, the higher the total cost of the programme per farmer. Even though the direct subsidy percentage of the program is lower for those farmers, the price of the pumps are higher ($1,600 vs $600)[1] – Care must be taken to ensure subsidies do not inadvertently support richer farmers

Source: Dalberg analysis
Note: (1) comparison between three-acre and one-acre pumps prices

Rwanda has a similar farmer profile to Togo, and therefore, the required level of subsidy is higher than in Kenya



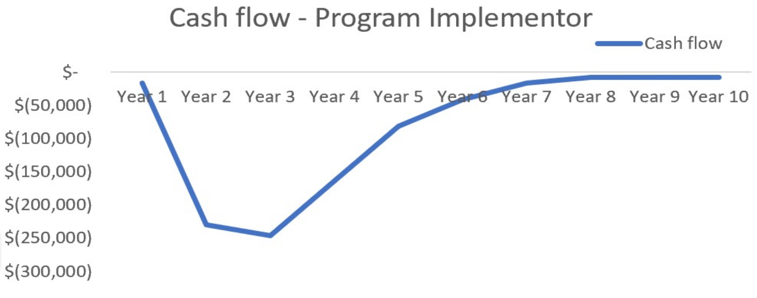
- In Kenya, horticulture farmers only need financing under these settings/choices. Unstructured farmers are significantly richer than in the other countries ($235 vs $80 per month), leading to a lower direct subsidy needed (13% vs 67-70%)
- Rwanda and Togo have similar farmer profiles (farmers with lower income than in Kenya). As a result, they have significantly higher direct subsidy needs (more than 50% in all cases)
- In general, the larger the scale of the farmer, the lower the direct subsidy needed and the higher the financing component.

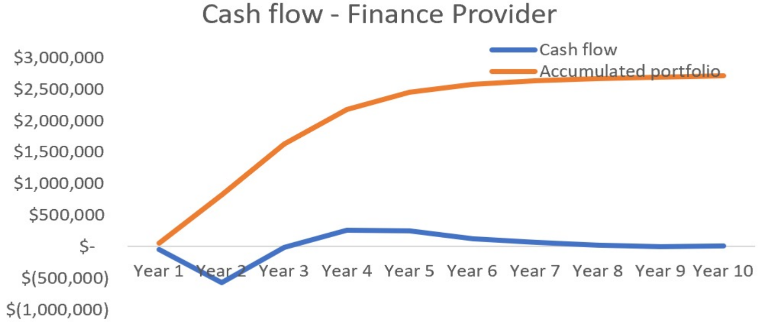
Source: Dalberg analysis

The cash flow evolution for implementers is similar for the three countries; the main difference is the size

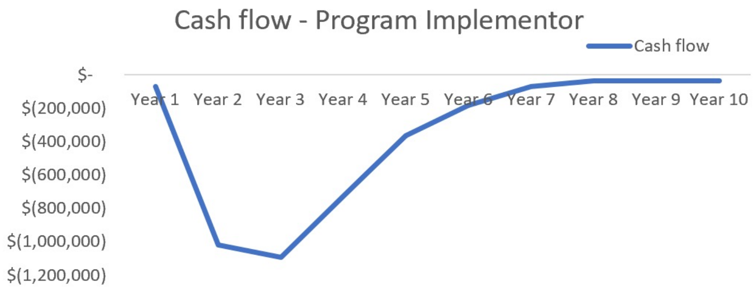
Kenya	Rwanda	Togo

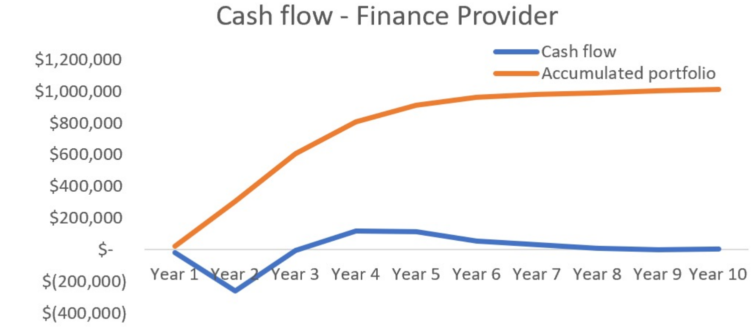
Kenya



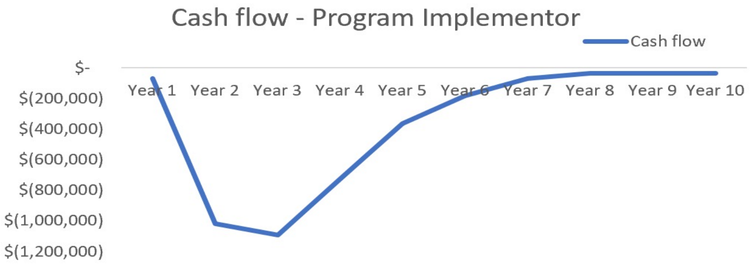


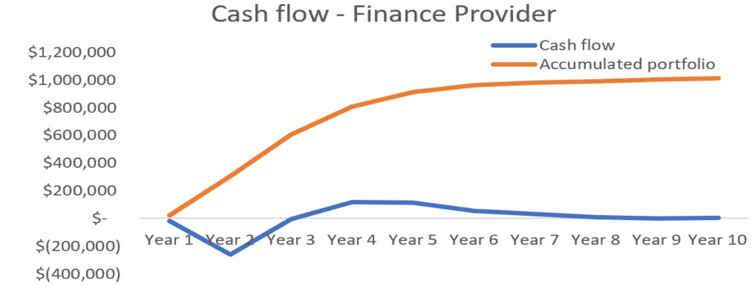
Rwanda





Togo



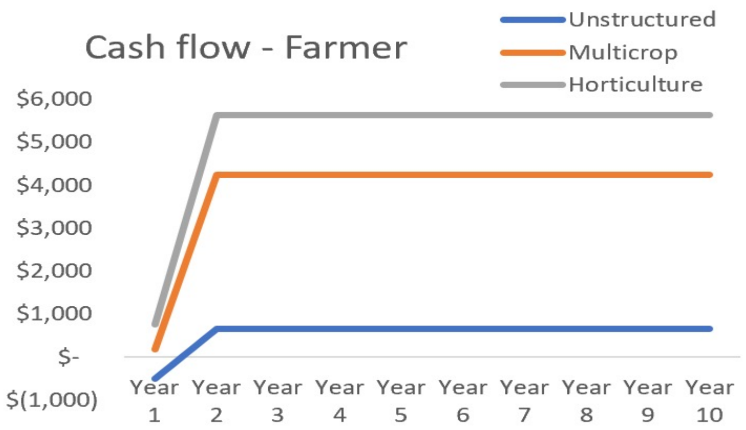


- The evolution on cashflow curves are similar between the three countries since the main driver is the proportion of total beneficiaries that take up the subsidy per year – Which is assumed to be the same between countries[1]
- The main differences are in the scale of cash flow – Larger amounts are needed from the program implementer in Rwanda and Togo, while the investment is higher from the finance provider perspective in Kenya (the accumulated portfolio is more than double vs. other countries on year 10)
- By year four, in all countries the financier would be **cumulatively cash flow positive** (interest on loans outweighs defaults)

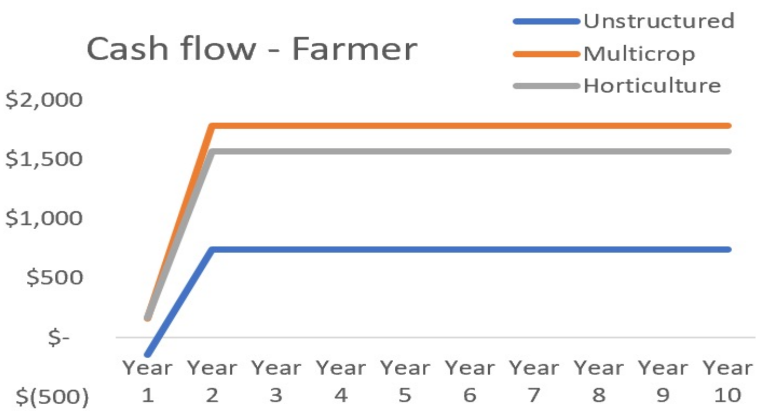
Source: Dalberg analysis
Note: (1) Beneficiaries curve is one of the adjustable inputs of the model

The farmer cash flow growth is similar between the three countries; with the main difference between farmer segments

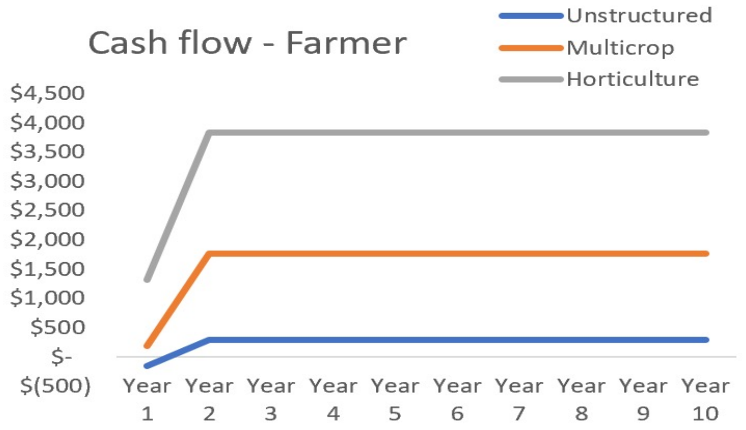
Kenya



Rwanda



Togo



- *For an individual farmer, they are immediately cash flow negative (or significantly low) due to the upfront payment*
- *Monthly cashflows then improve due to a) Reduced fuel payments or b) Improved yields, and reach their peak on the second year after purchase once the pump has been fully paid off*
- The cash flow magnitude is significantly different between countries driven by differences in productivity and prices. Therefore, also the affordability per month and the need for subsidy percentage differs per country.
- The evolution of cashflow curves is again similar between the three countries since the main driver is the loan tenor, productivity increase and savings in diesel[1], and these are assumed to be the same between countries (although can be adjusted). By year 2 and 3, the pump has been fully repaid and the annual income improvement is set.
- In all countries, unstructured farmers have less income vs baseline on the first year because they have to pay the pump deposit[2] (10-20% of the total value of the pump) and the monthly payments. This amount is normally greater than the additional income they receive from extra produce since they are producing low-value crops, and the lag in productivity increase is greater than in high-value crops
- In Rwanda, multicrop farmers have more additional income than horticulture farmers since the prices between high and low-value crops are more homogeneous than in other countries
- In Kenya and Togo, horticulture farmers are the ones experiencing a greater increase in income per year since high-value crop prices almost double the prices of low-value crops in both countries

Source: Dalberg analysis
Note: (1) Productivity increases and savings in diesel are adjustable inputs of the model; (2) A PAYGo provider in some cases ask for a deposit (e.g., three monthly payments in Togo). For the FI, the 'deposit' is the amount spent on the pump that is not financed.

The differences in impact per country are explained by the productivity levels and diesel irrigation penetration

Kenya

Total impact per year

	Total	Per beneficiary
Production (additional kg)	21,328,131	4,266
Income (additional usd)	$ 10,803,326	$ 2,161
Emissions (reduction in CO2 in kg)	-1,148,759	-230
Gender (hours saved on water collection)	2,646,250	529
Resillience (kg. not lost due to drought)	1,446,687	289

Rwanda

Total impact per year

	Total	Per beneficiary
Production (additional kg)	9,042,291	1,808
Income (additional usd)	$ 5,523,968	$ 1,105
Emissions (reduction in CO2 in kg)	-1,249,683	-250
Gender (hours saved on water collection)	2,463,750	493
Resillience (kg. not lost due to drought)	582,628	117

Togo

Total impact per year

	Total	Per beneficiary
Production (additional kg)	6,610,680	1,322
Income (additional usd)	$ 5,422,626	$ 1,085
Emissions (reduction in CO2 in kg)	-1,013,698	-203
Gender (hours saved on water collection)	2,874,375	575
Resillience (kg. not lost due to drought)	516,644	103

- There is greatest potential improvement in production and income in Kenya, as the other supportive conditions are already in place (education, markets)
- Emissions reduction per beneficiary is higher in Rwanda, as it has the highest diesel pump penetration
- Togo has the least current access to motorized irrigation and therefore the one with the higher number of hours saved on water collection per beneficiary; this benefits women more than men
- Improvement in resilience (e.g., kg saved) is highest in Kenya; this is driven by the higher productivity of farmers

Source: Dalberg analysis

ANNEX

SECTION SIX

Areas for further development and consideration

Several areas were beyond the scope of this report but should be considered in any future development of an end-user subsidy. These include:

1. **Ecosystem: Further detail on the full set of ecosystem issues relating to catalyzing SIS uptake –** Further analysis and work on improving credit scoring, risk portfolios of lenders and PAYGo providers, how to stimulate market awareness, how to support distributor liquidity constraints, and how to improve infrastructure requirements (e.g., boreholes).
2. **Water table risks: Develop considerations on the water resource requirements before solar irrigation is deployed, alongside best practices in water management –** Additional assessments on water table baseline conditions and potential risks per region should be performed to define whether an irrigation subsidy is suitable for the country/region. Anecdotal input from current distributors suggested this was not a current area of major concern; but if the market developed at pace, water usage could rise substantially.
3. **Alternative models: Include alternative models such as combined ownership –** There are multiple other ownership models that could be considered in a roll out, such as several farmers owning a pump together. This should be factored into any deep market assessment when rolling out a subsidy
4. **Crop-specific subsidies: Consider crop-specific programs – Local conditions are better suited to some crops rather than others.** Whilst administering a crop-specific subsidy would be complex, it could allow targeting to those crops that have the best return on the farmers investment.

Resource repository (1/4)

Institution/Publisher	Report Name	Year	Main topics/description
GIZ	Toolbox on Solar Powered Irrigation Systems	2021	• Information and tools for advising on solar water pumps and irrigation
GOGLA	End User Subsidies Resource Center	2021	• Overview of how end-user subsidies can help reach the poorest • Papers profiling smart design • Recordings from recent webinars on smart subsidies and bridging the affordability gap
Economic and Political Weekly	Solar Irrigation Pumps: Farmers' Experience and State Policy in Rajasthan	2014	• Lessons learned form the SEP subsidy in Rajasthan
Economic and Political Weekly	Karnataka's Smart, New Solar Pump Policy for Irrigation	2014	• Karnataka's Policy for Irrigation • Groundwater over-exploitation
Energy Policy	Solar-based groundwater pumping for irrigation: Sustainability, policies, and limitations	2017	• Groundwater over-exploitation
Lighting Global	The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa	2019	• Market size for PULSE use cases in SSA • Uptake of PULSE appliances by country • Main Actors bringing PULSE appliances to market in SSA
Efficiency for access	Use and benefits of Solar Water Pumps	2019	• Kenya, Tanzania and Uganda Consumer Research
Lighting Global, GOGLA & ESMAP	Off-grid market trends report	2020	• The State of the Off-Grid Solar Market • Socioeconomic and Environmental Impact • Market Outlook 2030

Resource repository (2/4)

Institution/Publisher	Report Name	Year	Main topics/description
Efficiency for Access	Global LEAP Awards: Buyer's Guide for Solar Water Pump	2019	• Competition overview • Solar water pump testing process • Information included for each product
Efficiency for Access	Promoting high-performing off-grid appliances	2019	• Quality standards for off-grid appliances
World Bank	Enabling the Business of Agriculture	2019	• Assessment of whether governments make it easier or harder for farmers to operate their businesses
GOGLA	Discussion Paper: How End-User Subsidies Can Help Achieve Universal Energy Access	2021	• Discussion on how end-user subsidies for off-grid solar solutions fit within the 'toolkit' of public financing solutions to accelerate energy access
Efficiency for Access	Solar Water Pump Outlook	2019	• Size of the opportunity • SWPs technology snapshot • Consumer and supply side actors dynamics • Pathways to growth
USAID & Power Africa	Off-Grid Solar Market Assessment Rwanda	2019	• Country context • Energy sector overview • Agricultural and productive-use solar companies
USAID & Power Africa	Off-Grid Solar Market Assessment Kenya	2019	• Country context • Energy sector overview • Agricultural and productive-use solar companies
International Solar Alliance	Pre-feasibility Report for implementation of solar pumps scheme in Togo	2019	• Feasibility analysis • Advantages of solar irrigation • Key Stakeholders

Resource repository (3/4)

Institution/Publisher	Report Name	Year	Main topics/description
Energy for Impact	Solar Irrigation Rwanda – Developing a new Market for smallholder farmers	2021	• Lessons learned from the SWPs subsidy in Rwanda
World Bank	Solar Pumping: The basics	2018	• Economic benefits • Major components & sizing guidance • System design & installation
Lighting Global	Lighting Global Quality Assurance Framework	2018	• Framework and intentions of the Lighting Global Quality Assurance (QA) program
GOGLA	PAYGo SOLAR: Lighting the Way for Flexible Financing and Services	2017	• PAYGo model description
FuturePump	What irrigation options are there for SHFs?	2019	• Pros and cons of the different ways to irrigate farms
ESI Africa	Partnership cultivated to deliver solar-powered farming in Togo	2020	• Description of the SWPs subsidy design in Togo
GSMA	Smart subsidies and digital innovation: Lessons from Togo's off-grid solar subsidy scheme	2021	• Lessons learned form the SHS subsidy design
International food policy institution	Instruments to target agricultural subsidies to desired beneficiaries	2012	• Identification of beneficiaries for a subsidy • Subsidy instruments to optimize targeting
Mercy Corps	Policy Brief: Achieving food security in Kenya through smart solar irrigation	2020	• Current solar irrigation market & constraints • Recommendations for policy interventions
FAO	The benefits and risks of solar- powered irrigation	2018	• How different countries promote and manage solar-powered irrigation (California, India, Kenya, Mexico, Morocco, Nepal, Senegal)
Open Capital	A new approach to significantly scaling climate smart technologies	2021	• CLIPP platform development

Resource repository (4/4)

Institution/Publisher	Report Name	Year	Main topics/description
Water and energy for food	"Water and Energy for Food (WE4F) Grand Challenge for Development"	2020	• Southern and Central Africa Landscape Mapping
Water and energy for food	"Innovator guidebook"	2019	• Business Models for the Base of the Pyramid in Water and Energy for Food
World Bank	"The Farmer-led Irrigation Development Guide"	2019	• A what, why and how-to for intervention design
Agrilinks	"Building a Better Solar Irrigation Market in Ghana"	2021	• Solar irrigation market assessment in Ghana
60 Decibels	"Uses and impacts of solar water pumps"	2021	• End-user insights from Kenya, Rwanda, Senegal, Tanzania, Uganda, Zambia
Efficiency for Access	"Solar water pump durability research memo"	2020	• Information about SWP durability compiled through testing, interviews with various SWP experts, and available literature
Global LEAP	"Global LEAP Solar Water Pump Test Method"	2021	• Description of test methods for evaluating small solar water pumping systems (SWPs)
Efficiency for access	"Solar Water Pumps: Sola appliances technology brief"	2021	• Synthesis of the latest market intelligence and pathways to commercialization for SWPs
IDCOL	"Solar Irrigation Program"	2021	• Description of the solar irrigation program in Bangladesh
Ministry of Agriculture Uganda	"Micro Scale Irrigation Program"	2021	• Description of the micro-scale irrigation program in Uganda
World Bank	"Doing More with Less : Smarter Subsidies for Water Supply and Sanitation"	2019	• Assessment of subsidies for water supply and sanitation

Interview list (1/2)

Institution	Title	Interviewee
Mercy Corps	Agriculture Manager	Samuel Karanja
Ignite	Chief Operating Officer	Teddy Ongamo
International Solar Alliance (ISA)	Director	Jagjeet Sareen
FuturePump	Managing Director	Toby Hammond
Bboxx	Expansion Manager	Olivier De Vreese
Ministry of Energy – Kenya	Advisor	Eric Mwangi
Centre for Alternative Technologies (CAT)	Sales Director	Dalila Ibrahim
CLASP	Senior Manager	Jenny Corry Smith
CLASP	Senior Manager	Jeff Stottlemyer
CLASP	Manager	Makena Ireri
Davis & Shirtliff	Solar Division Manager	Norman Chege
Davis & Shirtliff	Head of Irrigation	Stephen Wambua
Rwandan Agriculture Board (RAB)	Irrigation Technology Transfer Specialist	Papias Mucyo
One Acre Fund (OAF)	Manager	Joel Ogembo
One Acre Fund (OAF)	Associate - Program Design Impact	Hepsiba Chepngeno
Juhudi Kilimo	Chief Business Officer	David Njiru
Angaza	Head of Channel Partnerships	Shelby Degalan
Angaza	Sales Specialist	Margaret Wambugu

Interview list (2/2)

Institution	Title	Interviewee
Lorenz	Head of Marketing	Adrian Honey
World Bank	Energy Access Consultant	Johanna Galan
IFC	Consultant	Honglin Hui
KOSAP	Project Manager	Ashington Ngigi
National Irrigation Authority – Kenya	Deputy General Manager (Research, Planning and Strategy)	Vincent Kabuti
Energy for Impact (E4I)	Project Technical Manager	Saulve Divin Ntivunwa
Global Off-Grid Lighting Association (GOGLA)	Head of Policy and Regional Strategy	Patrick Tonui
Global Off-Grid Lighting Association (GOGLA)	Research Lead	Susie Wheeldon
VeraSol	Director	Ari Reeves
Population Services Kenya	Director – Franchise and Partnerships	Sylvia Wamuhu
SunCulture	CEO & Co-Founder	Samir Ibrahim
IKEA Foundation	Head of Renewable Energy	Jeffrey Prins
SNV Netherlands Development Organisation	Sector Lead for Energy in Kenya & Burundi	Susanne Hounsell
SNV Netherlands Development Organisation	Team lead & Energy Expert	Merijn Havinga
Ministry of Agriculture, Animal Industry and Fisheries – Uganda	Civil Engineer	Allan Ollando
Ministry of Agriculture, Animal Industry and Fisheries – Uganda	Principal Engineer, Irrigation and Drainage	Dominic Banaga Mucunguzi

Disclaimer

The conclusions and judgments contained in this report should not be attributed to, and, do not necessarily represent the views of, IFC or its Board of Directors, or the World Bank or its Executive Directors, or the countries they represent. IFC and the World Bank do not guarantee the accuracy of the data in this publication and accept no responsibility for any consequences of their use. The information contained in this publication is derived from carefully selected sources that are believed to be reasonable. IFC and the World Bank do not guarantee its accuracy or completeness and nothing in this document shall be construed to be a representation of such a guarantee. Any opinions expressed reflect the current judgement of the author of the relevant article or features, and does not necessarily reflect the opinion of IFC or the World Bank. The opinions presented are subject to change without notice. IFC or the World Bank accept no responsibility for any liability arising from the use of this document or its contents

THANK YOU

LIGHTING GLOBAL
Catalyzing markets for modern off-grid energy

AN INNOVATION OF WORLD BANK GROUP
THE WORLD BANK IBRD • IDA | IFC International Finance Corporation

In Partnerships with

ESMAP Energy Sector Management Assistance Program

Dalberg Design