PRODUCTIVE USE OF ENERGY:

A Program Design Guide

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1818 H Street NW, Washington, DC 20433

Telephone: 202-473-1000; Internet: www.worldbank.org

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Foreword

Josephine Waweru, a smallholder farmer in Kenya, spent years carrying water to her crops, only to watch them fail during droughts. A solar water pump, which she was able to pay for over time, turned her farm and her life around. It helped her coffee plants recover and allowed her to diversify her crops.

Farmers, entrepreneurs, and businesses are using productive use of energy (PUE) equipment like Josephine's pump to raise their productivity, incomes, and resilience. Other examples include cold storage that keeps produce from spoiling and milling equipment that allows agricultural products to be processed locally. As Josephine said, these tools "can turn hopelessness into dignity." As electricity reaches more people, governments are increasingly asking how access to energy can translate into jobs, higher incomes, more resilient livelihoods, and broader economic transformation.

Answering that question means learning from what has not worked. Too many PUE programs have started with a planned technology or a financing instrument and then looked for people to use it. Equipment has been delivered into markets that could not sustain it. Solar-powered cold rooms that did not fit local food systems now stand unused, together with other assets that have fallen idle once program support ended.

The programs that succeeded tell a different story. They started from viable economic opportunities and customer demand, not from a predetermined technology. They addressed the end-user constraints that determine whether productive activities can grow, including access to finance, market linkages, skills, and policy support. They brought in agriculture ministries, cooperatives, NGOs, and companies that held knowledge the energy sector lacks. They planned from the outset for how results would last beyond the end of the program.

This guide draws on lessons from more than 50 in-depth studies and the experience of over 40 programs, considering both the successes and the missteps. We found that effective program design should be outcome-led, cross-sectoral, agile, holistic, and lasting. Throughout, the focus should be on the intended outcome, not on any particular technology, power source, or financing instrument. Above all, productive use cannot be achieved by the energy sector acting alone. The guide turns these principles into a practical process.

We hope this guide helps governments and development partners build on what has already been learned, avoid the pitfalls of the past, and design programs grounded in local realities. We hope it helps create many more stories like Josephine's.

Fanny Missfeldt-Ringius
Manager, ESMAP, World Bank Group

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Principal Authors

Dalberg: Axel Schoerner Emillon, Parth Madan and Sarvesh Singh
ESMAP/World Bank: Charlie Miller, Charlotte Heffer and Leo Blyth

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- **Expert Panel and External Reviewers:** Anne Waburi (GOGLA), Bas Hetterscheid (Wageningen University & Research), Carlos Sordo (GOGLA), Chianda Njogu (GEAPP), Chris Emmott (Acumen), Denis Karema (SokoFresh), Duda Cardoso Slawek (Open Capital Advisors), Jakub Vrba (Energy Saving Trust), Luc Severi (Sustainable Energy for All - SEforAll), Michael Maina (Global Energy Alliance for People and Planet), Odunayo Onafuye (Africa Minigrid Developers Association – AMDA), Sarah Alexander (SNV), Susie Wheeldon (GOGLA), Tanya Kothari (Shell Foundation)

ESMAP
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Abbreviations

AC	Alternating current
ASCENT	Accelerating Sustainable and Clean Energy Access Transformation
B2B	Business-to-business
B2C	Business-to-consumer
BGFA	Beyond the Grid Fund for Africa
CapEx	Capital expenditure
DARES	Distributed Access through Renewable Energy Scale-up
DC	Direct current
DFI	Development finance institution
dMRV	Digital Monitoring, Reporting, and Verification
DRE	Decentralized renewable energy
EaaS	Energy-as-a-service
EASP	Electricity Access Scale-up Project
ESMAP	Energy Sector Management Assistance Program
FCDO	Foreign, Commonwealth & Development Office
FI	Financial institution
GEAPP	Global Energy Alliance for People and Planet
GOGLA	Global Off-Grid Solar Association
IDCOL	Infrastructure Development Company Limited
KOSAP	Kenya Off-Grid Solar Access Project for Underserved Counties
MAAI	Ministry of Agriculture, Animal Industry and Fisheries
MEMD	Ministry of Energy and Mineral Development
MFI	Microfinance institution
MSIP	Micro-scale Irrigation Program
MSME	Micro, small, and medium enterprise
NESAP	Niger Solar Electricity Access Project
NGO	Non-governmental organization
OEM	Original Equipment Manufacturer
OGS	Off-grid solar
OpEx	Operating expenditure
PASA	Programmatic Advisory Services and Analytics
PAYG	Pay-as-you-go
PER II	Plan de Electrificacion II
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan
PREO	Powering Renewable Energy Opportunities
PRODEFI II	Value Chain Development Programme Phase II
PRODUSE	Productive Use of Energy
PUE	Productive use of energy
PUFF	Productive Use Financing Facility
PULSE	Productive Use Leveraging Solar Energy
PURE	Productive use of renewable energy
QA	Quality assurance
RBF	Results-based financing
REACT	Renewable Energy and Climate Technologies
RERED	Rural Electrification and Renewable Energy Development
SACCO	Savings and credit cooperative organization
SEFFA	Sustainable Energy for Smallholder Farmers
SHF	Smallholder farmer
SHS	Solar home system
SWP	Solar water pump
TA	Technical assistance
UECCC	Uganda Energy Credit Capitalisation Company
VAT	Value-added tax
WE4F	Water and Energy for Food

Executive Summary

Universal electricity access has still not been achieved. 655 million people still lacked basic electricity access in 2024,[1] with the population lacking access increasingly concentrated in sub-Saharan Africa and in remote, low-income, and fragile settings where extending a connection alone may not generate enough demand or income to sustain reliable service. Historically, electrification and productive activity have advanced together, each reinforcing the other. This mutually reinforcing pathway has been more difficult to establish in underserved areas. Productive use of energy (PUE) – commercial use of energy that enhances productivity and leads to job creation, increased incomes, cost savings, and economic growth – can help to convert access into income and jobs, while strengthening demand for reliable energy services.

PUE has moved from a secondary consideration to a shared priority across governments, development partners, and financiers. Mission 300, the new Global Energy Alliance for People and Planet (GEAPP)/World Bank Group Productive Use of Energy Center of Excellence, and the inclusion of PUE in National Energy Compacts all reflect this shift, as does the growing focus of funders such as the Foreign, Commonwealth & Development Office (FCDO) and Shell Foundation on job creation. Past programs also show the limits of technology-led approaches, which have too often produced low uptake or stranded assets.

The guide is written for PUE program designers within governments and development partners, including multilateral development banks such as the World Bank Group. It aims to help practitioners identify where a market needs support, what kind of support is warranted, and how to best sequence interventions, with the objective of building healthy, lasting PUE markets capable of attracting significant private co-investment. A recurring theme is the need for a common language across sectors: what the energy sector calls PUE is described as mechanization in agriculture, income-generating assets in finance, and value addition in trade programs. Speaking only in energy terms risks a program being read too narrowly by the ministries and partners it needs to work with.

Program designers do not need to wait for perfect conditions. They can start once they know the development outcome they are seeking and the sector(s) they will focus on and can identify at least one meaningful intervention against a clear market barrier, adding analysis, partnerships, and components as evidence builds. The "How to Use this Guide" box in the Introduction shows different readers where to start.

Five design principles run through the guide and are treated as interdependent, rather than as a menu to select from. Programs should be:

Outcome-led: starting from the targeted development outcome rather than from a preferred technology means design should be end user centric, not supplier- or technology-centric. Programs need to track whether end-user businesses actually grow and sustain jobs, not just how much equipment is deployed – and treat power supply setting as a design choice rather than a guiding assumption.

Cross-sectoral: the building blocks that determine PUE success sit mostly outside the energy sector, requiring active, continuous partnership with agriculture, water, finance, and trade counterparts rather than coordination at the margins. Programs anchored in national sectoral strategies prove more durable than externally driven ones.

[1] Source: IEA, IRENA, UNSD, World Bank Group, WHO, Tracking SDG 7: The Energy Progress Report, 2026, Chapter 1.

Agile: comprehensive market assessments are often unnecessary before launch, since strong cross-sector stakeholder engagement paired with existing institutional knowledge can support a flexible, adaptive design. This enables programs to reserve data gathering for the decisions – in areas such as targeting, subsidy levels, or financing structures – that benefit most from quantitative primary data. During implementation, management information systems and stakeholder feedback loops should flag changing market conditions early, and designs should be flexible enough for programs to reallocate funds, revise eligibility, or recalibrate incentives quickly.

Holistic: barriers rarely stop at energy access, since working capital, market linkages, and end user or micro-entrepreneur skills are frequently just as binding, and no single actor – least of all the supplier – can close every gap alone. Programs must identify the most appropriate partner(s) to address each market barrier and enable them to do so. Equity and inclusion, particularly for women who make up a substantial share of productive users in agriculture, food processing, and informal commerce, must also be built into design from the outset.

Lasting: programs should design for sustained use, not just initial uptake, with every instrument carrying an explicit exit logic that identifies from the outset which market actor will sustain each function once support tapers or ends – and a live decision point, not just a fixed timeline, for what happens if that actor isn't ready when planned support runs out.

The guide then puts these principles into practice through a three-step design process built around five building blocks: technology and innovation, market and business development, access to finance, policy and regulation, and – as a cross-cutting block – cross-sectoral, multi-stakeholder, and evidence-based planning and collaboration.

Designers begin with a broad situation analysis, anchored in government priorities, and choose a lower- or higher-risk entry point. Substituting costly, high-emission or unreliable energy supply, such as diesel generation, is typically the lowest-risk entry point, because existing energy spending shows both demand and ability to pay. Enhancing existing economic activity carries moderate risk, while building new activity can have high impact but carries a higher risk of low uptake and stranded assets. Programs can pursue more than one of these strategies in parallel.

From there, designers assess the strength of each building block against local evidence and allocate responsibility for closing gaps to the stakeholders best placed to act, distinguishing who delivers a function during the program from who will own and sustain it afterward, and sequencing interventions rather than attempting all of them at once.

Finally, designers select specific interventions: quality assurance and digital tools; technical assistance to asset owners, end users, and suppliers, and consumer awareness campaigns; financing instruments – results-based financing, upfront grants, equity financing, credit lines and guarantees, matching grants, and utility- or developer-based financing – matched to market maturity and suppliers' business models; and the policy and regulatory conditions – cross-sector coordination mechanisms, import and tax policy, and tariff design – that determine whether other interventions can succeed at all. Before choosing a financing instrument, teams should be able to answer a short set of diagnostic questions, set out at the start of Step 3.3. A consistent message throughout is that financing works best when bundled with market development and technical support rather than deployed alone.

The guide closes with a short conclusion and a research agenda. The agenda covers topics such as the cost-benefit profile of specific interventions and ways of measuring PUE outcomes across sectors. It also calls on program designers to help close these evidence gaps by setting and tracking clear indicators, reserving budget for independent evaluation, and disclosing results publicly. PUE program design can only continue to improve if the evidence base underpinning it improves too.

Introduction

More than a century after the emergence of modern electricity grids, universal access has still not been achieved. Global electricity access reached 92% in 2024, yet 655 million people were still living without basic electricity access.[2] The remaining gap has become increasingly concentrated in sub-Saharan Africa, and in remote, low-income, and fragile settings where conventional approaches are often more costly and difficult to sustain. Low population density, limited household purchasing power, weak infrastructure, and constrained public and private finance make these communities among the hardest to reach.

Historically, electrification and productive activity have often advanced together.[3] Electricity enabled enterprises to mechanize, raise productivity, create jobs, increase incomes, and improve living standards. Expanding economic activity, in turn, helped households and businesses afford and productively use electricity. This mutually reinforcing pathway has been more difficult to establish in still underserved areas, where extending a connection alone may not generate sufficient demand or income to sustain reliable service. However, advances in decentralized renewable energy technologies, efficient productive equipment, digital finance, and service-based business models continue to create new possibilities. By placing viable productive activity and development outcomes at the center of program design, productive use of energy (PUE) can help convert electricity access into income and jobs while strengthening demand and sustained energy-service delivery. This guide sets out how programs can realize that opportunity without reverting to technology-led approaches that have too often produced low uptake or stranded assets.

PUE has become a shared priority for governments and development partners alike, across multiple sectors. Scaling up PUE is essential to enhancing the economic and fiscal impact of access programs, as well as to the achievement of a broader range of development goals such as food security and climate resilience. Powering economic activity is central to the World Bank Group's job creation strategy. Mission 300,[4] which aims to connect 300 million people in sub-Saharan Africa by 2030, frames access as a platform for economic transformation, and the new GEAPP/World Bank Group Productive Use of Energy Center of Excellence reflects the same shift.[5] Governments are embedding PUE in National Energy Compacts,[6] and funders including FCDO and Shell Foundation consider job creation a critical outcome of their energy programs.

This guide is for program designers seeking to leverage energy to achieve a range of development outcomes. It is written for governments and development partners building or refining PUE programs. It is intended to help program designers make better decisions, faster, when designing PUE programs, by providing a practical framework for gathering data, mapping and consulting stakeholders, analyzing market barriers, and designing interventions. **It is organized into three chapters:**

Chapter 1: PUE Concepts, Markets and Design Principles

→ Proposes a common language for talking about PUE, provides an overview of PUE technology, business models, and value chain structures, and introduces five key design principles.

[2] Source: IEA, IRENA, UNSD, World Bank Group, WHO, Tracking SDG 7: The Energy Progress Report, 2026, Chapter 1.
[3] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.
[4] Source: Mission 300.
[5] Source: GEAPP, Center of Excellence on Productive Use of Energy.
[6] Source: Mission 300, Compacts.

Chapter 2: The PUE Program Design Process

→ Presents a structured process to guide program designers in transforming a broad idea into the core elements of a program design, based on best practice.

Chapter 3: Conclusion and Further Research

→ Draws the guide's lessons together and identifies areas for further research to support informed decision-making going forward.

The guide is based on a literature review that examined more than 50 studies in depth (see Appendix V), alongside extensive stakeholder consultations (see Appendix II). The proposed design principles and process are grounded in best practices and pitfalls identified across more than 40 programs, and build upon key reports from the World Bank Group,[7] the Global Off-Grid Solar Association (GOGLA),[8] GET.transform,[9] and Energising Development (EnDev).[10] Findings were further validated and stress-tested through expert interviews and panel reviews. Productive use in grid, mini grid and off-grid settings is within scope, but social uses of energy in health, education, and other public services are not. For more information on off-grid PUE market trends please see this guide's companion publication, the Off-Grid Solar Market Trends Report 2026.

The guide encourages program designers not to wait for perfect conditions. They can start once they know the development outcome they are seeking, which PUE sector(s) they will focus on, and can identify at least one meaningful intervention against a clear market barrier. Analysis, partnerships, and components can then be added as evidence builds (see the Agile design principle in Chapter 1). A project can develop just one business model or address just one market barrier, as long as it leaves the market better placed for the next phase.

[7] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.
[8] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.
[9] Source: GET.transform, Energy for Rural Industrialisation Productive Use of Energy 2.0, 2022.
[10] Source: EnDev, Productive Use of Energy: Moving to Scalable Business Cases, 2021.

How to Use this Guide

Where to start depends on your background and role (see table below). Energy sector stakeholders usually know power supply settings well but have less experience of the demand side: viable PUE use cases, the value chains they sit in, and the market and business development support end users need to turn access into sustained, profitable use. Non-energy sector stakeholders – for example from agriculture, water, finance, or trade – tend to know end users and value chains better but need the energy basics: technologies, power supply settings, PUE supplier business models and their financing and support needs. Governments designing large-scale programs need the broadest view, covering all five "building blocks" and which actors are best placed to address each of them. For teams designing financing instruments, the report offers a checklist of questions teams should ideally be able to respond to before doing so at the start of Chapter 2, Step 3.3.

Suggested starting points for specific audiences

If you are...	Consider starting with...	Then focusing on...
An energy sector stakeholder...	**Chapter 1:** **The Outcome-led** **Cross-sectoral principles**	Step 1.2 (mapping opportunities from demand and business case, not equipment); Step 2.2 (which actors lead on each building block); Step 3.2 (market and business development, which energy programs most often under-design)
A non-energy sector stakeholder...	**Chapter 1:** **Technologies** **Business models** *(Table 1)* **Value chains**	Step 1.3 (equipment, power supply, business models and financing); Step 3.1.1 (quality assurance); Steps 3.3.1 and 3.3.6 (results-based financing, utility or developer-based financing)
A government designing a large-scale program	**Chapter 1:** **Design principles**	Step 1 (taskforce) and Step 1.1 (national strategies and roadmaps); Step 2.1 (building block assessment) and Step 2.2 (roles and sequencing); Step 3.4 (policy and regulation)

Chapter 1:
PUE Concepts, Markets and Design Principles

photo credit: Joel Mulwa for GOGLA

Finding a Common Language across Sectors

PUE is an energy-sector term. These same activities are described differently elsewhere: as 'mechanization' or 'productive assets' in agriculture, as 'income-generating assets' or 'green solutions' in finance, and as 'value addition' in trade and enterprise programs. Programs that use only energy-sector terminology risk being seen as purely energy projects by the ministries and partners from other sectors that energy professionals need to work with. Understanding how other sectors think about productive use and 'speaking their language' is a requirement for effective cross-sectoral design. This guide uses PUE for consistency, but program designers should adapt their language to the audience. For practical resources to support collaboration across sectors, and language energy stakeholders can use to talk about PUE with different audiences, please see Appendix I, and "Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar" (Agri-Energy Coalition, 2025). Key terms used in this guide are set out below.

DESIGN TERMINOLOGY:

- **Productive use of energy (PUE):** Commercial use of energy that enhances productivity and leads to job creation, increased incomes, cost savings, and economic growth. In principle, almost any commercial or industrial use of electricity meets this definition, but this guide focuses on productive uses that do not emerge on their own, and that need an intervention to overcome a market barrier before they can take off. Mainstream commercial and industrial use of grid electricity by larger businesses tends to grow without such support once connections are available and is not the focus here. Barriers are typically greatest for farmers, cooperatives, and micro and small enterprises, who may be unable to finance the equipment they need without support. On a new mini grid, for example, productive demand can take a decade or more to mature on its own; well-designed programs aim to shorten that to a few years. The boundary is not precise, and program designers will need to judge what is relevant in their context.

- **PUE equipment** covers everything from small-scale 'appliances' for use by individual farms or micro, small and medium enterprises (MSMEs) such as irrigation pumps and refrigerators, to larger-scale 'infrastructure' such as walk-in cold rooms, and agro-processing hubs.

- **Program designers** are the personnel and teams working day-to-day on PUE program design and implementation. Teams should ideally be cross-sectoral, consisting of representatives of energy and non-energy sectors.

- **PUE taskforces** are coordination mechanisms which bring together relevant ministries and other stakeholders periodically to provide coordination, strategic oversight, and links to wider policy and planning.

- **Power supply** setting refers to whether the PUE equipment is powered by grid, mini grid, or standalone off-grid power sources.

- **Use case** refers to the activity or process through which PUE equipment is used to realize productive gain.

STAKEHOLDER TERMINOLOGY:

- **Suppliers** are businesses that distribute PUE equipment. Some are manufacturers, while others are distributors that source from manufacturing partners. Some own and operate portfolios of PUE assets, while others sell directly to asset owners. These actors can also play multiple roles across the value chain – for example, SokoFresh distributes technology while also buying, storing, and selling produce.

- **Asset owners** are individuals, businesses, or cooperatives that own PUE equipment. They may operate the equipment themselves or allow others to use it in exchange for a fee or as part of a membership structure. They often play broader roles; for instance, an agricultural cooperative may source inputs for its members, own PUE equipment for shared use, and aggregate and sell their produce.[11]

- **End users** (or 'customers' from a supplier perspective) are individuals, businesses, or cooperatives utilizing PUE equipment to generate economic value. End users have typically been overlooked by PUE programs that primarily sought to support suppliers and treated end user support as a supplier concern. When programs pursue job creation and income growth outcomes, however, it is important to place end users at the center of the programs' activities and financing. End users fall into two categories:

  - **Owner-Operators:** Entities that own and operate their PUE asset or will do so following a pay-as-you-go (PAYG) repayment period.

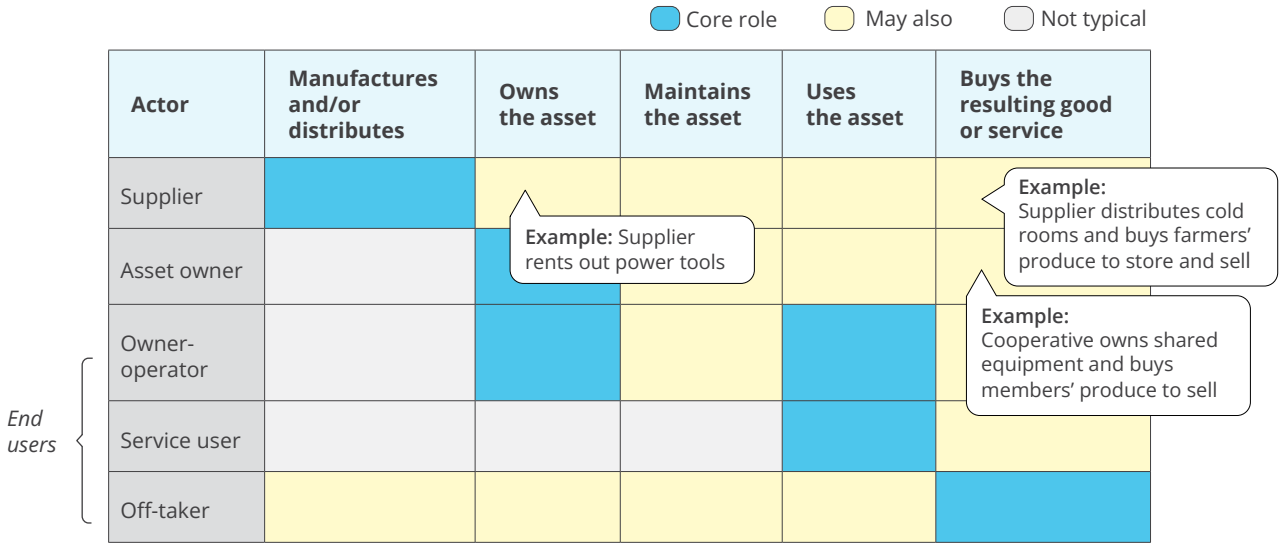
  - **Service Users:** Entities that do not own the asset, but access its energy services on a rental, leasing, or fee-for-service basis.

- **Off-takers** are the downstream market actors whose purchase of the resulting goods or services generates the revenue required to sustain PUE asset operations and financing. In the agricultural sector, off-takers typically purchase produce from farms or agro-processing hubs. In commercial and light industrial sectors, end users sell processed goods and services (e.g., metalwork, carpentry, internet access) directly to customers.

- **Aggregators** are intermediaries that consolidate dispersed produce, credit risk, payment collection or utilization, making small or fragmented PUE markets easier to serve and finance. They play a cross-cutting role across the categories above (see Value Chains).

Stakeholders often play multiple roles within the value chain, as outlined in Figure 1 below. Programs should be explicit about which actor is responsible for the long-term operation and maintenance (O&M) of each asset, since this determines whether equipment stays productive once program support ends. Figure 1 sets out who typically maintains the asset under each business model.

Figure 1: Overview of actors and their potential roles in PUE



Source: Dalberg analysis, 2026. See, for example, Hystra, Market Access for Agro-PURE Companies, 2025

[11] Source: SokoFresh.

Technologies, Business Models, and Value Chains

Technologies

Alternating current (AC)-powered PUE technologies for use in grid and mini grid settings are mature, mass produced and sold globally, while direct current (DC)-powered PUE solutions designed for use in off-grid areas range from emerging to near-to-market. In this guide maturity terms such as horizon, emerging, near-to-market or commercial refer to both the technology and the business models used to deliver it – in many PUE segments the equipment works well, but what is not yet proven is a business model that can deliver it at scale and recover its costs. The performance and longevity of off-grid PUE equipment is steadily improving, with business model innovation ongoing in areas such as sales, marketing, logistics, installation, consumer financing, after-sales services and market linkages. Off-grid PUE suppliers are generally early-stage and only a few pioneers such as SunCulture and Ecozen have succeeded in attracting significant equity or debt financing.

Historically, public support for off-grid PUE has focused on irrigation, milling, and small-scale refrigeration. Much of the recent growth in the off-grid sector, however, has come from captive power: commercial and industrial (C&I) solar systems serving larger businesses, and solar generators with inverters that can run standard AC equipment away from the grid or alongside an unreliable one. Off-grid AC power has become more viable in recent years thanks to falling battery and inverter costs, widening the range of productive activities that standalone systems can serve. Program designers scoping power supply should compare captive solar and solar generators with grid and mini grid options. For more information, see the Off-Grid Solar Market Trends Report 2026.

Figure 2 organizes common PUE use cases along four linked dimensions: size/ownership model, power supply setting, market maturity and outcome profile. Technology size shapes the likely ownership model: small-scale equipment is typically acquired outright or through PAYG (also referred to as lease-to-own) by an individual owner, while larger, capital-intensive infrastructure is more often accessed as a shared service. Size also shapes which power supply setting fits best. Smaller, DC-powered equipment suits standalone systems, while larger, AC-powered shared infrastructure needs more power, which is more likely to come from mini grid or main grid supply. Standalone solar can also power large AC loads such as mills, cold rooms and light industrial machinery, through captive solar systems or solar generators with inverters. The best fit depends on reliability, load profile, and economics. The same productive activity, such as irrigation, can be delivered at different scales and in different power supply settings, each implying different design choices. The outcome profile shows which development outcomes each combination is best placed to advance.

Figure 2: Illustrative PUE use cases by market maturity, ownership model, power supply setting, and outcome profile (non-exhaustive)

Power source fit[a,b,c]

- Common fit
- Viable depending on context
- Less common

Market maturity*[a,b,c]

- Commercial
- Near-to-market
- Emerging
- Horizon

Ownership & model

Upfront purchase / PAYG: owner-operator acquires the asset

As-a-service: entrepreneur or PUE supplier owns the asset, while service users buy access

Enterprise use: SMEs own/finance equipment

Outcome profile

- Strong
- Moderate
- Indirect / weak

Irrigation & water pumping

Most established off-grid PUE use case. Owner and model shift as power source changes.

Maturity: Near-to-market

Small-scale **Upfront purchase / PAYG**

Standalone	Mini grid	Main grid
Field pump	Shared	Shared

Shared infrastructure **As-a-service**

Standalone	Mini grid	Main grid
Co-op pump	Community pump	Scheme / canal

Outcome profile

Productivity & incomes
Higher yields, crop diversification, extended seasons.

Food security
Irrigation can significantly boost nutritional intake, especially in dry season as seen in Benin. (e)

Jobs creation
Mostly across value chain, e.g., jobs in farming, inputs, aggregation, processing, and trade.

Women
Cuts time and effort for irrigating; in Benin, it lowered watering time for women by 50%. (f)

Climate resilience
73% of farmers in Kenya felt solar irrigation improved ability to adapt to climate hazards. (g)

Grid/mini-grid revenue[a,h]
Pumps can be large loads, but irrigation is inherently seasonal.

Cooling & cold chain

Reliability is critical. Standalone and mini-grid hold strong advantage over intermittent grid.

Maturity: Emerging

Small-scale **Upfront purchase / PAYG**

Standalone	Mini grid	Main grid
Fridge/freezer	Fridge/freezer	Fridge/freezer

Shared infrastructure **As-a-service**

Standalone	Mini grid	Main grid
Cold room	Cold room	Hub / packhouse

Outcome profile

Productivity & incomes
Reduces losses and raises saleable output; 77-100% of users self-report income growth. (i)

Food security
Reduces post-harvest losses. Extends storage life and market reach of perishable food.

Jobs creation
Creates jobs in operation, handling and logistics; cold rooms more job-intensive than fridges.

Women
Cold storage can increase women's incomes and reduce time spent handling perishables. (j)

Climate resilience
Extends shelf life across seasons; buffers climate-induced supply shocks.

Grid/mini-grid revenue[a,h]
High continuous loads, among the most valuable anchor loads.

Agro-processing & milling

Service users buy access to shared facility owned by entrepreneur or PUE supplier. Strong opportunity on mini-grid and grid.

Maturity: Horizon

Small-scale **Upfront purchase / PAYG**

Standalone	Mini grid	Main grid
Small mill	Small mill	Small mill

Shared infrastructure **As-a-service**

Standalone	Mini grid	Main grid
Village mill	Shared facility	Commercial hub

Outcome profile

Productivity & incomes
Mechanization raises throughput and value addition. Reduces processing time and losses.

Food security
Processing can extend shelf life, reduce losses, and improve access to staple foods.

Jobs creation
Direct. Operators, mechanics, processors; downstream distribution and retail jobs.

Women
Motorized milling saves 2-6 hours/day. Reduces women's drudgery and processing time. (f)

Climate resilience
Indirect. Longer shelf life and diversified income can reduce exposure to climate-related losses.

Grid/mini-grid revenue[a,h]
High motor loads help close the mini-grid demand gap.

Micro-entrepreneur

An individual runs an enterprise on a single powered asset. The use case is well suited to small-scale upfront purchase / PAYG and can operate on standalone solar, unlike light commercial and industrial uses

Maturity: Commercial (main grid), near-to-market (off-grid)

Small-scale **Upfront purchase / PAYG**

Standalone	Mini grid	Main grid
Owner-operated	Owner-operated	Owner-operated

Outcome profile

Productivity & incomes
Powered tools and longer hours; 1 in 5 off-grid customers use their energy access to support or start a business or income-generating activity. (k)

Food security
Indirect. Relevant only where the enterprise handles food.

Jobs
Supports self-employment and can enable hired work, but evidence on net job creation remains limited.

Women
Strong potential in women-dominated segments such as cooking and textiles. (c)

Climate resilience
Indirect. Reliable energy and diversified non-farm income may strengthen resilience.

Grid/mini-grid revenue
Individually modest loads, but clusters of daytime businesses can raise utilization and revenue.

Light commercial & industrial

Larger operations. Customers buy a good or service and the owner buys higher-load assets. Opportunity sits mainly on mini-grid and grid

Maturity: Near-to-market

Larger businesses (SMEs) **Enterprise use**

Standalone	Mini grid	Main grid
Hybrid system	Services & light production	Services & light production

Outcome profile

Productivity & incomes
Powered tools and reliable energy raise throughput, reduce downtime, and can extend operating hours.

Food security
Indirect. Relevant only where the use case handles food.

Jobs
Direct. Service workers and tradespeople: cooks, carpenters, welders, metalworkers.

Women
Gender impact varies by subsector; women are especially prominent in food, cooling, and textiles.

Climate resilience
Indirect. Reliable energy and diversified non-farm income may strengthen resilience.

Grid/mini-grid revenue
Higher-load daytime businesses can materially raise consumption and load factor.

Note: Figure 2 is illustrative and applies across reliable-grid, weak-grid, and off-grid settings. 'Main grid' assumes reliable supply; where the grid is weak, standalone or hybrid options may apply alongside it. Anchor loads such as telecommunication towers and public facilities are not shown, as the figure focuses on enterprise-level PUE use cases. Maturity assessments are based on available evidence – which is strongest for off-grid PUE markets, and more limited for mini grid and main grid-connected PUE. Maturity levels vary across markets within each use case.[12]

Business Models

PUE suppliers utilize a range of business models to maximize uptake and profit potential (Table 1). Equipment may be sold outright, financed, rented, or used to provide services-for-a-fee. The appropriate model depends on factors such as the cost of the asset, the end user's ability to pay, projected frequency of asset use, and the feasibility of remote locking or retrieval in case of default. The cost of installing a mill, oil press, cold room, or large workshop machine can only be recovered if there is sufficient demand and a high utilization rate.[13] Business models are evolving to address these affordability and utilization constraints. Off-taker-linked models can strengthen market access, helping end users increase equipment utilization and generate the revenues needed to repay financing,[14] and utility- or mini grid-led equipment financing can address affordability while increasing electricity consumption and revenues.[15]

PUE suppliers typically target small businesses as end users, which are fewer and more dispersed than households in most communities. With smaller addressable markets and lower customer density than household off-grid solar (OGS) or mini grid companies, PUE suppliers often need a broad product range to generate enough revenue per customer and location to cover their costs. Programs can also address low customer density directly, as Uganda's Micro-Scale Irrigation Program (MSIP) did by bundling approved farmers into geographic lots and tendering the right to serve each lot to pre-qualified suppliers (see Chapter 2, Step 2.2).[16]

Public funding mechanisms designed to scale these different business models need to align with the (often seasonal) revenue cycles and financing needs of end users and suppliers. For upfront purchase / PAYG business models, subsidies to lower retail prices may be appropriate, using matching grants or results-based financing (RBF). For third-party asset financing, relevant support may include on-lending or guarantees to reduce collateral constraints, interest rates, and lender risk. For rental and energy-as-a-service (EaaS), support could seek to reduce asset owners' capital expenditure (CapEx) and operating expenditure (OpEx) burdens, enabling them to offer services at lower cost. For more detail see Chapter 2, Step 3.3 on access to finance.

The level of support needed also varies with scale. For individual farmers and micro-enterprises buying pumps, refrigerators or tools, subsidy and credit needs can be substantial. For larger shared infrastructure operated by established enterprises, such as agro-processors, the magnitude of financial support needed may be considerably lower, since these businesses can often fund part of the investment themselves. Here, convening, business-to-business matchmaking, technical assistance and limited de-risking of early transactions may matter more than subsidy (see Figure 9).

[12] Sources: (a) Dalberg analysis, 2026; (b) GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023; (c) Shell Foundation, Exploring the Potential of Under-researched Productive Uses of Energy, 2025; (d) World Bank Group, Accelerating the Productive Use of Electricity, 2023; (e) Burney et al., Solar-powered Drip Irrigation Enhances Food Security in the Sudano-Sahel, 2010; (f) Caribou, Clean Energy as a Catalyst for Women's Economic Empowerment, 2026; (g) GOGLA, Off-Grid Solar: Powering Climate Resilience, 2025; (h) CrossBoundary, Appliance Financing 3.0 Innovation Insight, 2023; (i) 60 Decibels and Efficiency for Access, Appliance Impacts Over Time, 2023; (j) TEA and Shell Foundation, Results Based Financing for Productive Use Appliances to Promote Gender Outcomes, 2024; (k) 60 Decibels, Why Off-Grid Energy Matters, 2024. See also: Agri-Energy Coalition, Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar, 2025; Energy 4 Impact, Solar Irrigation Rwanda: Developing a New Market for Smallholder Farmers, 2021; Efficiency for Access, Green Jobs for Rural Youth: Unlocking Renewable Energy's Potential in Agriculture, 2024; World Bank Group, Jobs For A Livable Planet, 2023.

[13] Source: GET.transform, Energy for Rural Industrialisation Productive Use of Energy 2.0, 2022.

[14] Source: Hystra, Market Access for Agro-PURE Companies, 2025.

[15] Source: CrossBoundary, Appliance Financing 3.0 Innovation Insight, 2023.

[16] Source: Stakeholder consultations, 2026. See also: World Bank Group, The Farmer-Led Irrigation Development Guide, 2021; World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025; MAAIF, Design, Supply and Installation of Micro-Scale Irrigation Equipment and Related Services, 2023; MAAIF, Micro-Scale Irrigation Program: A Guide for Smallholder Farmers, 2020.

Table 1: Illustrative business models used to deliver PUE equipment (non-exhaustive)[17]

		Upfront purchase	PAYG/lease-to-own	Third-party asset finance	Rental	Energy-as-a-service
Business model description	**Summary**	Asset owner buys equipment outright at full price upfront	Supplier finances equipment while the end user pays through instalments; ownership transfers to end user once fully paid. End user is then the owner-operator	A third-party financier (bank, MFI, SACCO, utility) underwrites a loan for the end user to buy and own the equipment	Asset owner retains ownership; end user rents and operates it for a defined period	Asset owner retains the ownership; end user pays a fee for the service or output rather than renting the equipment itself
	Who owns the asset?	End user becomes asset owner upfront	Supplier retains ownership until fully paid off, end user then becomes the asset owner	End user is typically the upfront owner, but equipment may serve as collateral	Asset owner retains ownership	
	How is the asset/ service paid for?	Full purchase price at point of sale	Down payment, then periodic installments to provider	Deposit/co-payment if required, then loan repayments	Rental fee based on time or access	Fee based on service/output delivered, or recurring service fee
	Who carries credit risk?	None	Provider	Third-party financier	None / provider	
	Who carries utilization risk?	Buyer			Provider	
	Who maintains the asset?	End user/asset owner, with supplier/original equipment manufacturer (OEM) after-sales support and/or warranties			Provider	
Assets and asset owners/ service users	**Typical route to market**	Direct to end users, including asset owners who rent out their equipment or sell services onward			Asset owner (supplier or entrepreneur) provides services direct to end users	
	Typical asset or asset owner fit	Lower-cost assets; or buyers with enough liquidity to purchase larger assets	Standardized, discrete assets. Often smaller, where remote lockout/ monitoring or recovery is feasible	Durable assets where borrower cash flow / creditworthiness can be underwritten; remote lockout not required	Often higher-cost assets used intermittently or shared across users	Often larger or more complex assets where users buy an output/service and provider can aggregate utilization
	Example assets (non-exhaustive)	Mobile phone chargers, hair clippers, small tools	Solar water pumps (SWPs), refrigeration, some e-mobility or machinery	SWPs, refrigeration, mills, machinery, tools	Portable SWPs, e-vehicles, tractors	Cold rooms, irrigation systems, food processing

Private equipment suppliers and financiers should be involved in program design from the outset, so that PUE programs leverage private sector capacity and attract private co-investment to achieve sustainable impact at scale. Support should match the role a program asks each company to play. A company asked to open a new territory, carry inventory, extend credit, provide after-sales service, and broker new off-taker partnerships for the farmers it serves needs support commensurate with all five. Where a supplier is not best placed to take on a role, programs should assign it to another actor rather than fund the supplier to stretch (see Chapter 2, Step 2).

[17] Source: Each source is tagged to relevant business models in parentheses, where 1=upfront purchase and 5=EaaS: Dalberg analysis, 2026 (models 1-5); GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023 (models 1-5); Efficiency for Access, Business Model Innovations Addressing Affordability: Case Studies, 2021 (models 2-5); GOGLA, Powering Protection: Navigating Consumer Risks in the PURE Sector, 2025 (models 2, 3, 5); Efficiency for Access, Lighting a Path to Affordability, 2026 (models 1, 2, 5); CGAP, Getting Repaid in Asset Finance, 2021 (model 2); World Bank Group, Accelerating the Productive Use of Electricity, 2023 (models 2, 3, 5); Agri-Energy Coalition, Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar, 2025 (models 2, 3, 5); Oorja, Oonnati (model 5).

Value Chains

In agriculture, market linkages within value chains – in which off-takers buy farmer produce before aggregating, transporting and selling it on – are essential to converting access to PUE assets into job creation, income and growth outcomes. Farmers who gain access to irrigation, refrigeration or agro-processing equipment can switch to higher-value crops or start selling chilled or processed produce – such as threshed grain, pressed oil, milled flour, chilled milk or iced fish – and need support to establish partnerships with new off-takers. PUE suppliers face a parallel gap: many have limited experience working with agricultural financiers, off-takers, cooperatives and other agri-sector actors, which can prevent them from closing deals with agribusinesses or raising capital from non-energy investors. Brokering these relationships, for example through joint consultations or matchmaking events, is a low-cost way for programs to help both groups.[18]

Once connected to markets, farmers need bargaining power to secure higher incomes. Without it, and without price transparency, added value risks being captured by off-takers and intermediaries rather than reaching producers themselves – particularly where farmers face few buyer options, lack price information, or cannot store produce to negotiate from a position of strength. Cooperative aggregation, transparent pricing, and access to more than one buyer can help ensure PUE-driven productivity gains translate into higher farm-gate incomes rather than higher intermediary margins.[19]

The market linkage constraint looks different, and in some cases matters less, outside agriculture. For micro-enterprises serving local, walk-in demand – phone charging, welding, tailoring, or small workshop services – output is typically sold directly to customers on the spot.[20] Here, "market linkage" support is more about local demand density, footfall, and customer purchasing power within reach of the business – a materially smaller and different constraint than in the agricultural case. For light commercial and industrial operations producing goods at greater scale, the business constraint is again similar to the agriculture case: reliable buyers, consistent quality, and integration into wholesale or distribution networks remain critical to converting capacity into income, even where the product is not perishable.

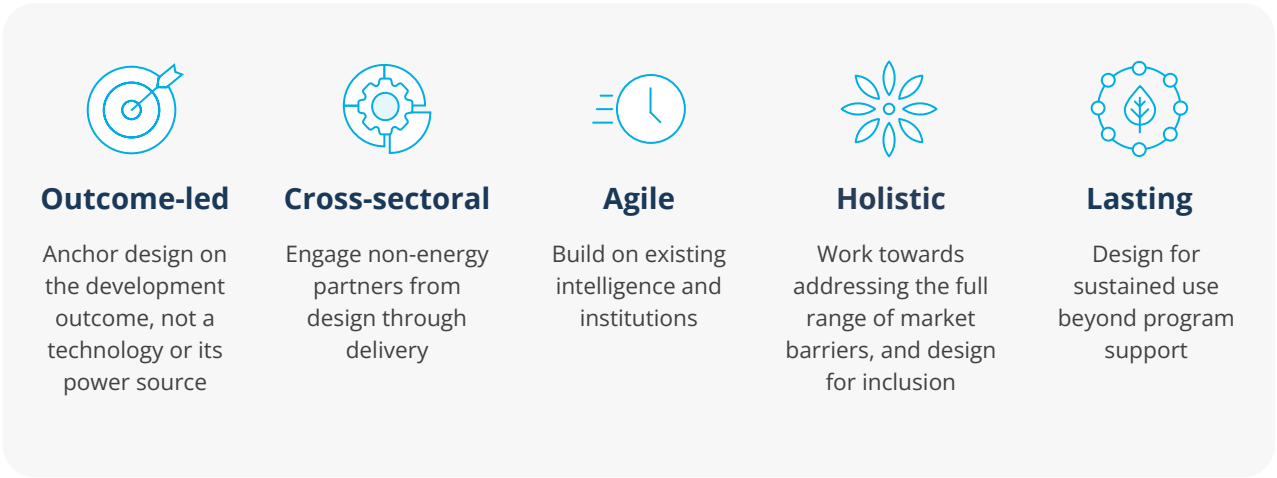
Aggregation can make small or dispersed PUE markets easier to serve, finance, and connect to value chains. Cooperatives, producer organizations, off-takers, and processors consolidate dispersed output into volume for processing, transportation and sale. SACCOs and MFIs aggregate credit risk and administration, letting a wholesale funder underwrite one institutional relationship rather than thousands of individual borrowers. Utilities and mini grid developers can aggregate payment collection, using existing metering and billing relationships to collect equipment repayments alongside electricity bills. Rental and EaaS business models aggregate utilization, spreading the fixed cost of a capital-intensive asset such as a mill or cold room across enough users to make it commercially viable. Digital platforms make dispersed transactions or usage visible and enable remote monitoring of shared assets, producing aggregate commercial data to inform investment decisions. See Chapter 2, Step 1.3 for implications for business models and equipment, and Steps 3.2 and 3.3 for examples of how aggregation can support financing and program delivery.

[18]Source: Stakeholder consultations; Agri-Energy Coalition, Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar, 2025.
[19]Source: World Bank Group, Working with Smallholders: A Handbook for Firms Building Sustainable Supply Chains, 2013.
[20]Source: Lighting Global/ESMAP, The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa, 2019.

PUE Program Design Principles

The guide's five design principles are intended to help avoid the mistakes of the past, and position PUE as a cross-sectoral, collaborative endeavor (Figure 3). The five principles are interdependent. A program that is agile but works within a single sector will move quickly in the wrong direction, while one that is cross-sectoral but does not address the full range of market barriers will leave the conditions that matter unaddressed. The recommendations below should therefore be read as a set, not as a menu from which individual items can be selected. Chapter 2 provides examples of how the principles have been applied in practice.

Figure 3: PUE program design principles



Outcome-led: anchor design on the development outcome, not a technology or its power source

Programs should begin by defining the outcome they want to support, and then identify the end users and market actors relevant to that outcome, as well as the equipment, business models and interventions needed to achieve it. Starting from a preferred technology or power supply can narrow the opportunity set too early and encourage programs to fit productive activities around an energy solution. An outcome-led approach reverses that logic: design should be end-user-centric rather than technology- or supplier-centric. The approach, therefore, centers on what end-user businesses need to look like to deliver on the outcome, and then identifies the technologies, suppliers, and other support mechanisms needed to enable them to do so. The outcome – more jobs, higher incomes – is generated by the end user's business, not by the equipment or the company that sold it.

This approach changes what a program should track. If the objective is more and better jobs, programs need to track whether end-user businesses grow and jobs last, and the capabilities that drive this – skills, business management, working capital, customer acquisition and market access. Equipment sold or connections made may be useful data, but they are not evidence of either. Similarly, a program seeking to raise farmer incomes may need to support agronomic advice, aggregation and relationships with reliable buyers alongside irrigation, cooling or processing equipment – the equipment is a means to that end-user outcome, not the outcome itself. For program designers, this means combining engineering and financial expertise with the small business and sector knowledge needed to understand what will make the productive activity succeed.

Power supply should be treated as a design choice, not a starting assumption. The right solution depends on the activity, location, load profile, reliability needs, existing infrastructure, and cost. Standalone systems may be the best fit for dispersed users, or solar-aligned loads such as irrigation; grid, mini grid, or hybrid systems may be better suited to larger or more continuous loads. Programs should compare these options on their merits and remain open to revising the choice as infrastructure, demand, and technology costs evolve. The objective is not to favor one setting, but to ensure that the energy solution serves the productive activity rather than defining it.

Cross-sectoral: engage non-energy partners from design through delivery

PUE generates value across sectors – energy, agriculture, water, trade, and enterprise development among them – and program design is most effective when it reflects that from the start. A program team composed primarily of energy-sector specialists tends to design supply-side solutions and then search for use cases to which they can be applied. A team that integrates agricultural, water, or enterprise development expertise from the beginning is more likely to start with the value chains and end users themselves, and subsequently to identify the solutions that best serve them. Cross-sectoral expertise is also a risk mitigation tool, as it helps identify unintended consequences and dependencies that may not be visible through an energy lens alone.

Cross-sectoral collaboration underpins every building block of an effective outcome-oriented PUE program, across planning, design, and delivery. Many of the elements that determine whether a program succeeds sit primarily outside the energy sector – particularly when increased incomes and job creation are the intended outcomes. These include interventions such as end-user training and business development; market linkages between end users, suppliers, and off-takers; demand aggregation through cooperatives; technical workforce development; policy and regulatory alignment; and the integration of PUE into national and sectoral plans. Addressing these elements requires active ongoing partnership with agriculture, water, finance, trade, education, and planning counterparts, not coordination at the margins. In many cases, this means inter-ministerial coordination, with stakeholders working to design and deliver complementary activities across building blocks alongside each other.

Stakeholder engagement should be continuous rather than confined to the design phase. Aggregators, financial institutions (FIs), training institutions, off-takers, and suppliers each hold information that the others do not. A program team that engages other sectors only at inception will find that gaps compound during implementation. Standing forums, such as PUE taskforces, that maintain this exchange during implementation allow programs to identify and respond to market signals that were not visible at the outset.

Program objectives should also be anchored in national development priorities and sectoral strategies. A program grounded in a national agricultural transformation plan, irrigation strategy, or rural enterprise development framework carries more institutional weight and is more likely to continue through changes of administration. Engagement should extend to planning commissions and to agriculture, trade, and finance ministries, not to the energy ministry alone.

Agile: build on existing intelligence and institutions

Programs do not always need a comprehensive market assessment before launching. In data-scarce settings, commissioned assessments can be slow, and where they rely mainly on literature review and consultation they often add little that program designers could not gather faster themselves. An in-house literature review combined with strong cross-sector stakeholder engagement, bringing together energy and non-energy government, private sector and investor stakeholders, can be sufficient to design and launch a PUE program, provided the program is flexible enough to adapt based on early experience. Programs should not wait for ideal conditions before starting. It is usually better to begin with a narrower scope, such as a single value chain or power supply setting, and to add partners, components, and analysis in later phases as evidence and relationships develop.

Agile programs should use existing knowledge first. Sector ministries, development partners active in agriculture, water, and finance, and private sector companies themselves hold a depth of usable intelligence that many programs leave untapped. This local knowledge should be paired with cross-country experience and specialist technical support to avoid siloed approaches and duplicated effort. Strong management information systems and stakeholder feedback loops can be used for early identification of changes in market conditions, while flexible program design can enable programs to adjust – reallocating funds across components, revising eligibility criteria, or recalibrating incentive levels quickly – as needed.

Deeper analysis should be reserved for specific market barriers or design considerations. Decisions on targeting, subsidy-setting, project sizing, financing structures, and sequencing benefit from quantitative primary data that stakeholder engagement cannot provide. Studies to fill these gaps can be commissioned in parallel, rather than delaying program launch. Where getting a design decision wrong would require fundamental redesign of a component, however, the required data collection should be commissioned before finalizing that specific design choice.

Program teams should work through and adapt existing institutions before building new ones. Convening should happen through existing coordination platforms and government structures – sector taskforces, inter-ministerial working groups, established program units – wherever they exist. This is easiest where productive demand is already established, since the institutions to work through – supplier networks, cooperatives, sector associations – typically already exist there too. In less developed markets, fewer such institutions exist, and they may need to be established or strengthened. Regional programs can also help. Where a country's own capacity to manage a broad, outcome-oriented PUE program is a binding constraint, World Bank Group regional projects such as Accelerating Sustainable and Clean Energy Access Transformation (ASCENT) and Distributed Access through Renewable Energy Scale-up (DARES) can help countries unlock economies of scale and access high-quality fund management. They also give access to instruments that would be too complex or costly to implement individually, such as digital Monitoring, Reporting, and Verification (dMRV) platforms or carbon financing mechanisms.[21]

[21]Source: World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026.

Holistic: work toward addressing the full range of market barriers, and design for inclusion

The barriers to functioning productive use markets are seldom limited to energy access. Alongside the cost and reliability of power supply, end users commonly face constraints in equipment finance, working capital, market linkages, and the technical skills needed to operate and maintain equipment. A holistic approach is needed because if only some of these barriers are addressed, the remaining ones will become bottlenecks. This does not mean a single program must address every barrier at once, but that each binding barrier is identified and has an actor responsible for addressing it, whether within this program, another program, or over later phases.

No single actor is positioned to close all of these gaps – least of all the supplier. Suppliers depend on customers who can use equipment productively, repay financing, and purchase maintenance or replacement services over time, but they rarely have the capacity to address every barrier those customers face. Agricultural extension services, technical and vocational education and training institutions, business development providers, financial institutions, cooperatives and off-takers may each be better placed to provide part of the required support. Programs should identify who can perform these functions and finance the coordination and delivery required (see Chapter 2, Step 2: Assess Building Blocks and Assign Roles). The more the private sector is expected to take on outside its core role, the more financing and support it will need to deliver on it – or the stronger the case for assigning that role to another actor.

In practice, this means identifying the binding constraints in a given context alongside the energy barrier. Working capital is frequently as significant as equipment finance; market linkages between producers and off-takers are often a more immediate constraint than power supply. Programs should also avoid designing a single facility for both small-scale PAYG assets and large-scale shared infrastructure: the two need different financing and technical assistance (TA) arrangements (see Business Models), and a facility designed for both typically serves neither well.

Equity and inclusion should be built into program design at the outset. Programs should identify groups at risk of exclusion in the local context, which may include women, young people, people with disabilities, displaced people and host communities, and poorer or remote users, and adapt consultation, targeting, financing, TA, delivery channels, and monitoring accordingly. Women make up a substantial share of productive users in agriculture, food processing, and informal commerce in most of the contexts this guide addresses, yet face greater constraints in asset ownership, mobility, access to financial services, and available time. Addressing this requires gender targets at intervention level, financing terms that do not rely on collateral women are less likely to hold, and TA designed to reach them. Outcome data should be disaggregated by sex, and by other at-risk groups where feasible.

Lasting: design for sustained use beyond program support

Programs should design for sustained use, not only initial uptake, by testing whether the underlying activity and the wider system can remain viable over time. This means prioritizing activities with a credible business case and sufficient demand, ensuring viable market linkages and off-take where relevant, and putting in place the skills, maintenance, after-sales support, and institutional arrangements needed to keep equipment operational. This includes agreeing early which actor will be responsible for long-term O&M, and how it will be paid for, particularly for shared infrastructure. New economic activities may require more intensive support, phased as the business model matures. The institutions a program works through (see Agile principle above) also determine what survives it: where local institutions, representative organizations, or public actors are expected to carry functions forward, programs should build their capacity during implementation, since parallel structures created by the program tend to disappear when support ends. The aim is to build lasting capability and functioning markets, and to avoid underused equipment or stranded assets.

Finally, each instrument deployed should carry an explicit exit logic: a program should be clear from the outset about how support will change over time and which market actor will sustain the function once it ends. Programs that leave this implicit tend either to extend indefinitely or to lose their effect at closure. The sustaining actor may be a private firm, utility, public institution, or other local actor. Where that actor is commercial, programs should assess whether its business model remains financially viable once subsidies, grants, or other program support are withdrawn. Exit logic need not always mean tapering down: a planned trajectory from a smaller to a larger subsidy can be appropriate where programs deliberately move toward harder-to-reach frontier markets, while support tapers in the markets they leave behind. The "Designing Responsible End-User Subsidies for Energy Access" toolkit provides a workable framework for thinking through exit design.[22]

Exit planning should also specify what happens if the sustaining actor is not ready when planned support ends, since market maturation is frequently slower than anticipated. Programs should define in advance a small set of trigger conditions – a minimum revenue or utilization threshold, or an independent viability assessment – that determine whether to extend support on a defined, time-bound basis, restructure the instrument, or accept that the function will lapse. Treating this as a live decision point, rather than assuming the original exit timeline will hold, reduces the risk of either indefinite extension or abrupt withdrawal from a function that was nearly self-sustaining.

[22] Source: Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024.

Chapter 2:
The PUE Program Design Process

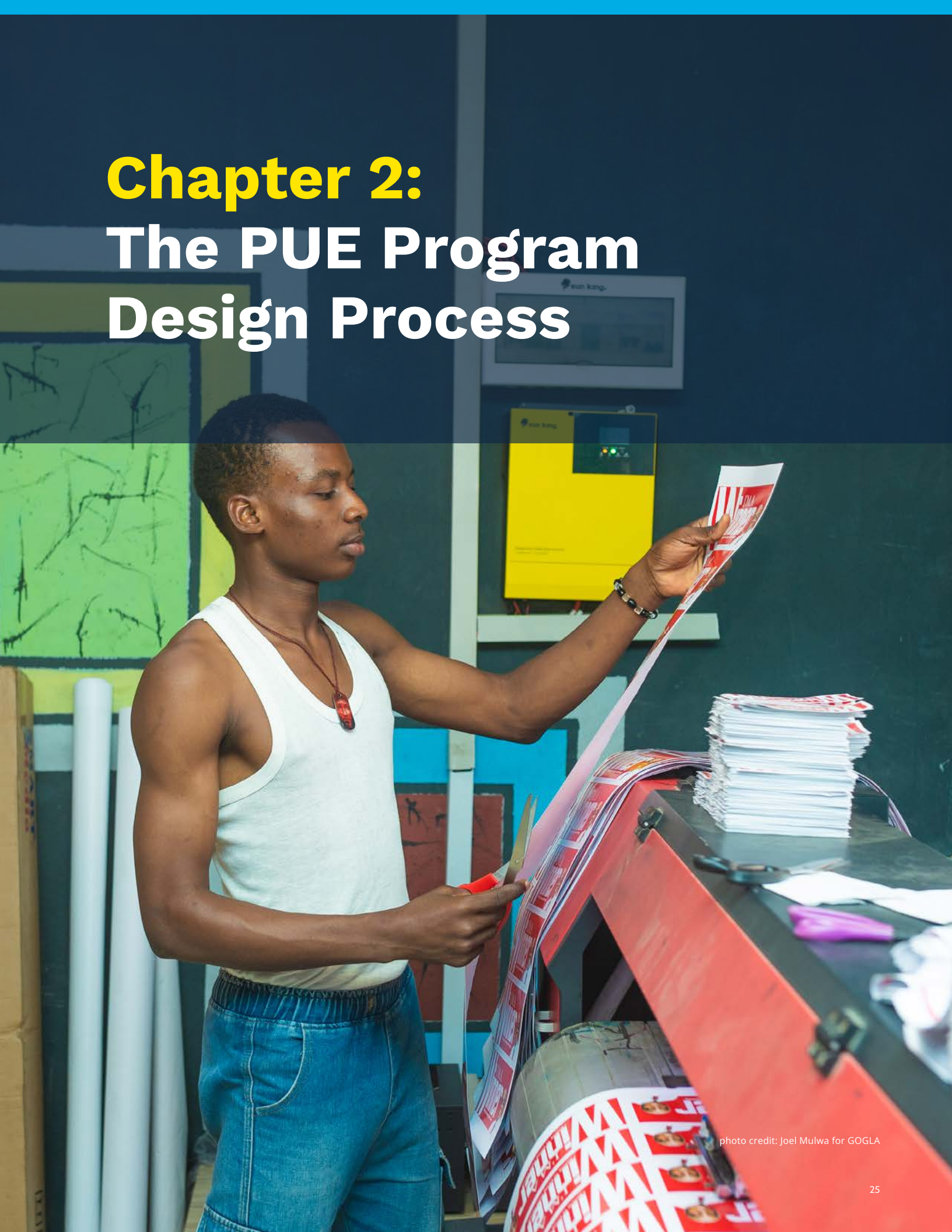


photo credit: Joel Mulwa for GOGLA

This chapter proposes a program design process – a structured way for program designers to work through the main decisions involved in shaping a PUE program. It is an entry point for strategic program design rather than a detailed implementation manual. It is intended for PUE program designers in governments and development partners, including those in non-energy sectors designing projects that contain PUE elements. It describes an outcome-led approach, designed and delivered by a cross-sector project team, supported by a higher-level cross-sector taskforce.

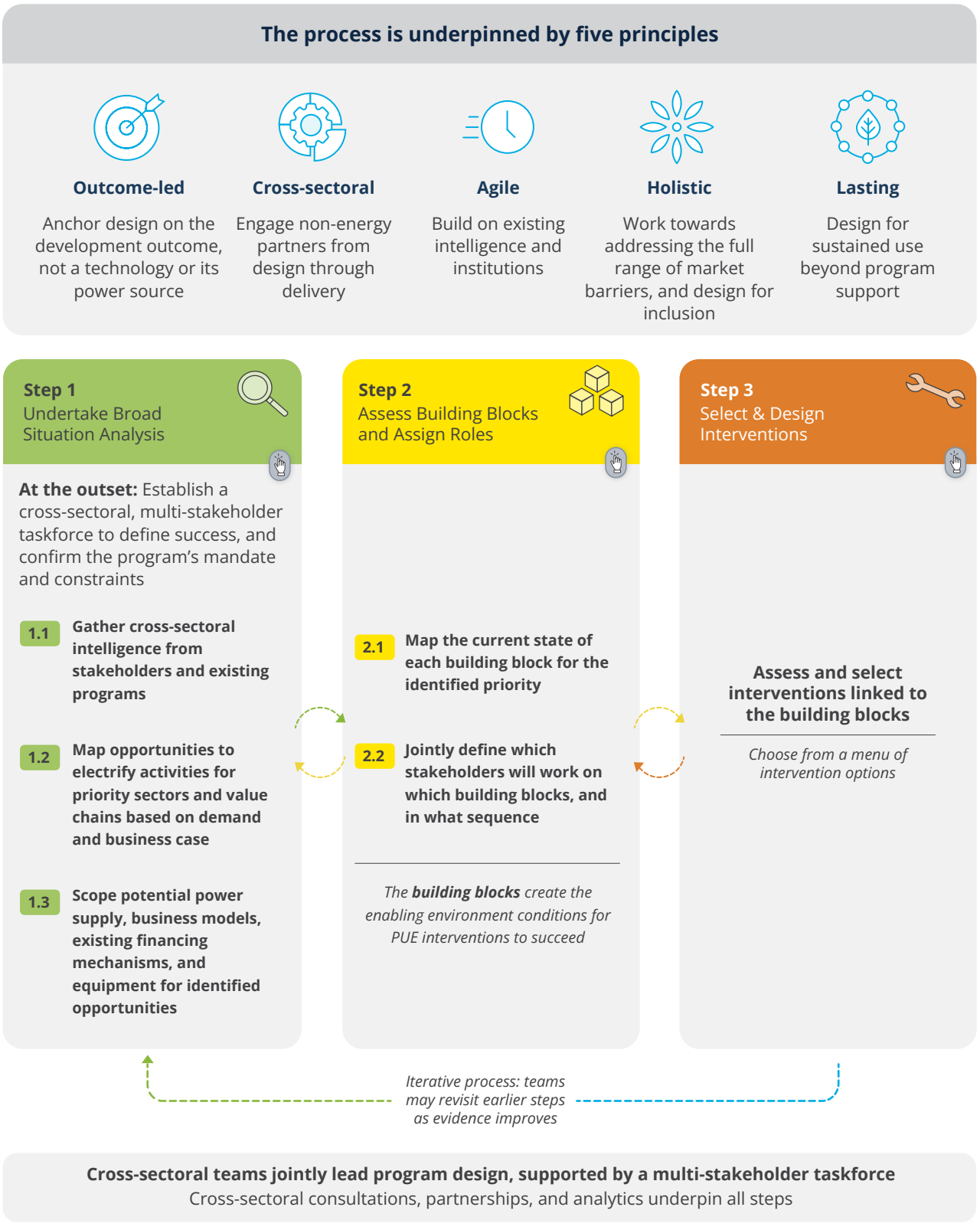
PUE program design can be structured around five core building blocks (see Figure 4). Each of the five building blocks contains key considerations which together create the conditions for PUE interventions to succeed. The framework builds on and streamlines a more complex version developed in "Accelerating the Productive Use of Electricity" (World Bank Group, 2023).[23]

Figure 4: The five building blocks used to design PUE programs

This guide proposes a three-step program design process (see Figure 5). These steps are sequenced to help program designers move from conceptualization to concrete design choices. In Step 1, situation analysis narrows a broad set of potential geographies, sectors, and value chains down to the PUE opportunities most likely to advance the program's development outcomes. Step 2 involves deeper assessment of building blocks, identifying the stakeholders best placed to address key challenges and assigning roles. In Step 3, interventions are selected and designed. Program design should be iterative with continual learning and revision built in, and cross-sectoral stakeholder engagement should be maintained throughout. See Appendix III for an end-to-end case study of Productive Use Leveraging Solar Energy (PULSE) and Electricity Access Scale-up Project (EASP) in Uganda, which maps the process to a real-world program design example.

[23] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.

Figure 5: Overview of the program design process



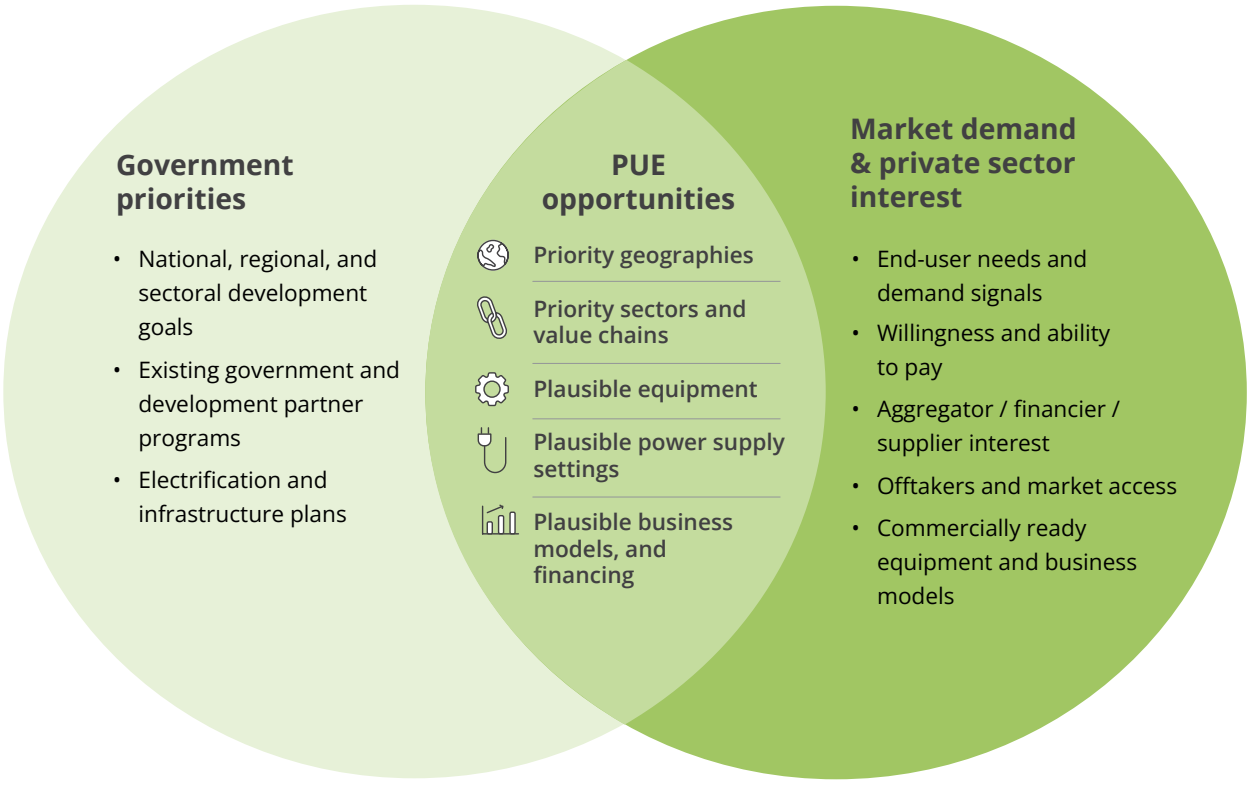
Step 1: Undertake Broad Situation Analysis
1.1 Gather cross-sectoral intelligence from stakeholders and existing programs
1.2 Map opportunities to electrify activities for priority sectors and value chains based on demand and business case
1.3 Scope potential equipment, power supply, business models and financing mechanisms to identified opportunities

Step 1: Undertake Broad Situation Analysis

At the outset, program designers should seek to establish a cross-sectoral, multi-stakeholder taskforce – or build on an existing coordination platform where one exists – to define what success looks like. This should cover the short-, medium-, and long-term development outcomes the program intends to contribute to. These agreed outcomes will guide decisions throughout Steps 1–3. The taskforce also needs to confirm its mandate and clarify any key design constraints (e.g., budget, geographic scope, target end users, sectoral priorities, and institutional context).

Situation analysis then combines cross-sectoral intelligence, opportunity mapping, and early scoping. The three sub-steps below cover (1.1) gathering cross-sectoral intelligence, (1.2) mapping and prioritizing economic activities for electrification, and (1.3) scoping potential power supply settings, business models, financing mechanisms, and equipment suited to local contexts. The key is to let community needs and existing market intelligence drive decisions. This involves working with the private sector to identify where it sees market opportunities and mapping these against national development priorities and other programs (see Figure 6).

Figure 6: Government Priorities, Market Demand and Private Sector Interest



1.1 Gather cross-sectoral intelligence from stakeholders and existing programs

Step 1.1 puts the Agile and Cross-sectoral design principles into practice (see Chapter 1): program designers draw on the taskforce's knowledge and networks, and on existing sector expertise, to make early design decisions without commissioning a full market assessment. Intelligence gathering is often where the most critical design decisions are made and where the most common pitfalls are avoided. Stakeholder claims that materially affect design should not be taken at face value: consider each stakeholder's interests and incentives, and triangulate against observed behavior, data, or other evidence. Where stakeholder engagement reveals decision-critical evidence gaps, programs should seek to fill these through targeted data collection or analysis (e.g., surveys, demand or willingness-to-pay research, or technical assessments).

Insight from stakeholder:

> *"We don't want to impose any untested methodology on them, but rather listen... not only to the energy ministries, but to the agricultural ministries, water ministries, and our own teams on the ground. This hopefully provides us with the intel to identify the low-hanging fruit, where we can try out a codified methodology or approach and move faster from there, skipping the long-winded market analysis that provides us with analysis we mostly already know."*
>
> **– PUE Program Designer (World Bank Group, Regional DARES)**

Intelligence gathering draws on four sources, which can run in parallel and inform each other: (i) non-energy colleagues within and outside the project team; (ii) multi-stakeholder consultations with governments, development partners, representative organizations, and communities; (iii) national strategies and existing government programs; and (iv) the private sector. Together they show what is already being done, where the gaps are, and where PUE can add most value.

1. **Start with non-energy colleagues, both within and outside the project team.** They can contribute knowledge of economic activity and value chains, end user constraints, and the functions and equipment needed to address them, and can flag dependencies, alternative solutions (e.g., when energy is not required),[24] and unintended consequences.[25] Ask whether constraints that are manageable today (e.g., water scarcity, farmer organization, market access, or institutional capacity) could become binding if uptake became widespread, and flag any material risk early to the relevant institutions. Step 3.4.1 covers mechanisms that can institutionalize this cross-sectoral collaboration.

[24] Note: For example, in agriculture, a water-access constraint does not necessarily require solar water pumping. Depending on the context, alternatives may include rainwater harvesting, soil-moisture retention, drought-resilient crops, or more water-efficient irrigation methods such as drip irrigation. Similarly, post-harvest loss does not always require cold storage; drying, smoking, salting, or alternative production approaches such as greenhouses may sometimes be more appropriate or affordable.

[25] Note: A non-exhaustive list of examples of unintended consequences in agriculture includes groundwater depletion from SWPs, land-use change or overfishing risk as commercial markets grow, absent landscape or nature conservation governance, soil health depletion from increased production without holistic interventions, food processing or fortification dosing-accuracy concerns from a nutrition perspective, and cold chain market access failures or stranded assets where farming and value chain practices (GAP compliance, food safety, certification) have not matured enough to reach formal markets.

» **Insight from stakeholder:**

> *"Often we found it successful to interact with, for example, sister agriculture programs... if we have another project, program or another [non-governmental organization (NGO)] that we work closely with working in mangoes or tea or whatever, let them tell us where [for example] the aggregation needs are."*
>
> **– PUE Program Designer (Energising Development - EnDev)**

2. **Organize multi-stakeholder consultations with governments, development partners, representative organizations (e.g., cooperatives, industry associations), and communities to understand existing priorities and programs, and to identify barriers and enablers.**[26] Mapping who is doing what helps to avoid duplication and ensure additionality. Include groups likely to be underserved or excluded,[27] in line with the Holistic principle (see the PULSE and EASP case study in Appendix III).

» **Insight from stakeholder:**

> *"In these times when funds are really tight, the first thing donors are looking for is clear additionality... we don't have the luxury anymore of duplicating similar work in similar markets anymore."*
>
> **– PUE Program Designer (Energising Development - EnDev)**

» **Best practice.** Tanzania's SWP project illustrates how a dedicated community engagement consultant can surface the ground-level intelligence that makes PUE programming viable. The consultant worked directly with community organizations to map existing capacity, identify gaps, and co-prioritize interventions, generating community-level knowledge. This early engagement was critical for program design and ultimately for community buy-in and sustainability.[28]

3. **Build on national plans and active government programs.** Where a national or sub-national PUE strategy or roadmap exists, make it a primary input for prioritizing sectors, geographies, use cases, and institutional roles (see the Cross-sectoral principle). Established programs can also provide delivery channels, institutional relationships, end user networks, and complementary support that would otherwise be built from scratch. For example, Zambia's Rural Electrification Master Plan (REMP 2.0[29]) was informed by agribusiness and value chain intelligence from Zambia Agribusiness and Trade Project (ZATP) II,[30] while Kenya's ASCENT[31] is leveraging agricultural priorities and delivery platforms under AgriConnect.[32]

[26] Note: Different stakeholders will also bring evidence relevant to different building blocks. For example, FIs and investors can inform Access to Finance; suppliers, technicians, and operators Technology & Innovation; end users, cooperatives, aggregators, and off-takers Market & Business Development; and government agencies, regulators, and utilities Policy & Regulation. Cross-sectoral planning and collaboration underpin all four.

[27] Note: Research on inclusive energy access highlights the risk that standard consultation processes overlook marginalized groups. Many of these findings translate to PUE programs. Recommended practices include directly involving underserved users and representative organizations in research and co-design, adapting engagement to accessibility and local context, collecting disaggregated data, and incorporating inclusion into program design and decision-making from the outset. See, for example, 60 Decibels, Disability Insights Report: Transforming Energy Access, 2023; Efficiency for Access, How Can Energy Access Programmes Address the Needs of People with Disabilities?, 2021; GPA, Transforming Humanitarian Energy Access (THEA), 2023; and Practical Action, Poor People's Energy Outlook 2018: Achieving Inclusive Energy Access At Scale, 2018.

[28] Source: World Bank Group, Implementation Completion and Results Report - Accelerating Solar Water Pumping via Innovative Financing, 2023.

[29] Source: Rural Electrification Authority of Zambia, Powering Zambia's Future: Government Launches REMP 2.0, 2026.

[30] Source: Zambia Agribusiness & Trade Project II.

[31] Source: World Bank Group, Accelerating Sustainable and Clean Energy Access Transformation (Ascent) In Eastern and Southern Africa, 2024.

[32] Source: Stakeholder consultations, 2026 and Agri-Energy Coalition, Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar, 2025.

Step 1: Undertake Broad Situation Analysis

1.1 Gather cross-sectoral intelligence from stakeholders and existing programs

1.2 Map opportunities to electrify activities for priority sectors and value chains based on demand and business case

1.3 Scope potential equipment, power supply, business models and financing mechanisms to identified opportunities

4. **Engage the private sector early, at multiple key decision points, and treat its priorities as design inputs.** Aggregators, distributors, FIs, and suppliers hold ground-level knowledge about demand, cultural norms, willingness and ability to pay, and infrastructure and logistical realities, and are best placed to say what they are willing to engage in and support. Time engagement around key decision points, reflecting the shorter decision cycles of private sector actors. Industry associations (e.g., solar, renewable energy, mini grid, or agribusiness) are a useful first point of contact: they offer a single, representative channel and reduce the risk of design being shaped by a few well-connected firms. Engage individual firms directly for specific questions such as pricing, eligibility, and verification requirements.

» **Best practice.** For Uganda's MSIP, the program team conducted market sounding studies and held consultative workshops with irrigation equipment suppliers and FIs. These directly informed subsidy levels, equipment standards, and procurement processes. This early and continued private sector involvement also facilitated their participation throughout implementation.[33]

Additional resources

- For a framework that can help collaboration across energy and food systems: "Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar", (Agri-Energy Coalition, 2025)
- For planning and conducting stakeholder workshops as part of PUE/electrification program design: "PRODUSE Manual for Electrification Practitioners," (EUEI PDF and GIZ, 2011)

> **"The key is to let community needs and existing market intelligence drive decisions".**

[33] Source: World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.

1.2 Map opportunities to electrify activities for priority sectors and value chains based on demand and business case

For the opportunities identified in Step 1.1, programs should rapidly build a picture of demand, commercial viability, and market conditions. Geospatial planning tools – platforms that combine commercial, demand, spatial, and technical data – can speed up site identification and assessment. Odyssey, for example, uses geotagged data to forecast energy demand, financial flows, and site viability,[34] and Energy Access Explorer overlays energy supply data with demographic and productive-use data to prioritize geographic areas.[35]

» **Best practice.** Nigeria's DARES program paired geospatial tools with cross-ministry engagement. The team worked with the Ministry of Agriculture and other World Bank Group programs to identify existing irrigation and livestock hotspots, geotagged them on the VIDA satellite platform, and shared them with participating private sector companies to ease market entry. This addressed a limitation of its predecessor, the Nigeria Electrification Project, where the lack of targeted identification of PUE opportunities undermined mini grid viability.[36]

Within government priorities and the program's objectives, opportunities fall into three entry points, ordered from lower to higher uptake risk. They are not a required sequence: programs can pursue more than one in parallel, and the right mix depends on national development priorities as well as risk:[37]

1. **Substitute or supplement costly, high-emission, or unreliable energy supply.** Target value chains where users already spend meaningfully on energy (e.g., >30% of OpEx).[38] This is typically the lowest-risk entry point, because demand and ability to pay are already proven and uptake tends to be rapid. It may involve replacing diesel pumps with solar, as in the Tanzania Solar Water Pump Program,[39] Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan (PM-KUSUM) in India,[40] or Peru's Rural Electrification Project,[41] or hybridizing the grid to improve reliability or cut costs, as ASCENT Madagascar aims to do at 30 isolated power centers using solar and battery storage.[43] The main benefits are typically lower costs for asset owners and end users (and for governments, if diesel is subsidized), greater resilience, and lower emissions. In off-grid settings, assess whether retrofitting or hybridizing existing equipment is more viable than replacing it, given the maturity of local installation, maintenance, and after-sales services. Substitution should not crowd out opportunities where users have no power source at all and may have the most to gain.

» **Best practice.** Bangladesh's SWP program under RERED II shows the value of diesel replacement. Before the initiative, 1.34 million diesel irrigation pump users spent approximately USD 900 million a year on diesel, which was subsidized, creating a large fiscal burden. SWPs were more reliable, easier to maintain, and cut costs by about half.

[34] Source: Odyssey, How the Rural Electrification Agency of Nigeria Uses the Odyssey Platform to Bring Distributed Energy to 7M+, 2023.

[35] Source: Energy Access Explorer, About.

[36] Source: Stakeholder consultations, 2026; Odyssey, Odyssey Selected as Digital Platform for DARES Nigeria: Scaling Clean Energy Access for 17.5 Million Nigerians, 2025; REA, Blueprints for Scale: Embedding Sustainability, Achieving Impact, and Systemic Change in Africa's Next Electrification Frontier, 2026; World Bank Group, Project Appraisal Document - Distributed Access through Renewable Energy Scale-Up Project, 2023.

[37] See, for example, IIED, Productive Uses of Energy for Resilient Livelihoods in LDCs, 2021.

[38] Source: Stakeholder consultations, 2026.

[39] Source: World Bank Group, Implementation Completion and Results Report - Accelerating Solar Water Pumping via Innovative Financing, 2023.

[40] Source: Ministry of New and Renewable Energy of India, PM-KUSUM.

[41] Source: World Bank Group, Project Performance Assessment Report - Peru Rural Electrification Project, 2017.

[42] Source: World Bank Group, Madagascar: New World Bank Group Program Set to Provide Reliable and Affordable Energy to Over 2.5 Million People by 2030, 2026.

[43] Source: IWMI, Solar Irrigation in Bangladesh, 2021; BCCRF, Annual Report, 2014; World Bank Group, Solar-Powered Pumps Reduce Irrigation Costs in Bangladesh, 2015; ADB, Road Map to Scale Up Solar Irrigation Pumps in Bangladesh, 2023; World Bank Group, Project Paper - Rural Electrification and Renewable Energy Development II, 2014.

2. **Electrify existing economic activities.** Identify value chains where electricity would meaningfully improve an activity already underway. This can lead to improved quality, higher throughput, reduced drudgery, or lower costs. For example, EnDev's Indonesia PUE pilot financed off-the-shelf equipment for existing village businesses, raising profits by 20–33% for breadmaking, carpentry, tailoring, and other activities.[44] Some behavioral change or new skill building may be needed, but far less than when building markets from scratch. If the objective is value chain growth, consider supporting new entrants, helping existing actors raise productivity or cut costs, or a combination of the two.

» **Best practice.** Bolivia's Plan de Electrificación (PER II) shows how electrifying existing economic activity can make PUE a vehicle for gender-focused empowerment, while reducing stranded asset risk. The program prioritized dairy, cheese production, and rice processing, where women represented a relatively high share of the workforce (54% of beneficiaries). It financed equipment that replaced manual labor or inefficient existing equipment, such as electric pumps and storage tanks that increased dairy production, and localized rice milling that cut transport costs, increasing women's incomes and reducing drudgery.[45]

3. **Establish new economic activities.** Identify opportunities where PUE introduces an entirely new process or creates or reshapes a value chain, as with irrigation through Uganda's MSIP (see best practice below) and cold storage solutions that were piloted under Nigeria's Energizing Agriculture Programme (EAP), before being scaled up through the Energising Women & Youth in Agri-Food Systems Programme (EWAS).[46] Impact potential can be high, particularly for jobs and economic growth, but the risks of low uptake and stranded assets are also higher. Programs should therefore factor in more TA to asset owners and end users, such as training and help to develop market linkages (see Step 3.2.1).[47]

» **Best practice.** In Uganda's MSIP, irrigation was delivered through existing local government structures, with district-led farmer vetting, on-farm visits, and procurement on behalf of approved farmers from pre-qualified suppliers. Programs introducing a new productive activity may need to pair financing with local delivery capacity, user screening, technical support, and safeguards to support effective uptake and use.

» **Pitfall to watch out for.** Solar walk-in cold rooms have often become "white elephants": ill-suited to local food systems, seasonal crop cycles, farmer skill levels, and market maturity. Where consumers are unwilling to pay for refrigerated produce, or cheaper alternatives exist, they become economically unviable and are abandoned.[49]

[44] Source: EnDev, Productive Use of Energy (PUE): Findings of the EnDev Indonesia Pilot Project, 2013.

[45] Source: BID, Rural Electrification Program II, 2016.

[46] Source: RMI, Harvesting Sunshine - How Productive Uses of Minigrid Electricity Make Farmers Richer and Energy Cheaper, 2024; RMI, Nigerian Businesses, RMI, and the Global Energy Alliance for People and Planet Collaborate to Empower Women and Youth Through Renewable Technology, 2026.

[47] Source: Stakeholder consultations, 2026.

[48] Source: World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.

[49] Source: Wageningen University and Research, Postharvest Interventions, Key for Improvement of Food Systems, 2020.

» **Pitfall to watch out for.** New economic activities are vulnerable to collapse once support ends (see the Lasting principle). Community-managed, solar-powered cold rooms serving purely local markets show why: without dedicated commercial off-takers, professional after-sales service, or sufficient year-round produce volumes, they fail to generate the cash flow to cover expenses, let alone maintenance or scaling. Programs should achieve commercial sustainability before funding is withdrawn, phasing out subsidies in step with business model maturation.[50]

Additional resources

- For choosing between "lean" and more comprehensive approaches to identifying and supporting high-potential PUE opportunities: "PRODUSE Manual for Electrification Practitioners," (EUEI PDF and GIZ, 2011)
- For a methodology to assess postharvest value chains, identify bottlenecks and root causes, and inform appropriate interventions: "Postharvest Assessment Methodology" (Wageningen Food & Biobased Research, 2022)
- For assessing the viability of cold-chain opportunities across production, markets, infrastructure, governance, and finance before selecting technology: "Cold Chain for Ocean Communities: A Playbook for Project Developers and Investors" (WWF and Open Capital Advisors, forthcoming in late 2026).

[50] Source: See, for example, RMI's experience with a walk-in cold room in Kiguna, Nigeria, which highlighted the importance of sufficient utilization, aggregation, off-taker linkages, and strong on-the-ground operations for commercial viability. RMI, Harvesting Sunshine - How Productive Uses of Minigrid Electricity Make Farmers Richer and Energy Cheaper, 2024.

1.3 Scope potential equipment, power supply, business models and financing mechanisms to identified opportunities

Having identified priority value chains, program designers should scope equipment, power supply, business models, and financing mechanisms, guided by the Outcome-led and Lasting principles.

A) Equipment

Scope equipment based on the requirements of the productive activity (see the Outcome-led principle). Draw on end users, sector experts, and existing market players to assess availability, commercial readiness, and expected serviceable market (e.g., through user design workshops).

» **Insight from stakeholder:**

> *"We need to have some stakeholder engagement at equipment scoping stage. There's lots and lots of equipment that we [as program designers] do not know about. We assume that we know, but we don't."*
>
> **– PUE Program Designer (World Bank Group, Regional DARES)**

» **Insight from stakeholder:**

> *"It's not technology that should be your entry point. And if you make that your entry point, your program is going to fail."*
>
> **– PUE Program Designer (SNV)**

» **Pitfall to watch out for.** Even high-performance, good quality, market ready equipment from reliable companies can fail to solve end user needs if there is a misalignment of PUE equipment capacity with desired outcomes. A Green Technologies Project in Rwanda piloted solar powered fridges to chill milk on farms, but they were found to be unfit for the use-case: unable to consistently reduce the thermal mass of the milk before bacteria formed, undermining the viability of the venture.[51]

B) Power supply

Power supply is a design choice, not a starting assumption (see the Outcome-led principle). No setting is inherently preferable as long as the source is low-emission, so compare options on reliability, cost, load requirements, the availability of suitable equipment and services, expected grid expansion, and local capacity to operate and maintain equipment. If improving utility or mini grid performance is a key objective, look for underused or planned infrastructure and test whether productive demand can use it viably. Reliable supply can itself be an entry point, especially alongside appliance financing (see Step 3.3.6).[52]

[51] Source: Efficiency for Access, Lessons Learned from IFAD Green Technologies Project, 2021.
[52] Source: CrossBoundary, Appliance Financing 3.0 Innovation Insight, 2023.

1. **Grid-based supply (main grid and AC mini grid) can support larger loads at lower cost per unit of energy, and AC equipment needs no bundled generation and storage, widening the PUE equipment available to target populations.** Where existing supply is costly or unreliable, assess whether to retain, supplement, hybridize, or replace it, weighing cost, reliability, operating requirements, and the maturity of the installation and after-sales ecosystem.

2. **Standalone systems suit dispersed users and loads that align with solar generation and can serve larger AC loads through captive solar or solar generators with inverters (see Chapter 1, Technologies).** They may be the least-cost or the only practical option where grid or mini grid service is unavailable or unreliable. Efficient DC equipment can reduce generation and storage needs, but standalone systems need closer attention paid to sizing, installation, maintenance, and after-sales capability.

Power supply choices need to be coordinated with electrification authorities, and revisited as grid expansion, reliability, tariffs, demand, and technology costs evolve (see Step 3.4.3 on tariff design).

» **Pitfall to watch out for.** Avoid promoting off-grid equipment without coordinating with electrification authorities or utilities to assess on-grid options. Infrastructure Development Company Limited (IDCOL), the implementing agency for the Second Rural Electrification and Renewable Energy Development (RERED) project in Bangladesh, supported standalone SWPs in rural areas with high subsidies. Faster-than-expected grid expansion meant many farmers gained grid access during the program and stopped using their solar systems, and the program pivoted to piloting grid-connected SWPs – an intervention that stronger coordination could have included from the start.[53]

C) Business models and financing mechanisms

Work with the private sector to understand both the end user's business model, which determines whether the productive activity can generate enough value and revenue (including whether increased output sells profitably), and the supplier's delivery and financing model, which determines how users access, pay for, and use the equipment. Once the landscape is mapped, stay flexible: let demand identified in stakeholder consultations set the focus of interventions, and design facilities that can support both established, well-functioning business models and novel ones (see the Agile principle).

1. **Map how target end users already access finance.** Identify whether farmers, MSMEs, and other asset owners already borrow through cooperatives, SACCOs/MFIs, off-takers, aggregators, suppliers, or others, and strengthen or extend viable channels before creating parallel ones (see the Agile principle). Consult sector-relevant financiers, including agriculture, MSME, and other non-energy lenders and investors, on their investment criteria, risk perceptions, and constraints, and on what would enable them to finance PUE through existing sector portfolios.

[53] Source: IWMI, Solar Irrigation in Bangladesh, 2021; World Bank Group, Solar-Powered Pumps Reduce Irrigation Costs in Bangladesh, 2015; Hellqvist, L. and Heubaum, H., Setting the Sun on Off-Grid Solar? : Policy Lessons from the Bangladesh Solar Home Systems (SHS) Programme, 2021.

2. **Identify viable, scalable business models to prioritize for support, and the constraints limiting them.** These may be financial, commercial, operational, technological, regulatory, or related to market access. In agriculture, for example, reliable buyers and off-takers are essential: financing equipment will not create a sustainable business if increased output cannot be sold profitably.[54]

» **Insight from stakeholder:**

> *"[PUE equipment] suppliers need to have breadth to target peri-urban and grid-connected [end users] as well to build a large enough revenue stream and scale to be effective at also providing services to the rural poor"*
>
> **– PUE Program Designer (World Bank Group, ESMAP Mini Grid Team)**

[54] Source: Hystra, Market Access for Agro-PURE Companies, 2025.

photo credit: Joel Mulwa for GOGLA

Step 2: Assess Building Blocks and Assign Roles

Step 2 first assesses the strength of each building block in the program's context, then maps the gaps it reveals against the capability, experience, and mandate of potential partner organizations within and outside the PUE taskforce. The aim is a focused intervention logic: program designers commit to the gaps their organization is best placed to address, and every building block is assigned to the most appropriate entity. Any building block left uncovered puts program effectiveness at risk.

2.1 Map the current state of each building block

Once Step 1 has narrowed the options to a focused set of priority value chains, technologies, and business models, program designers should assess each building block with the taskforce, repeating stakeholder consultations as needed. Rank each building block's strength as low, medium, or high using the criteria in Table 2. Base each rating on available evidence and validate it with relevant stakeholders, including market actors where appropriate. Where institutions or organizations rank a building block very differently, record the divergent views and the reasons for them rather than forcing consensus; program designers then make the final assessment.

Use the assessment to focus program design on the building blocks most in need of support, and to sequence that support: which constraints need attention first, which interventions can proceed in parallel, and which can wait. Low strength is not a go/no-go test: some constraints, particularly policy reform, institutional capacity, and business model development, may need to be addressed progressively over more than one program cycle.

The assessment is deliberately qualitative. Strength levels are indicative rather than precise thresholds, given the limited comparable primary data in many PUE markets. Where a decision needs greater precision, commission targeted research (see the Agile principle).

Table 2: Indicative description of building blocks at different strength levels

	Low strength	Medium strength	High strength
Technology & Innovation	**Fit-for-purpose technology not yet proven or accessible.** Equipment may be unavailable, still at pilot or prototype stage, or insufficiently adapted to local conditions to function as intended. Few suppliers or technicians can size, install, and maintain it, and quality assurance is absent at product, company, and installer level.	**Technology meets the need, but quality is inconsistent.** Equipment has demonstrated that it can meet the intended need, but availability, adaptation to local conditions, and performance remain inconsistent. Some product testing or supplier vetting exists, but system sizing, installation, maintenance, and after-sales service vary widely between suppliers and technicians.	**Fit-for-purpose technology with strong quality assurance.** Equipment is suited to local conditions, has a clear track record of advantages over the status quo, and is consistently high quality or quality assured. Suppliers and technicians are vetted or certified to size, install, and maintain it, and after-sales support is accessible.
Market & Business Development	**Markets weak or unproven** Demand is largely assumed or based on pilots rather than demonstrated through repeat purchases or sustained use. Limited evidence that users can and will pay, or that the underlying business case is viable. Few capable suppliers or service providers are active. Market linkages or off-take are weak or need to be created, and relevant business and technical skills are limited.	**Markets developing.** Demand and willingness to pay are demonstrated for some segments or geographies, with some repeat purchases or sustained use. Some viable businesses and suppliers are operating, but profitability or ability to scale remains uneven. Market linkages and off-take exist but may be incomplete, and supplier and skills networks remain patchy.	**Markets deep and viable.** Sustained demand and willingness to pay are demonstrated across the target market. Several viable businesses, suppliers and business models operate without dependence on a single firm or pilot. Market linkages and off-take function reliably, and the skills and commercial networks needed to support continued growth are widely available.
Access to Finance	**Financial access low** **Demand-side:** Equipment and other inputs are unaffordable for many target users and/or users able to repay over time cannot access suitable finance because of e.g., collateral, tenor, or interest rates. **Supply-side:** Suppliers commonly lack working capital or investment finance, particularly smaller or local firms.	**Financial access limited** **Demand-side:** Some target users can afford equipment outright or access workable finance, but substantial segments remain excluded or face unsuitable terms. **Supply-side:** Established suppliers can access some finance, but smaller or newer firms continue to face material constraints.	**Financial access high** **Demand-side:** Equipment is affordable for most target users, either upfront or through widely available financing on workable terms. **Supply-side:** Suppliers of different sizes can generally access working capital and investment finance on terms that support growth.
Policy & Regulation	**Policy framework absent or unsupportive.** Cross-government coordination is weak or ad hoc. Relevant policies, regulatory standards and safeguards are absent, unclear, or poorly enforced. Taxes, import duties, tariff structures, and permit requirements are burdensome or unpredictable.	**Policy framework evolving.** Relevant policies and coordination mechanisms are partly in place, but implementation or enforcement is inconsistent. Regulatory standards and safeguards are emerging. Taxes, import duties, tariff structures, and permit processes may still create material friction.	**Policies supportive and predictable.** Relevant policies and institutional responsibilities are clear and coordination mechanisms function effectively. Regulatory standards and safeguards are established and consistently enforced. Taxes, import duties, tariff structures, and permit processes are transparent, predictable, and do not create barriers to viable market activity.

Additional resources

1. For conducting a more detailed market assessment tailored to energy access where rapid consultation is insufficient: "Market Development Scorecard," (EnDev, 2019)
2. For diagnosing constraints to farmer-led irrigation and identifying appropriate responses: "The Farmer-Led Irrigation Development Guide," (World Bank Group, 2021)

2.2 Identify which actors are best placed to lead or support on addressing each building block

Program designers should map which actors are best placed to lead or support on addressing each building block, working with the relevant institutions and private sector partners. The taskforce should agree the proposed allocation of roles at a strategic level. Where a government-owned national PUE strategy or roadmap exists, it should be the starting point (see Step 1.1). Kenya, Uganda, and Ethiopia, for example, have national roadmaps for scaling up productive use of renewable energy (PURE), developed by their energy ministries with national industry associations and GOGLA support.

Role allocation should weigh each actor's mandate, capabilities, existing or planned activities, and willingness to collaborate. It should also take account of the strength of each building block (see Step 2.1) and the program's time horizon, since mandates and budget priorities change and may affect phasing. Look beyond formal mandates to incentives and to institutional, administrative, or power dynamics that could block action: a role may fit an actor's formal mandate but still conflict with its commercial or institutional incentives. Chapter 5 of the "Off-Grid Solar Policy Toolkit"[55] gives practical guidance on identifying credible institutional champions, mapping stakeholder interest and influence, and anticipating resistance; see its decision tree in Figure 11 (Appendix IV).

Responsibility mapping should distinguish who delivers a function during the program from who will own and sustain it afterward. For each critical function, programs should identify, build the capacity of, and resource the entities expected to carry it forward once support ends (see the Lasting principle). Table 3 gives indicative focus areas for each building block, based on its strength and the program's capability to address it. It is a simplification and should be adapted to relative capabilities and time horizons, for example through phasing of components.

Table 3: Indicative focus areas based on the strength of the building block and program capabilities to address them

	Low capability	Medium capability	High capability
Low strength	**Support partners** A critical gap, but the program is not best placed to lead. Consider mitigating actions or partnering more actively with better-placed actors.	**Direct intervention** A critical gap and the program is sufficiently capable to justify active intervention. Strongly consider targeted support to partners.	**Direct intervention** A critical gap and the program has the capability to address it. This is likely a central pillar of the program design.
Medium strength	**Support partners** There may be value in supporting this area, but the program is not best placed to lead. Favor partnerships or light-touch support.	**Support partners** Market shows traction and the program can support other entities in moving forward. Consider targeted support alongside more core areas.	**Direct intervention** Market shows traction, and the program is capable of pushing it further. This is likely a major program component.
High strength	**Let other stakeholders address** Limited need for intervention and beyond program capabilities. Typically, not a suitable focus area for the program.	**Support partners** Partners are already addressing this well, so any interventions should be tightly scoped. Focus on light-touch support that does not displace existing momentum.	**Support partners** Market is functioning, but program capabilities may justify selective support at the margin. Intervene only where the program adds clear value.

Note: Building block strength assessments should account for variation within the identified priority area. A market that appears strong at the national level may have significant gaps at the sub-national, segment, or value chain level. Programs should therefore apply these assessments at the most granular level practical, particularly where national averages may mask regional or segment-level gaps, and should be cautious about assuming that nationally assessed strengths translate to the communities or segments they intend to serve.

[55] Source: Lighting Global/ESMAP, PPIAF, DDP, The Off-Grid Solar Policy Toolkit, 2024.

» **Best practice.** EnDev Bolivia illustrates how a program can leverage partnerships for a holistic approach to PUE program design. As the PUE component of an energy-access program scaled, EnDev recognized that uptake was constrained by market access despite its existing tailored and user-centered support. To address this, it partnered with NGOs and private sector actors who took measures to strengthen market linkages. This partnership-centered approach was one of EnDev Bolivia's core strengths, helping it sustain results even through politically difficult periods.[56]

Role Allocation and Partnership Building

1. **Build partnerships across the ecosystem and match the degree of collaboration to each actor's mandate and capabilities.** Partners may include aggregators, development partners, financiers, government agencies, private sector actors, and research institutions (see the Holistic principle). The "Beyond Silos" framework distinguishes four degrees of collaboration – independent, consultative, collaborative, and facilitative – and the right one will vary by building block and intervention.[57] In some cases, energy actors are best placed to facilitate, helping sector-led programs identify and address energy constraints in support of their own development objectives. The World Bank Group's AgriConnect initiative,[58] for example, treats energy as enabling infrastructure for agricultural productivity, jobs, incomes, and food security, working with initiatives such as Mission 300[59] and the Energy Sector Management Assistance Program (ESMAP).[60] The Water Forward[61] initiative offers a similar cross-sectoral entry point, with energy supporting water sector objectives across its three pillars, in particular irrigation and water-energy efficiency under Water for Food.

» **Best practice.** Peru's National Rural Electrification Fund (FONER) I and II programs show how PUE programs can coordinate multiple actors to address building blocks holistically. The government recognized that regional electricity distribution companies had financial incentives to increase productive use of energy but lacked community relationships and marketing expertise. It therefore competitively procured NGOs and paired them with the distribution companies to conduct market assessments, build MSME awareness, develop business plans, and link consumers with equipment suppliers and credit services, while the distribution companies provided grid connections, preferential tariffs, and improved service quality. This division of roles helped more than 25,000 family businesses benefit and quadrupled average electricity consumption.[62]

» **Pitfall to watch out for.** Programs should not assume that stakeholders, particularly utilities, have the incentives or structures to support building blocks beyond their immediate priorities. Indonesia's Rural Electrification program initially expected PLN, the national utility, to promote PUE equipment to rural businesses. PLN did not see this as its role, had limited experience of marketing to businesses, and its staff incentives did not reward rural equipment sales. The program corrected course in part by outsourcing marketing to NGOs with established community relationships and business development capabilities, illustrating the value of assessing partner mandates, incentives, and capabilities early.[63]

[56] Source: EnDev, Productive Use of Energy: Moving to Scalable Business Cases, 2021; EnDev, Exit Evaluation of EnDev Bolivia - Grid Densification and PUE, 2024; EnDev, Energising Development Progress Report, 2024.

[57] Source: Agri-Energy Coalition, Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar, 2025.

[58] Source: World Bank Group, AgriConnect.

[59] Source: Mission 300.

[60] Source: ESMAP.

[61] Source: World Bank Group, Water Forward.

[62] Source: World Bank Group, Promoting Productive Uses of Electricity in Rural Electrification Programs, 2017; World Bank Group, Accelerating the Productive Use of Electricity, 2023.

[63] Source: World Bank Group, Raising Rural Productive Uses of Electricity, 2021.

2. **Absorb costs that suppliers cannot efficiently carry alone.** Programs can take on activities such as market assessment using geographic information systems (GIS), raising awareness, or bundling customers into concessions, where economies of scale favor collective action. Identifying demand clusters and presenting them as ready-made tender opportunities, for example, lowers barriers to private sector entry and can create the customer density suppliers need to justify investment in local infrastructure and staffing.

   » **Best practice.** In Uganda's MSIP, local government teams took on farmer outreach, registration, farm visits, and data collection, then requested quotations from pre-qualified suppliers on farmers' behalf. Suppliers could bid without visiting each farm themselves, and concentrating demand within defined service areas cut their overheads and made after-sales service more efficient.[64]

3. **Sequence building blocks rather than addressing them all at once, and adjust as evidence builds (see Figure 7)**. Some constraints must be addressed before others: production and market linkages, for example, typically need to be in place before financing can have meaningful impact. Sequencing may extend beyond a single program cycle where policy, institutional, or market development constraints take time to resolve, and the stakeholder best placed to address a building block may change over time. Where market intelligence is strong, interventions can be targeted from the start; where it is thin, consult more broadly and build in room to iterate across program phases. Program operations should allow interventions to be scaled up, scaled back, or retired according to results (see the Agile principle).

   » **Best practice.** EnDev's RBF program for solar home systems (SHS) in Rwanda shows how components can be sequenced using a recurring market review. EnDev reviewed the market annually and adjusted its RBF and phasing accordingly. In Phase 1 (2012–2019), a supply-side RBF helped suppliers overcome entry barriers; as the market matured, Phase 2 (2019–2020) shifted to a demand-side, pro-poor approach, with the subsidy passed on to consumers. Once proven, the Rwandan government scaled this approach nationally.[65]

4. **Some barriers take longer to overcome but remain feasible with dedicated action by the right actor; others may be insurmountable.** Where no credible pathway exists to address a constraint essential to program effectiveness, the scope or ambition of the intervention may need to be reconsidered.

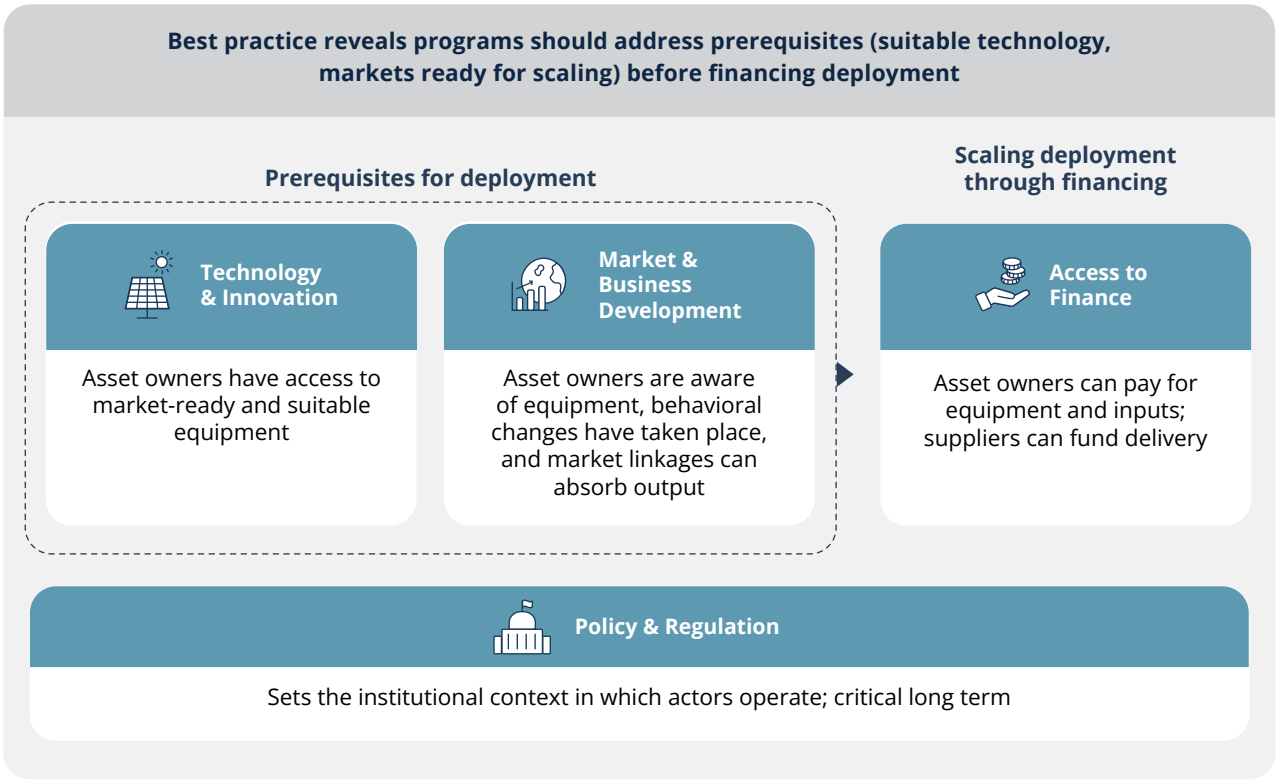
   » **Insight from stakeholder:**

   > *"No matter how good you are in the kitchen preparing food – if at the institutional level nobody is willing to eat, it becomes a challenge"*
   >
   > **– PUE Program Designer (World Bank Group, Regional DARES)**

[64] Source: MAAIF, Micro-Scale Irrigation Program: Technical Guidelines, 2022; World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.

[65] Source: EnDev, How Shifting to a Pro-Poor Approach Accelerated Energy Access in Rwanda, 2026.

Figure 7: Simplified illustration of the sequencing of building blocks



“Responsibility mapping should distinguish who delivers a function during the program from who will own and sustain it afterward”.

Step 3: Select and Design Interventions

This section provides a non-exhaustive menu of interventions to address identified constraints. Program designers need to consider how the building blocks fit together, how to sequence interventions, and which actors will deliver them. The Lasting principle should be kept top-of-mind to ensure continuity after program support ends. As program design narrows toward specific interventions, objectives and KPIs should become more specific and measurable. Each intervention should clearly link to these, with responsibility assigned to actors able to influence them.

Figure 8: Overview of interventions discussed in this guide, by building block

Icons indicate the primary actor(s) targeted by the intervention

Asset owner / end user | Suppliers | Other ecosystem actors

3.1 Technology & Innovation

Creates the information, standards, and digital infrastructure needed for markets to scale. In some markets, information failure is a critical constraint

- Quality assurance
- Digital tools for end users

3.2 Market & Business Development

Turns equipment access into productive use. Addresses demand- and supply-side capacity gaps, market linkages, and awareness. Often the first investment in very nascent markets.

- Technical assistance to asset owners and end users
- Technical assistance to suppliers
- Consumer awareness campaigns

3.3 Access to Finance

Addresses affordability of equipment and liquidity constraints across the value chain. Choice of instrument depends on market maturity and supplier business models.

- Results-based financing
- Upfront grants to suppliers
- Equity financing to suppliers
- PUE Credit Lines and Guarantees
- Matching grants to asset owners
- Utility or developer-based financing

3.4 Policy & Regulation

Shapes whether other interventions can succeed. Policy stability often matters as much as policy design.

- Mechanisms for cross-sectoral collaboration
- Import and tax policy
- Tariff design and cross-subsidization for PUE

3.1 Technology and Innovation

INTERVENTIONS COVERED IN THIS SECTION: Quality assurance | Digital tools for end users

Technology and innovation are enabling functions that help PUE markets scale. Quality assurance – covering products, the companies that supply them, and the technicians who install and maintain them – creates the information and standards needed to compare options, protect users, and build confidence among asset owners, end users, governments, lenders, and suppliers. Digital tools can reduce the information and access barriers that limit uptake and sustained use of PUE equipment.

These interventions should complement market development support, and finance. Building quality assurance into eligibility criteria helps ensure that RBF, matching grants, and credit lines fund reliable equipment and services, provided smaller suppliers have a supported pathway to compliance (see Step 3.2.2). Embedding digital tools in program delivery can help structure the end user's journey through a program. The right instrument in each case depends on market maturity and user capabilities, as set out under each intervention below.

3.1.1 QUALITY ASSURANCE

Quality assurance (QA) supports the emergence of high-quality technologies, products, and services that sustain access and impact while protecting end users and their investments. It reduces the prevalence of low-quality or counterfeit products, makes performance comparable across suppliers, lowers lifecycle costs for end users, and channels public and private financing toward lower-risk products and services.[66,67] QA operates at three levels. At product level, it typically includes harmonized test methods, standards, and verification schemes backed by accredited test labs and market surveillance. At company level, it involves accreditation linked to TA and capacity building, and at staff level it involves workforce development, training, and certification.

In the OGS sector, QA has been led by VeraSol, which has developed test methods for key PUE product categories and rapid assessment methods for nascent technologies such as egg incubators, milling machines, and agricultural sprayers, but has not yet defined PUE quality standards or begun certification. Efforts are underway to establish a harmonized QA framework that provides a common approach across PUE technologies, with assessment methods tailored to specific appliances and systems.[68]

» **Insight from stakeholder.**

> *"We had to also think about the quality assurance framework because we wanted to make sure that the right equipment was in place. So, we worked with VeraSol on that piece."*
>
> **– PUE Program Designer (World Bank Group, Regional DARES)**

[66] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.
[67] Source: UNIDO, Energy Efficiency for Sustainable Livelihoods in Africa (EELA) - Regional Project, 2024.
[68] Source: VeraSol, Test Methods. See also: VeraSol, Database.

Firm or staff-level certification approaches have an important role to play in PUE QA, alongside product certification. Product certification alone is not enough for PUE. OGS QA was built around certifying products, which made sense for integrated plug-and-play solar kits that customers could install themselves. Many PUE appliances and infrastructure, however, run on large component-based systems that require site visits, bespoke sizing, and professional installation and maintenance, so qualified and certified engineers and firms are also needed. Linking company- or staff-level certification to TA and workforce development (see Step 3.2.2) builds capability rather than simply requiring it. Standardized protocols for site assessment and system sizing can also be applied as a condition of financing eligibility, and monitoring should include site visits that check installation and after-sales quality, not only product test results. Wherever possible, QA approaches should be harmonized across countries and programs to make compliance easier for companies.

» **Best practice.** Uganda's MSIP combined product- and company-level QA. Suppliers were pre-qualified annually against general equipment quality standards and had to commit to providing after-sales service. System sizing relied on standardized farm visit and data collection protocols run by local government teams rather than on suppliers' own assessments, and pre-qualified suppliers then bid using that verified farm-level information. Together, these addressed supplier-quality and site-assessment risks that product-only certification leaves open.[69]

QA is most effective when:

The QA instrument is matched to market maturity. In nascent PUE markets, test methods, product performance data, voluntary standards, and third-party verification give programs, suppliers, lenders, and users better information without imposing excessive compliance costs. Mandatory standards or labeling become more appropriate as markets mature and can bear the cost of enforcement. The shift is rarely linear, though: mandatory standards are sometimes introduced for political or procurement reasons before markets are ready, and programs should plan for that possibility.[70]

QA is tied to program incentives. Linking QA to financial assistance means public funding directly rewards quality: the Productive Use Financing Facility (PUFF), for example, requires third-party testing before subsidies are disbursed.[71] Testing costs can themselves be a barrier to entry and scale for smaller companies and startups. Where eligibility depends on QA, programs should consider covering some or all of the cost of product testing (see below).[72]

[69] Source: World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.
[70] Source: World Bank Group, Reaching the Full Potential of Standards with Quality Infrastructure, 2025.
[71] Source: VeraSol, Appliance Testing Process for the Productive Use Financing Facility, 2025.
[72] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.

Key challenges and risks to address in program design:

1. **Over-designing QA too early can raise costs and exclude smaller suppliers.** Distinguish between QA as a condition of financial eligibility, which raises the entry bar and can lock out smaller or earlier-stage suppliers, and QA as an information instrument (testing, data publication, voluntary benchmarking) that informs the design of TA, capacity building, and workforce development. In nascent markets the latter is usually preferable. Where eligibility-based QA is introduced, sequence it with supplier TA (see Step 3.2.2) so that firms have a supported pathway to compliance.

2. **QA can become a bottleneck where few compliant products or testing options exist.** Assess availability before launching procurement or subsidy windows, and consider sequencing QA with supplier TA, distributor-manufacturer matchmaking, or phased eligibility requirements.

» **Best practice.** The Green People's Energy program found limited good-quality solar PUE equipment available in Benin, so it introduced new brands and connected suppliers with manufacturers that could meet its requirements.[73]

Additional resources

1. For selecting appropriate quality-assurance approaches for PURE markets: "Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy" (GOGLA, 2023)
2. For identifying available testing approaches and requirements for PUE equipment: "Appliance Testing" (VeraSol, 2026)

> **"Product certification alone is not enough for PUE".**

[73] Source: GIZ, Productive Use of Energy (PUE) in the Agricultural Sector, 2024.

3.1.2 DIGITAL TOOLS FOR END USERS

Digital tools can strengthen PUE programs by reducing the information, finance, and service barriers that limit uptake and sustained use of PUE equipment. They are distinct from digital services in PUE, which are a set of use cases (e.g., internet cafés). For end users, digital tools can improve access to PAYG or other credit-based financing, market information, weather and climate information, agronomic advice, remote monitoring, technical guidance, and links to buyers, input providers (e.g., fertilizer for smallholder farmers (SHFs)), insurers, public services, and suppliers. Safaricom's DigiFarm in Kenya, for example, gives farmers phone-based access to a bundled set of services, including advisory content, weather information, input suppliers, credit, insurance, and market linkages, and is estimated to have over 1 million users.[74]

Digital tools are most effective when:

1. **The enabling digital ecosystem is sufficiently strong.** Digital tools work best where target users have reliable mobile connectivity, access to phones, mobile money or digital payment services, and sufficient digital literacy. Where these conditions are weak, programs may need low-tech delivery channels, such as SMS, voice messages, call centers, extension agents, farmer groups, cooperatives, or field officers.

2. **They are multifunctional and embedded in program delivery.** Single-channel access to financing, advisory content, market linkages, and program support reduces the burden on users and increases uptake, as DigiFarm's bundled model shows. Tools designed into the program from the outset can structure the end user journey rather than run alongside it.

   » **Best practice.** Uganda's MSIP developed IrriTrack as a multifunctional delivery platform for micro-irrigation rather than a stand-alone digital tool. Although its intended users were local government staff, it directly supported end users: registering them, providing equipment cost estimates, tracking their applications, procurement, and installation, and recording grievances. It also linked the matching grant to complementary support, since farmers unable to pay the co-payment could, with their consent, be referred to FIs using program data.[75]

Key challenges and risks to address in program design:

1. **Digital exclusion can reinforce inequalities.** Digital tools may exclude exactly the groups PUE programs often seek to benefit, such as poorer, more remote, and marginalized rural users.[76] Programs should make tools user-friendly while also designing ways to reach those who cannot use them without support.

   » **Pitfall to watch out for.** In Uganda's refugee-hosting settlements, Energy Solutions for Displacement Settings (ESDS)/EnDev explored end user finance models for PUE equipment. PAYG through mobile money could improve affordability, but limited connectivity, literacy, and confidence in using mobile money constrained uptake: in one settlement, fewer than 5% of buyers could use mobile money accounts.[77]

2. **Data privacy, consent, and ownership can become major trust risks.** Digital tools may collect sensitive information such as location, income, payment history, and credit behavior. Fragmented data governance can reduce end users' willingness to adopt digital solutions,[78] and marginalized groups are at particular risk of privacy and data-rights violations.[79] Programs should set clear data-sharing rules and build in privacy and cybersecurity safeguards (see Step 3.3.6 on data sharing in utility or developer-based financing).

[74] Source: CGIAR, Safaricom DigiFarm.
[75] Source: World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.
[76] Source: FAO, Guide on Digital Agricultural Extension and Advisory Services, 2023.
[77] Source: GIZ, A Report on End user Finance and Payment Systems to Improve Access to Reliable, Sustainable, and Modern Energy Products in Displacement Settings (Uganda), 2021.
[78] Source: Jouanjean, M. et al., Issues around Data Governance in the Digital Transformation of Agriculture, 2020.
[79] Source: Dittmer et al., Principles for Socially Inclusive Digital Tools for Smallholder Farmers: A Guide, 2024.

3.2 Market and Business Development

INTERVENTIONS COVERED IN THIS SECTION:

- Technical assistance to asset owners and end users
- Technical assistance to suppliers
- Consumer awareness campaigns

Market and business development helps turn PUE equipment into productive outcomes, addressing the wider conditions that determine whether equipment can be used profitably (see the Outcome-led and Holistic principles). Programs should work through actors that already have trusted relationships with end users – aggregators, cooperatives, NGOs, off-takers, and suppliers – rather than building parallel delivery channels (see the Agile principle). This includes existing commercial distribution networks: agricultural input shops, equipment dealers, or mechanization centers that distribute conventional equipment may also be able to stock and distribute PUE technologies, lowering delivery costs and improving credibility.

3.2.1 TECHNICAL ASSISTANCE TO ASSET OWNERS AND END USERS

TA to asset owners and end users helps ensure that deployed PUE equipment translates into sustained use and reliable productive gains (e.g., higher income, lower waste). It can include market linkages, business development support, technical training, and financial literacy. TA should be treated as a core intervention, but it can be costly per end user and often needs partners to deliver it (see the Cross-sectoral principle).

» **Insight from stakeholder.**

> *"There is lack of skills to operate and maintain equipment. Emphasis is not only transfers of tech, but transfer of knowledge to repair, maintain etc."*
>
> **– PUE Program Designer (World Bank Group, East Africa Agriculture)**

Business and entrepreneurship support – business planning, financial management, and marketing – is a central part of this TA. Peru's rural electrification programs, for example, delivered it through NGOs paired with distribution companies (see the FONER best practice in Step 2.2).[80]

TA to asset owners and end users is most effective when:

1. **The program introduces new economic activities or new kinds of equipment.** These require changes in behavior and markets. Matchmaking with buyers reduces investment risk for end users, gives PUE suppliers more route-to-market certainty, and gives lenders a basis for assessing revenue when appraising equipment loans,[81] while training is critical to ensure proper use and maintenance of unfamiliar equipment.[82]

[80] Source: World Bank Group, Promoting Productive Uses of Electricity in Rural Areas of Peru, 2012.
[81] Source: Hystra, Market Access for Agro-PURE Companies, 2025.
[82] Note: For example, SWPs in areas lacking irrigation before. See also: GIZ, Productive Use of Energy (PUE) in the Agricultural Sector, 2024.

2. **The support is not already available.** Some PUE suppliers, such as Adili Solar Hubs, SokoFresh, and Zonful Energy, integrate market linkages into their business models.[83] Where capable supplier- or off-taker-led models already exist, programs should support them rather than duplicate them.

3. **It is delivered through existing intermediaries.** Aggregators, cooperatives, and producer organizations can lower delivery costs. Building Rural Income through Inclusive Dairy Business Growth in Ethiopia (BRIDGE), for example, first linked farmers to dairy cooperatives and then linked the cooperatives to processors.[84] Indonesia's rural electrification projects took a similar approach through local NGOs (see the Indonesia pitfall in Step 2.2).

   » **Best practice.** Burundi's Value Chain Development Programme Phase II (PRODEFI II) shows that output-market linkages are stronger when programs build them around cooperatives and support those cooperatives as credible commercial counterparties. PRODEFI II helped establish or strengthen 15 cooperatives, training them in governance, accounting, negotiation, and contract management, and giving them access to drying, storage, and marketing infrastructure. This helped them aggregate rice harvests, organize group sales, reduce costs for buyers, and strengthen farmers' collective bargaining power. The cooperatives signed 56 commercial contracts with private buyers and organized group sales of over 5.5 million kg of paddy. The approach also made them more bankable, since they could provide services to members, facilitate input access, and engage MFIs as organized counterparts.[85]

4. **The program focuses on a smaller set of equipment, value chains, or business models whose TA needs are well understood.** TA is more effective the more tailored it is, but tailoring it to many types of equipment or value chains can sharply increase program complexity and cost. Programs with a broader focus may need lighter-touch TA, modular training content, partnerships with specialized providers, or a narrower set of priority areas for TA.

Key challenges and risks to address in program design:

1. **Exclusion of the poorest.** Training must be widely accessible. Without deliberate inclusion mechanisms, such as working through cooperatives, programs may reinforce existing inequalities by excluding the hardest-to-reach from TA (see the Holistic principle).[86]

2. **Gender and intra-household effects.** Commercializing production can shift control over resources within households, potentially disadvantaging women where they manage subsistence output. Where feasible, program design should assess how PUE may affect gender dynamics and address this within the TA.[87]

3. **Fragile outcomes without a transition plan.** Asset owners and end users need to know how long TA will last and what is expected of them when it ends.[88] And programs should build local stakeholders' capacity to continue practices such as developing market linkages or offering training independently (see the Lasting principle).[89]

[83] Source: Colenbrander, E., et al., Five Hurdles to Getting Productive Use of Energy Products to the Last Mile, 2022; Hystra, Market Access for Agro-PURE Companies, 2025.

[84] Source: van der Lee, J., Building Rural Income through Inclusive Dairy Growth in Ethiopia (BRIDGE), 2026.

[85] Source: IFAD, Burundi Value Chain Development Programme Phase II, 2022.

[86] Source: IFAD, Sustainable Inclusion of Smallholders in Agricultural Value Chains, 2015.

[87] Source: IFAD, Sustainable Inclusion of Smallholders in Agricultural Value Chains, 2015.

[88] Source: Energypedia, Making Solar Equipment for Productive Use Available in Rural Areas in Ivory Coast, 2026.

[89] Source: IFAD, How to Do Public-Private-Producer Partnerships (4Ps) in Agricultural Value Chains, 2016.

Additional resources

1. For designing market access support and strengthening links between agro-PURE users and buyers: "Market Access for Agro-PURE Companies" (Hystra, 2025)
2. For diagnosing value chain constraints and designing complementary value chain support: "Toolkit: Commodity value chain development projects" (IFAD, 2014)

photo credit: Joel Mulwa for GOGLA

3.2.2 TECHNICAL ASSISTANCE TO SUPPLIERS

Technical assistance (TA) to suppliers builds the operational and commercial capacity needed to sell, finance, and scale PUE equipment. It can cover system design, market research and demand assessments, data collection and management, digital platform implementation (e.g., PAYG systems, carbon credit reporting), business development (marketing, branding, research and development), and after-sales support.[90]

TA is most relevant where existing or potential suppliers face specific capability, operational, or market-facing constraints that non-financial support can address. It can be particularly impactful in three situations: (i) building the supplier base in nascent markets where few companies have the skills to participate in formal programs; (ii) improving equipment quality and after-sales service standards; and (iii) de-risking private investment by reducing execution risk for suppliers already approaching commercial viability.[91,92,93] The PURE Distribution Innovation Lab, for example, targets suppliers already selling SWPs to underserved, last-mile customers.[94]

TA to suppliers is most effective when:

1. **It is tailored to company needs, and companies own it.** Programs should balance tailored support, which recognizes each company's context, against cohort-level training that addresses common knowledge gaps at lower cost, defaulting to cohorts where needs are shared (e.g., marketing or financial reporting).[95] TA is also more effective when suppliers help identify the problem, select or approve the provider, and have an internal sponsor responsible for implementation.[96]

» **Best practice. Powering Renewable Energy Opportunities (PREO) uses a combination of one-on-one TA and cohort support.** Companies define what support they need, and can select both the focus areas and experts they want to work with. PREO also uses cohort-based support where companies share common needs, such as marketing, business leadership coaching, or peer networks for founders, helping reduce transaction costs. Tied to this demand-led approach are success metrics that focus on outcomes, such as improved capabilities, investment readiness, and company satisfaction.[97]

» **Pitfall to watch out for.** TA imposed as a condition of financial support is not demand-led and risks a mismatch between what suppliers need and what is offered, wasting both time and money.[98] TA offered to help firms qualify for an instrument is different (see below).

» **Insight from stakeholder.**

> *"I've been in a position where I've been supporting companies that don't want the TA support... [they have] been told that they need to have it as part of the lock-in to the grant requirement and it's just a waste of everybody's time."*
>
> **– PUE Program Designer (Development Partner Program)**

[90] Source: Shell Foundation, Productive Use of Energy Solutions for Microenterprises, 2025.
[91] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.
[92] Source: EEP Africa, Building an Effective Technical Assistance Ecosystem to Further Clean Energy Access, 2025.
[93] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.
[94] Source: Global Distributors Collective, Productive Use of Renewable Energy (PURE) Distribution Innovation Lab, 2026.
[95] Source: EEP Africa, Building an Effective Technical Assistance Ecosystem to Further Clean Energy Access, 2025.
[96] Source: EEP Africa, Building an Effective Technical Assistance Ecosystem to Further Clean Energy Access, 2025.
[97] Source: Stakeholder consultations, 2026; PREO, Technical Assistance.
[98] Source: Stakeholder consultations, 2026.

2. **It is paired with finance, especially for smaller suppliers.** Where suppliers lack access to capital, or acting on TA recommendations involves capital costs such as upgrading equipment, hiring staff, or building distribution, TA alone is unlikely to unlock scale. The Efficiency for Access Coalition found that well-sequenced grants and TA significantly increased the likelihood of suppliers securing follow-on commercial financing (see Step 3.3.2 on how to sequence the two).[99]

3. **It is designed with other program instruments in mind.** TA raises the capability floor that makes other interventions work: helping suppliers meet quality assurance standards required for RBF eligibility, preparing them to create or manage market linkages, or supporting them through the documentation and reporting requirements of grant programs. This matters most for smaller companies, which are often excluded from financial instruments not because they lack viable products but because they cannot meet application and compliance requirements. Where TA enables access to other instruments, it should be designed and timed to align with them rather than delivered as a standalone track.[100]

Key challenges and risks to address in program design:

1. **Duplication with other TA programs.** Multiple donors and programs often provide TA to the same supplier base without coordination, wasting resources and fragmenting supplier attention. Programs should map existing TA provision before designing their own (see Step 3.3.2), and consider co-financing or referral arrangements with existing providers rather than building parallel capacity.[101]

2. **High per-supplier cost.** Tailored TA is expensive relative to cohort-based delivery (see above). Cost-sharing with investors whose incentives are aligned, such as impact investors whose portfolio companies receive TA, can reduce per-supplier costs for programs while improving quality.[102]

3. **Access barriers for small and remote suppliers.** Cost and time constraints make TA harder for small suppliers to access,[103] with more TA reaching better networked and more commercially mature firms. Deliberate outreach, including to female-owned suppliers and those in less-connected markets, is needed to avoid reinforcing existing market inequalities.[104]

Additional resources

1. For deciding how to combine grants and TA to strengthen early-stage PURE suppliers: "Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies" (Efficiency for Access, 2026)
2. For tailoring TA to companies at different stages of growth and designing effective TA delivery: "Building an Effective Technical Assistance Ecosystem to Further Clean Energy Access" (EEP Africa, 2025)

[99] Source: Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

[100] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[101] Source: Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

[102] Source: EEP Africa, Building an Effective Technical Assistance Ecosystem to Further Clean Energy Access, 2025.

[103] Source: EEP Africa, Building an Effective Technical Assistance Ecosystem to Further Clean Energy Access, 2025.

[104] Source: Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

3.2.3 CONSUMER AWARENESS CAMPAIGNS

Consumer awareness campaigns are outreach and consumer education activities, including trade fairs, exhibitions, and demonstrations, that help potential users learn what PUE equipment exists, what problems it solves, its potential benefits (e.g., higher income), how it can be financed, and what quality and performance to look for.

They are most relevant in nascent PUE markets, especially rural and peri-urban areas where potential users have low awareness of PUE. They provide most value when programs introduce relatively complex or high-ticket technologies, such as solar irrigation, milling, or cold storage, where adoption depends on users understanding not only the equipment but also how to adapt business practices to make it profitable.[105]

Programs are not always best placed to run awareness campaigns themselves; the private sector plays a crucial role in reaching potential buyers directly. Programs can coordinate and de-risk outreach, but private sector actors are usually better placed to roll out campaigns as programs scale. Programs can support this by including awareness campaign funding as an eligible use within grants (e.g., the PURE Growth Fund),[106] requiring suppliers to submit outreach plans as part of grant conditions, or directly funding suppliers to run demonstrations. For example, Sustainable Energy for Smallholder Farmers (SEFFA) funded Ntakye Ltd to run six demonstrations, among other activities.[107] Where established suppliers already run effective outreach, programs should check whether more campaign activity would add to it or duplicate it before investing.

» **Pitfall to watch out for.** While demonstration projects can be very effective for raising awareness and interest among potential asset owners, projects that lack a clear strategy for leveraging the private sector and market-based approaches will struggle to scale the approach.[108]

Consumer awareness campaigns are most effective when:

1. **They are targeted and locally credible.** Messaging should be in local languages, jargon-free, gender-sensitive, pretested, and delivered through channels users already trust, such as community groups, farmer cooperatives, SACCOs, extension agents, or local NGOs.[109,110]

» **Best practice.** In Uganda, MSIP combined broad communication with local, in-person engagement. The implementer, MAAIF, developed the communication materials, while district agricultural teams led local awareness-raising events, visited farmers, and explained equipment options and costs. The program combined media campaigns, radio spots, technical fairs, demonstration farms, brochures, and supplier engagement to make solar irrigation visible and credible.[111]

[105] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.
[106] Source: REEEP, Pure Growth Fund Application Guidelines, 2025.
[107] Source: EnDev, Transforming Mindsets to Spark Demand for Solar PU, 2024.
[108] Source: GIZ, Productive Use of Energy (PUE) in the Agricultural Sector, 2024.
[109] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.
[110] Source: IGC, Transforming Livelihoods through Scaling Up the Productive Use of Energy, 2025.
[111] Source: World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.

2. **They are tied to other program interventions.** Awareness should be linked to end user financing, quality assurance, user training, or market linkages, and campaigns should be launched only once supply-side follow-up capacity is in place and at least one financing pathway is available for interested buyers.

» **Pitfall to watch out for.** Consumer awareness campaigns without follow-up capacity or finance are unlikely to convert interest into sales. In Kenya, an Efficiency for Access SWP awareness campaign generated over 100 leads but did not convert them into sales, in part because companies had limited bandwidth to follow up and customers lacked financing options.[112]

> **“There is lack of skills to operate and maintain equipment. Emphasis should not be only on technology transfer, but also on knowledge and skill creation to operate, repair and maintain equipment”.**

[112] Source: Colenbrander, E., et al., Five Hurdles to Getting Productive Use of Energy Products to the Last Mile, 2022.

3.3 Access to Finance

INTERVENTIONS COVERED IN THIS SECTION:

Results-based financing | Upfront grants to suppliers | Equity financing to suppliers | PUE Credit Lines and Guarantees | Matching grants to asset owners | Utility or developer-based financing

Access to finance is a priority component of PUE programs working with the private sector, because affordability and financing constraints are critical to uptake and sustained use. On the supply side, suppliers and distributors need capital to hold inventory, extend customer credit, and fund distribution and after-sales networks. On the demand side, farmers and MSMEs may be unable to afford equipment upfront or access suitable credit. Lenders may view these borrowers, assets, or business models as too risky, and even where credit is available, repayment terms may not align with the revenues generated by the asset owner. It usually makes sense to implement multiple instruments in parallel to address distinct financial barriers across the value chain, for example by combining demand-side and supply-side financing support to ensure equipment is both affordable and available (see Step 3.3.1 for how RBF and matching grants can be combined). Finance also works best when bundled with the quality assurance, TA, and market development support covered in Steps 3.1 and 3.2 (see the Holistic principle).

The best-fit financing instrument will reflect power supply setting, PUE equipment market maturity, and supplier business model (see Figure 9). For grid and mini grid electricity supply, the user pays per kilowatt hour or a flat fee. For off-grid supply, users tend to buy generation assets outright or via PAYG. The size and cost of PUE equipment will differ significantly according to power supply setting. Mass-produced AC equipment is often competitively priced, while DC equipment, and equipment bundled with its own generation and storage, is likely to be more expensive. Ability to pay may be a function of distance from the grid, with hard-to-reach off-grid communities among the lowest-income groups. Equipment distributors may need to be incentivized to enter markets, expand into new territories, or scale operations significantly. Upfront grants are often better suited to fund inventory, distribution, demonstrations, and early market-building; credit lines and working capital support can help companies scale; and RBF can enable companies to serve lower-income populations.

Figure 9: Simplified illustration of how optimal financing depends on market maturity and supplier business model

	Small-scale direct sales / PAYG *Discrete product, supplier-led sales*	**Service-based / shared infrastructure** *Energy-as-a-service, rental*
Mature / proven	**Typical fit: RBF + credit lines** *For mature markets with capable suppliers* • RBF to reward verified results and support scale-up • Credit lines / working capital to ease supplier liquidity • Matching grants where affordability gap persists • Requires capable suppliers already present ◊ Pair with TA for quality assurance eligibility ◊ Design exit pathway from concessional to commercial	**Typical fit: asset-owner finance** *Less evidence on maturity* • **Service-based models generate recurring revenues at the asset owner-level:** this is where financing fits, not at the individual end user • **Instruments:** » Grants / adapted RBF » On-lending / guarantees » Blended finance facilities • **Sales-linked RBF is less suited to recurring-revenue models.** Adapted RBF can link to utilization or sustained service ◊ **Maturity still matters:** less-developed service-based markets may require more TA and concessional support
Nascent / immature	**Typical fit: upfront grants** *For early-stage markets and equipment* ◊ Fund product adaptation, inventory, distribution ◊ Support small suppliers to reach investment readiness ◊ Matching grants where there is affordability gap ◊ Innovation grants / challenge funds if pre-commercial tech ◊ Pair with TA; avoid over-subsidizing single firms ◊ Design graduation pathway to RBF / on-lending	

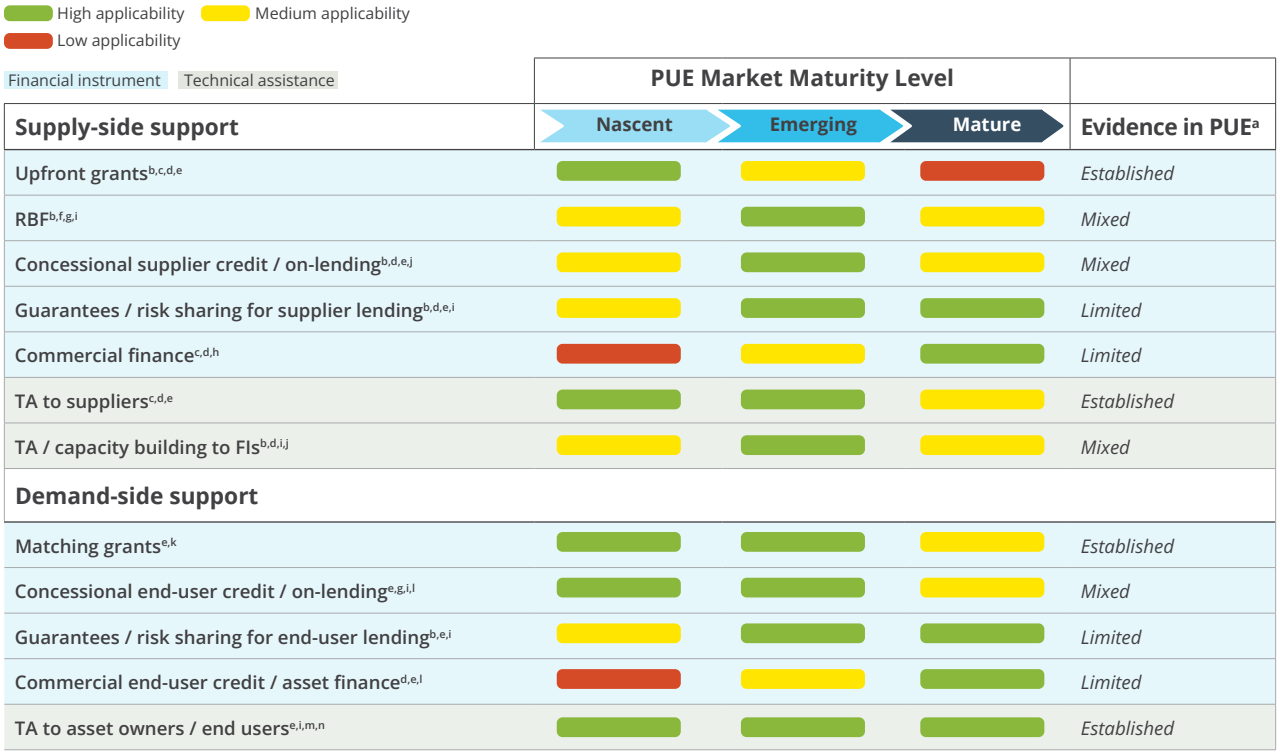
Source: Dalberg analysis, 2026.

1. **Programs often need to address both end user ability to pay and access to credit.** Subsidies and grants can reduce the upfront price where affordability is a constraint, while credit lines, guarantees, and other lending mechanisms can enable local FIs to offer financing to both end users and PUE equipment distributors.

2. **Interventions to increase end user bankability should build on existing financial institutions and relationships where possible.** If target users already access credit through cooperatives, off-takers, MFIs, suppliers, or other trusted channels, programs should assess whether these can be strengthened or de-risked before creating new financing facilities (see Step 1.3). Non-energy financiers, such as agriculture and MSME lenders, can also be an important pathway to commercial capital: public support such as liquidity, risk-sharing, TA, or better market information can bridge the gaps that stop them lending for PUE.

Figure 10 provides an indicative view of how financial instruments may evolve as markets mature. For suppliers, the typical progression runs from upfront grants to RBF, concessional finance, risk sharing, and ultimately commercial finance, though instruments can overlap: RBF, for example, may shift from market-building support toward targeted incentives for harder-to-reach customers. The maturity categories roughly map to the access to finance strength levels used in Step 2.1 (low, medium, and high) and are adapted from "Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy,"[113] which focuses on off-grid solar PUE. Figure 10 extends this framing across power supply settings. Firms in the same market but at different stages of growth require different forms of capital or TA.[114] The evidence ratings reflect the depth and consistency of documented PUE programs; they do not indicate that each instrument's effects have been causally demonstrated.

Figure 10: Indicative applicability of different instruments at different stages of market maturity



Source (a) Dalberg analysis, 2026. Evidence ratings reflect the breadth and consistency of documented PUE program experience and publicly available results across the sources cited for each instrument; (b) ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022; (c) Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026; (d) GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023; (e) GOGLA, Unlocking Off-Grid Solar: How Results-Based Financing is Driving Energy Access and Powering Productivity, 2023; (f) Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024; (g) GOGLA, After the Dip: Off-Grid Solar's Defining Moment, 2025; (h) World Bank Group, Project Appraisal Document – Grants to the Republic of Uganda, 2022; (i) World Bank Group, Implementation Completion Report (ICR) Review - Niger Solar Electricity Access Project, 2026; (j) World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019; (k) Efficiency for Access, Solar Water Pump Outlook 2019: Global Trends and Market Opportunities, 2019; (l) World Bank Group, Project Performance Assessment Report – Peru Rural Electrification Project, 2017; (m) World Bank Group, Raising Rural Productive Uses of Electricity, 2021.

[113] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.

[114] Source: See, for example, Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

Choosing the financing instrument before the constraint is understood is one of the most common failure modes in PUE programming. An instrument that suits one market can fail in another. Examples include RBF for suppliers that cannot pre-finance, credit lines where affordability is the barrier, and equipment finance where there is no off-taker. The questions below draw together the diagnosis from Steps 1 and 2 and the principles in Chapter 1. Program teams can use them as a check before committing to an instrument, for example at concept note stage. Each point to where the guide covers the underlying issue. Before choosing a financing instrument, program teams should be able to answer:

1. **What development outcome is the program targeting, and whose enterprise generates it?** (Step 1; Chapter 1, Outcome-led principle)

2. **Is the opportunity substituting an existing energy supply, electrifying an existing activity, or enabling a new one?** (Step 1.2)

3. **Which power supply setting and business model deliver the equipment, and who carries credit and utilization risk?** (Step 1.3; Table 1)

4. **Is the main constraint affordability, access to credit, supplier liquidity, or lender risk perception?** Each points to a different instrument (see Figure 9).

5. **How mature are the technology, business model, and suppliers, and can suppliers pre-finance activities and absorb verification costs?** (Figures 9 and 10; Step 3.3.1)

6. **Are off-take and market linkages in place, or could financing produce output no one buys?** (Step 1.3; Step 2.2; Step 3.2.1)

7. **What finance channels do target asset owners already use, including agriculture and MSME lenders, and can these be strengthened or de-risked before a new facility is created?** (Step 1.3)

8. **Who will sustain the function after program support ends?** (Chapter 1, Lasting principle)

Where a question cannot yet be answered, this is a signal to fill the gap before finalizing the financing design, not a reason to delay the program as a whole (see the Agile principle). Where the answer is uncertain, targeted studies can run in parallel. Where getting it wrong would force a fundamental redesign of the financing component, the evidence should come first.

3.3.1 RESULTS-BASED FINANCING

RBF, which has been widely used in household off-grid solar and mini grids, disburses funding once pre-agreed and verified results have been achieved, such as equipment sales, installation, or continued use after a defined period.[115] Companies typically pre-finance activities and receive reimbursement after results are verified, transferring commercial, delivery, and liquidity risk to participating firms. By linking public funding to performance, RBF can support market expansion and improve accountability for results, but its effectiveness depends heavily on design suited to context and on implementation quality.[116] Experience from SHS programs shows that paying mainly for sales can reward volume over after-sales service and sound credit management. PUE programs should therefore consider linking at least part of each payment to sustained use or service delivery (see below). Implementation capacity matters as much as design: PUE RBF can be more demanding to administer than SHS RBF, because equipment is more varied and verifying productive use takes more than confirming a sale. The complexity of design should thus match the capacity of the implementing agency.

RBF is typically deployed to achieve one or more of the following objectives:

- **Accelerating organic market growth.** Provide grants that companies can use as they wish, provided they achieve results – typically sales – at an untargeted, low, flat subsidy level. This strengthens the private sector broadly, without directing support toward any particular customer segment. RBF for SHS in Nigeria, Malawi, and Mozambique contributed to compound annual sales growth rates of 75–159%, with positive spillover effects on related products.[117]

- **Targeting harder-to-reach populations.** RBF can instead be designed with a higher, more deliberately targeted subsidy calibrated to reach customers that companies would not otherwise serve commercially – for example through geographic or vulnerability-based eligibility criteria. This also helps lower retail prices for these customers by stimulating competition between suppliers and passing the subsidy through into prices. The two approaches serve different objectives and should not be conflated: the 2026 Off-Grid Solar Market Trends Report found that where subsidies remain untargeted, companies tend to gravitate toward serving cheaper-to-reach, under-the-grid areas rather than delivering first-time access, so programs aiming to reach harder-to-serve populations need to target and calibrate subsidies deliberately.[118]

- **Promoting high-quality PUE products and services.** Strong quality assurance frameworks can be leveraged to ensure RBF promotes high-performing, durable products imported through official channels, as well as qualified companies with professional teams providing high-quality installation and after-sales services. Often this helps to "level the playing field" by bringing purchase prices in line with those of companies selling lower-quality products, imported through informal channels that avoid tax and national quality standards (see Step 3.1.1).

[115] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022. Note: Broader definitions of RBF exist; this is the one predominantly used for PUE.

[116] Source: Off-Grid Solar Market Trends Reports (2024 and 2026)

[117] Source: GOGLA, Unlocking Off-Grid Solar: How Results-Based Financing is Driving Energy Access and Powering Productivity, 2023.

[118] Source: World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026.

- **Supporting sustained use and service delivery.** RBF can link payments not only to equipment sales or installation, but also to outcomes such as verified consumption, revenue, utilization, uptime, or continued service. This can better align incentives with sustained productive use and longer-term viability, particularly for service-based or shared infrastructure models. Programs should account for seasonal demand when setting thresholds and verification periods. RBF can also split payments across initial delivery and later outcomes: for example, the Regional DARES program has explored tying a top-up payment to market linkages delivered three to six months after equipment provision.[119] However, requiring suppliers to provide additional services may disadvantage smaller firms that lack the capacity to bundle them. Programs can instead consider rewarding such services through additional incentives.[120]

» **Insight from stakeholder.**

> *"Within our productive use component, we have attached results-based financing payments against 2 milestones, first is equipment being provided, and the second is market linkages, 3-6 months post equipment provision. So there's a top up that comes with the supplier providing market linkages."*
>
> **– PUE Program Designer (World Bank Group, Regional DARES)**

RBF has shown strong results in PUE markets where technologies, business models, and supplier ecosystems are sufficiently mature, as in programs such as[121] PUFF and SEFFA.[122] Its effectiveness also depends on careful design calibrated to actual market conditions, and access to complementary finance and TA.[123] PUE RBF programs have underperformed where subsidy levels were set too low or technologies and businesses were not yet sufficiently mature: Uganda's PUE RBF facility, for example, was undersubscribed for both reasons until early 2026.[124] RBF is less common in agricultural programs, which more often use matching grants to farmers. Factors favoring matching grants include how agricultural projects are structured, procurement rules that preclude supply-side subsidies (as in Uganda's MSIP), and that direct end user support is easier to justify politically.[125]

RBF and matching grants address the same affordability problem through different mechanisms, and the better choice depends on market maturity, business model, and the depth of end user support needed. Where technologies and business models are mature and suppliers can absorb verification costs and pre-finance delivery, RBF is effective: verification costs sit with the supplier rather than the program, and competition can pass subsidies through into lower retail prices. Where technologies are nascent or the supplier base is fragile, these same features become liabilities – suppliers carry liquidity risk before disbursement, and smaller companies struggle to meet verification requirements – typically making upfront grants combined with TA more appropriate (see Step 3.3.2). Matching grants, paid directly to asset owners rather than suppliers, are easier to combine with other end user support such as farmer vetting, on-farm visits, or direct links to financing, an advantage in agriculture, where uptake often depends on access to inputs and market linkages as much as the equipment itself (see Step 3.3.5). Nascent markets often need both: where neither suppliers nor end users can absorb full commercial terms, upfront or results-based support on the supply side can run alongside matching grants on the demand side, addressing supplier liquidity and end user affordability in parallel.

[119] Source: Stakeholder consultations, 2026.

[120] Source: Stakeholder consultations, 2026.

[121] Source: CLASP, CLASP and GEAPP Expand Access to Affordable, Energy-Efficient Appliances in Africa, 2025.

[122] Source: EnDev, How Solar Technologies are Reshaping Farming for Uganda's Smallholders, 2024.

[123] Source: See, for example, lessons on RBF for mini-grids in Africa: TFE, Cracking the Code, 2025.

[124] Source: Stakeholder consultations, 2026.

[125] Source: World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019. Note: As of 2019, <1% of agricultural projects used RBF (Polastri and Savastano, Results-Based Financing: A Potential Game-Changer for IFAD's Future Operations, 2020).

RBF is most effective when:

1. **The private sector is consulted early and continuously, including to communicate objectives, values, and timelines.** Consultation helps programs set appropriate incentive levels, eligibility rules, and verification requirements based on real supplier capabilities and market conditions. It also helps suppliers decide whether to participate, plan operations and cash flow, and avoid delays or misunderstandings around claims, reporting, and disbursement.[126]

2. **The technology, use case, and business model are sufficiently proven.** RBF is better suited to scale-up than to early-stage experimentation: it works where companies have proven, durable technology and business models that can meet requirements, for example around after-sales service. Pre-commercial technologies or unproven business models are generally better served by upfront grants and TA.[127]

   » **Insight from stakeholder.**

   > *"RBFs are a great tool, but what we see is that they're only appropriate for technologies that have already reached a certain stage of market readiness... [we must ask ourselves] is it possible to do an RBF with [for example] egg incubators, or do we need more data, awareness raising, or pilots before companies are ready and the market can start to scale?"*
   >
   > **– PUE Program Designer (Energising Development - EnDev)**

3. **Companies have the upfront working capital required to fully participate in an RBF scheme.** For example, recipients of EnDev's RBF facility were typically established companies with strong track records, since these were best placed to scale with the grants.[128] Earlier-stage suppliers may lack the working capital and operational capacity to pre-finance activities, and carry commercial and verification risk until payment.

   » **Insight from stakeholder.**

   > *"RBFs may work for markets where we already have developed companies... but in [nascent] markets, there is a clear need for working capital support so companies are able to continue doing a lot of the on-ground work that supports the end users."*
   >
   > **– PUE Expert (Global Energy Alliance for People and Planet - GEAPP)**

4. **It is combined with TA.** TA can help companies meet eligibility, data, reporting, verification, consumer protection, and after-sales requirements, while also strengthening business strategy, marketing, distribution, customer finance, and investment readiness. This is particularly important for smaller or local suppliers, who may otherwise struggle to participate in RBF schemes designed around performance-based payment.[129] See Step 3.2.2 on TA to suppliers.

» **Pitfall to watch out for.** EnDev Ethiopia's RBF program incentivized sales of improved cookstoves by rural cooperatives, but most cooperatives were overwhelmed by application, documentation, and reporting obligations, requiring significant unplanned TA and causing major delays. The project adapted the RBF to target energy companies instead.[130]

[126] Source: Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024; ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[127] Source: EnDev, Incentives for the Private Sector to Promote Solar-Powered Irrigation, 2024.

[128] Source: EnDev, Transforming Energy Access Markets with Results-Based Financing, 2021.

[129] Source: Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024; ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[130] Source: EnDev, Transforming Energy Access Markets with Results-Based Financing, 2021.

5. **The payment structure fits the supplier business model.** Sales-linked RBF is most straightforward for direct-sale or PAYG models, where an individual end user owns the equipment. For shared, infrastructure-heavy PUE assets such as cold rooms and milling machines, OpEx subsidies in the form of RBF linked to utilization, revenue, or sustained service may fit the business model better than a CapEx subsidy aimed at an individual buyer, though the two are not mutually exclusive: CapEx subsidies or pre-financing instruments can still help the provider cover the upfront cost of the shared asset itself. These approaches remain less tested in PUE at a program-funding level and may need to be combined with grants, concessional finance, or other support for asset finance and working capital.

Key challenges and risks to address in program design:

1. **Subsidy dependency and crowding out.** Programs should clearly communicate the value and duration of RBF, gradually reducing and phasing out subsidies where feasible.[131,132] Where subsidies must remain in place indefinitely, long-term sources of public funding should be identified (e.g., redirected fossil-fuel subsidies, climate finance, or cross-subsidy). See "Designing Responsible End-User Subsidies for Energy Access" for more.[133]

   » **Best practice.** IDCOL's experience in Bangladesh shows subsidy levels should be adjusted dynamically rather than fixed at design: it tapered capital and refinancing support under the SHS program as costs fell and the market matured but kept its SWP package under RERED II highly concessional given persistently binding affordability constraints. Programs should design for reductions where market signals support it but retain flexibility to maintain or deepen support where affordability remains binding.[134]

2. **Market concentration risk.** A small number of companies can come to dominate a market or an RBF before eventually failing.[135] Programs can avoid this by providing timely disbursement, facilitating access to bridge financing for smaller suppliers' cash-flow constraints[136], and minimizing the complexity of applications and documentation where possible.[137] PUFF, for example, offers partial payment at procurement (40% of subsidy) and prioritizes smaller subsidy requests.[138]

3. **Leakage, poor targeting, and limited additionality.** RBF can end up subsidizing results that would have occurred commercially without support, particularly where eligibility is broad and PUE buyers are better-off MSMEs or larger farmers. Programs should link eligibility to the program objective – for example through geographic or customer targeting, product-size caps, differentiated subsidy tiers, or self-targeting through eligible equipment tiers – and monitor who receives subsidies, adjusting eligibility or subsidy levels if support is captured by non-target segments.[139]

[131] Source: SNV, Why Localisation Matters for Financing Off-Grid Energy, 2021.

[132] Note: This may also prevent too-low subsidies at the start, which can hamper uptake (EnDev, Results-Based Financing for Energy Access, 2018).

[133] Source: Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024.

[134] Source: World Bank Group, Implementation Completion and Results Report - Rural Electrification and Renewable Energy Development II, 2024; GPOBA, Lessons Learned - Bangladesh Rural Electrification and Renewable Energy Development, 2015; World Bank Group, Accelerating the Productive Use of Electricity, 2023; World Bank Group, Solar-Powered Pumps Reduce Irrigation Costs in Bangladesh, 2015.

[135] Source: Climate Compatible Growth, Current Practices in Results-Based Financing for Energy Access, 2025; SNV, Why Localisation Matters for Financing Off-Grid Energy, 2021.

[136] Source: IDA, A Review of the Use of Output-Based Aid Approaches, 2009.

[137] Source: Climate Compatible Growth, Current Practices in Results-Based Financing for Energy Access, 2025.

[138] Source: Stakeholder consultations, 2026; CLASP, Productive Use Appliance Financing Facility Frequently Asked Questions, 2021.

[139] Source: Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024.

4. **Verification, fraud, and non-use of subsidized assets.** Because RBF pays against reported results, programs risk paying for claims that are ineligible, inaccurately reported, not sustained, or do not reflect productive use. Equipment might not actually be delivered, could be resold, or could become non-operational, while utilization, consumption, revenue, uptime, or service delivery claims can be faked. Mitigation strategies include clear claim rules, independent verification, spot checks, staged disbursement where appropriate, and sanctions or clawbacks for false or non-performing claims.[140] Digital platforms can strengthen fiduciary risk management and facilitate timely claim disbursement: Prospect was built to cover productive use appliances alongside SHS and mini grids, and is already used as a dMRV platform for RBF-linked programs such as EASP,[141] while Odyssey provides claim management and remote verification used across large RBF programs including DARES and ASCENT, and has extended into pre-financing tools that let suppliers borrow against verified RBF receivables.[142]

5. **Funding gaps and stop-start program duration.** RBF programs are often designed and funded in short, disjointed cycles, and disbursement frequently lags behind claims, leaving companies to pre-finance the subsidy from their own working capital or, in the worst cases, holding stock priced against a subsidy that has since run out. See the 2026 Off-Grid Solar Market Trends Report for the full evidence base on this issue and how subsidy design has evolved in response.[143]

Additional design considerations

Once RBF is deemed suitable, three design choices are critical: equipment scope, whether to subsidize CapEx, OpEx, or both, and subsidy levels.

1. **Equipment scope: A broad equipment scope allows suppliers to apply for RBF for a broad set of PUE equipment across multiple value chains or sectors, useful where evidence is insufficient to predict which will gain traction.** Several programs take this approach, including PUFF,[144] Beyond the Grid Fund for Africa (BGFA) (Mozambique),[145] Investing in Renewable Energy and Climate Technologies (REACT) Kenya,[146] and ASCENT Rwanda.[147] A narrow equipment scope limits RBF to specific, already-proven equipment. These designs are more common in agriculture and easier to pair with targeted TA.

» **Insight from stakeholder.**

> *"If we fix the geography and technology, we haven't given any agency to the user or technology provider to understand where this makes the most sense."*
>
> **– PUE Expert (Research Institution)**

» **Best practice.** SEFFA's narrow focus on solar water pumps in Kenya allowed more tailored capacity building, awareness raising, and TA than a multi-equipment design would have, leading to greater uptake and a more sustainable market.[148]

[140] Source: Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024.

[141] Source: GET.invest, GET.invest and A2EI Launch Global Open-source Data Platform PROSPECT, 2022; A2EI, Year in Review, 2026.

[142] Source: Transforming Energy Access, Odyssey: How Digital Financing is Enabling the Epic Journey to Universal Energy Access, 2026; Odyssey, DARES - NEP Legacy Projects, 2026.

[143] Source: World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026.

[144] Source: CLASP, Productive Use Financing Facility (PUFF) Terms and Conditions, 2026.

[145] Source: BGFA, Application Guidelines, 2024.

[146] Source: AECF, Energy for Green Growth and Sustainability in Kenya, 2025.

[147] Source: Development Bank of Rwanda, Productive Use of Energy Results-Based Financing Operations Manual, 2026.

[148] Source: EnDev, Adoption and Use of Solar Water Pumps in Kenya, 2023; EnDev, Incentives for the Private Sector to Promote Solar-Powered Irrigation, 2024; SNV, Harvesting the Sun: Challenges and Opportunities in Solar-Powered Agriculture, 2023.

2. **Subsidizing CapEx, OpEx, or both:** CapEx subsidies reduce the asset and installation costs that must ultimately be recovered, while OpEx or ongoing-service subsidies can cover recurring costs where affordable user revenues are insufficient to sustain service. Hybrid approaches can combine upfront capital support with recurring performance- or service-linked payments, particularly for EaaS and concession models.[149]

3. **Setting subsidy levels:** Consider fixed subsidies if the program has a clear targeting objective. Fixed subsidies are set in advance, based on available information, and offer suppliers more certainty. They can be tiered by target group or equipment, or adjusted over time, either starting high to kick-start a market before tapering, or starting low and rising as programs target harder-to-reach segments.[150] Alternative designs carry trade-offs. Percentage-of-cost subsidies are simplest to implement but can direct more support to higher-cost products and encourage price inflation absent a cap. Affordability- or viability-gap approaches target support more precisely but require stronger cost and demand data. Consider reverse auctions if the program prioritizes market discovery and value for money, the scope is broad, evidence on which products will scale is limited, and the supplier base can bid credibly. In a reverse auction, suppliers bid for subsidies, directing funds toward the most commercially viable equipment. The trade-off is that auctions can discourage smaller suppliers and encourage underbidding, which makes awarded targets commercially unrealistic. They can also reduce additionality if suppliers simply bid to serve customers they would have reached anyway.[151]

» **Best practice.** Tanzania's RBF for off-grid solar applied a "Vulnerability Access Index", setting higher incentives in more vulnerable regions with lower prior market activity. After the VAI was introduced, the share of sales in the two highest-vulnerability tiers roughly tripled.[152]

» **Best practice.** PUFF's reverse auction lets its broad-technology-scope RBF stay market-responsive, with funds flowing to whichever PUE equipment requires the lowest subsidy and is thus most ready to scale.[153]

» **Pitfall to watch out for.** Reverse auctions can remove agency from program implementers to choose which suppliers receive grants, which is risky if those suppliers can't meet their targets due to financial difficulties or underbidding: BGFA found some companies may underbid because "any grant is better than no grant," despite being less likely to serve customers they wouldn't have served otherwise. Programs using reverse auctions should therefore set minimum eligibility criteria and assess whether bids are credible and deliverable, rather than selecting on subsidy level alone.[154]

[149] Source: World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026.

[150] Source: Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024.

[151] Source: Greencroft Economics, Ex-post Evaluation of the Beyond the Grid Fund for Zambia (BGFZ), 2024.

[152] Source: EnDev, Reaching the Bottom of the Pyramid with RBF - Wishful Thinking or Reality?, 2020.

[153] Source: Stakeholder consultations, 2026; CLASP, Productive Use Financing Facility (PUFF) Terms and Conditions, 2026.

[154] Source: Greencroft Economics, Ex-post Evaluation of the Beyond the Grid Fund for Zambia (BGFZ), 2024.

Additional resources

1. For designing and implementing RBF and applying lessons from existing energy-access programs and evaluations: "Current practices in results-based financing for energy access" (Climate Compatible Growth, 2025)
2. For designing, targeting, and planning the evolution of end user subsidies: **"**Designing Responsible End-User Subsidies for Energy Access" (Lighting Global/ESMAP, 2024)
3. For comparing RBF with other public funding mechanisms and understanding key design trade-offs: "Designing Public Funding Mechanisms in the Off-Grid Solar Sector" (ESMAP, 2022)
4. For applying practical lessons from EnDev's experience designing and adapting RBF programs: "Transforming energy access markets with Results-based Financing" (EnDev, 2021)

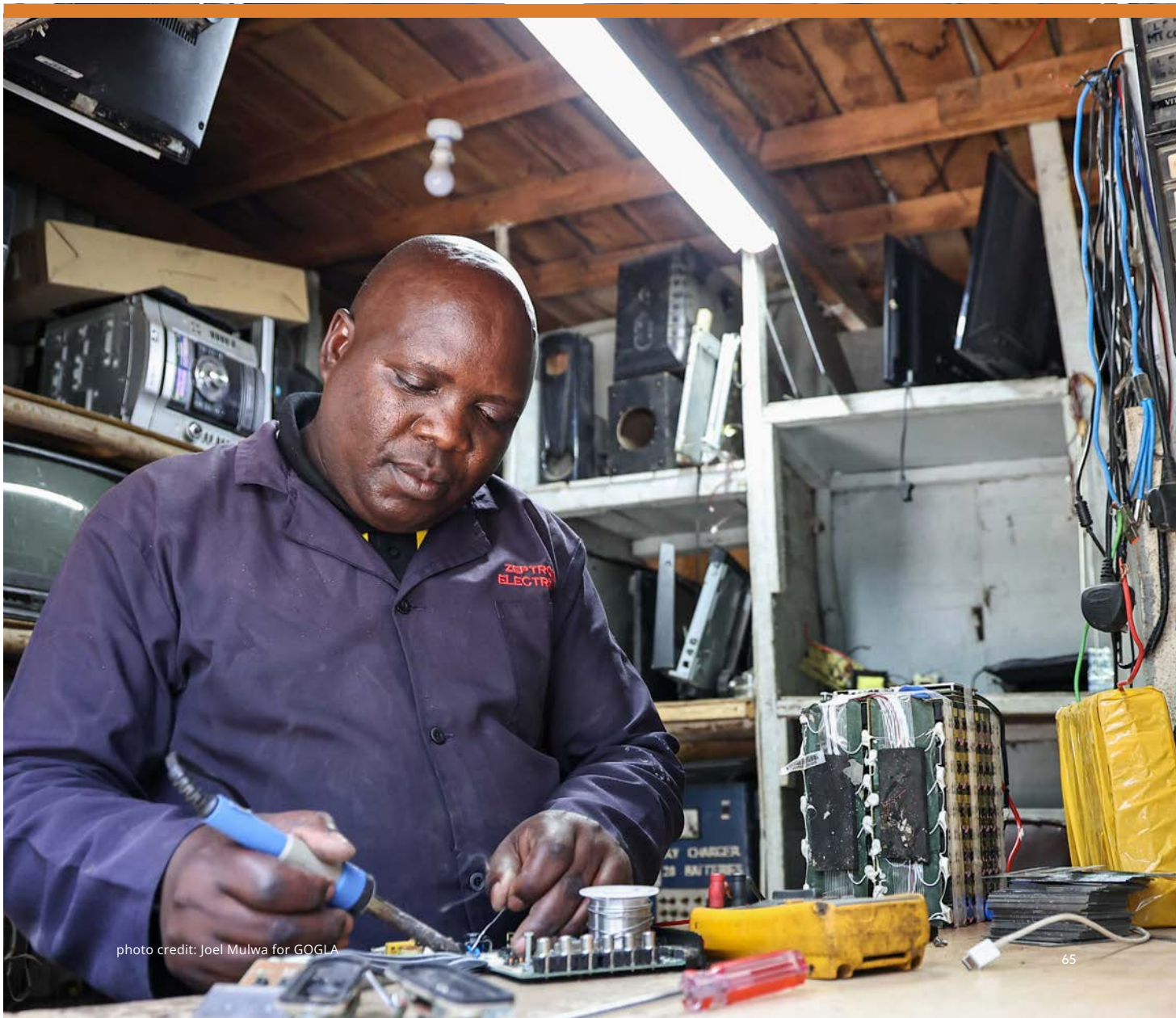


photo credit: Joel Mulwa for GOGLA

3.3.2 UPFRONT GRANTS TO SUPPLIERS

Upfront grants to suppliers are non-reimbursable payments, typically linked to achievement of pre-agreed milestones. They support early-stage companies with research and development and with business model development in areas such as sales, marketing, logistics, consumer financing, or after-sales service. Unlike RBF, funding is provided before verified sales or installations.[155] They have been used extensively by development partners such as FCDO to support PUE companies in the energy sector, but are rare in agriculture.[156]

Upfront grants are mainly used to help companies grow and become investment-ready, so they can attract private capital. Sometimes they are used to help established suppliers expand into new geographies or solve working capital constraints. For example, the Kenyan government's Kenya Off-Grid Solar Access Project for Underserved Counties (KOSAP) combined the two to expand into remote, low-density, and traditionally underserved areas of the country.[157] Governments are often reluctant to give upfront grants to private companies, since funds are paid before results are proven. They can nonetheless offer good value for money where few suppliers are active and the market will not develop unless someone bears first-mover costs, such as product adaptation and building distribution and after-sales networks, which later entrants also benefit from. Competitive selection, milestone-based disbursement, and co-financing requirements reduce the risk of wasted funds.

Across the PURE energy sector, early-stage grants and TA remain critical for piloting innovation, but evidence suggests they are often too fragmented, too short-term, and poorly sequenced to reliably build investable companies. An analysis of 127 PURE companies that received USD 46 million in grants and TA since 2015 found that only 28 – about one in five – went on to secure commercial capital, typically after a delay of one to five years; 89% of individual support instances were standalone grants or TA rather than part of a coordinated package, and two-thirds of companies received only a single round of support in their entire lifetime. Support is also unevenly distributed: over 80% of disbursements have gone to irrigation and cooling, while agro-processing – despite often requiring larger ticket sizes – has received comparatively little attention, and half of all recorded support has flowed to just five countries, with Kenya and Uganda dominating. These patterns point to a structural gap between the small, early grants most programs offer and the larger volumes of commercial capital companies eventually need, with few instruments available to bridge the two.[158]

How support is structured matters as much as how much is provided. Companies that received sequenced grants and TA – rather than a single bundled instrument or a one-off grant – were significantly more likely to secure follow-on capital. Programs that build in flexibility tend to perform better: companies consistently cite co-designed, adjustable milestones and trust-based, real-time disbursement as more useful than rigid, calendar-based reporting requirements, even where the latter offers clearer accountability. Program designers should therefore treat upfront grants as one step in a longer, deliberately sequenced pathway toward RBF, credit lines, and commercial finance, rather than a standalone intervention, and build in mechanisms to track and support that progression rather than assuming it will happen on its own.[159] Because most PUE companies will need grants and TA for some time, programs should also map what other funders already provide to the same companies and, where possible, align eligibility, timing, and milestones to avoid a feast-or-famine cycle.

[155] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[156] Source: See, for example, PREO, supported by UK aid through Transforming Energy Access. PREO, PREO's Blended Finance Strategy Sets Tone for Private Capital Investment for Early-Stage Companies In Africa, 2024.

[157] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[158] Source: Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

[159] Source: Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

Company-level analysis identifies recurring progression patterns showing that support structure, not company quality alone, often determines whether a company consolidates early promise, achieves sustainable growth, or stalls. "Pure mission operators," for example, serve ultra-low-income, high-cost markets where full cost recovery is structurally impossible; these companies depend on patient, milestone-linked grants as a permanent financing tool rather than a bridge to commercial capital, and are better judged on cost-to-impact efficiency than on investment readiness. Other companies are commercially sound but remain "invisible" to investors due to limited visibility or a niche market position; these benefit more from investor-aligned TA and network-building than from additional grant funding alone. Recognizing which archetype a company fits – and adjusting the type, sequencing, and exit pathway of support accordingly – is central to converting early-stage support into either sustainable impact or commercial scale.[160]

» **Best practice.** The Africa Enterprise Challenge Fund (AECF)'s Renewable Energy and Adaptation to Climate Technologies Sub-Saharan Africa (REACT SSA) Innovation Fund shows how upfront grants can support small-scale suppliers through co-financing commercialization of PUE equipment. The fund explicitly targeted small-scale suppliers in clean cooking and PUE. Applicants had to show a minimum viable product, market research in the target geography, and preferably sales or tangible demand, focusing on credible suppliers while excluding technology development. It also focused on funding specific projects, with a minimum 30% co-financing requirement to incentivize commitment by the company and thereby reduce the risk of wasted funds.[161]

» **Best practice.** The Regional Off-Grid Electricity Access Project (ROGEAP), implemented by ECOWAS and BOAD across 19 West and Central African countries, shows how upfront grants can be staged by company maturity. Start-ups and early-stage off-grid solar businesses can apply for small grants from USD 10,000–25,000 requiring a matching cash contribution; firms entering commercially viable but risky new markets can access market-entry grants; and firms serving markets not deemed commercially viable can access performance-based grants paid against verified results. By mid-2025 121 SMEs had been awarded grants totaling about USD 11.8 million across two calls, supporting the installation of 2,836 solar PV systems for productive use alongside household systems.[162]

Upfront grants are most effective when:

1. **Technologies or markets are still nascent or emerging.** In early-stage technology segments or country markets, suppliers may be unable to raise equity, while lacking the track record, balance sheet, or cash flow needed to take on credit for working capital. Upfront grants play a critical role in getting companies to the point where they can participate in RBF and credit lines and attract private debt and equity. For more mature markets, programs should consider shifting toward supplier on-lending and risk mitigation tools.[163]

[160] Source: Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

[161] Source: AECF, Innovation Fund; ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[162] Source: ROGEAP Project Fund Manager, Context and Objectives; World Bank Group, Project Paper, Report No. PPIAF000012 (Regional Off-Grid Electricity Access Project, P160708), 2025.

[163] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

2. They are combined with TA to suppliers, sequenced before or after grant-funded periods. This helps ensure suppliers can make the most of upfront grants, and conversely can help make the TA more effective. The sequencing matters as much as the pairing: TA tends to be most effective when delivered upfront to shape how a grant is deployed – informing market entry, pricing, or delivery model – or after the grant to strengthen unit economics and investor readiness. Parallel TA is often more generic, delivered alongside funding with no clear handoff between the two.[164] See Step 3.2.2 for guidance on designing the TA itself.[165]

Key challenges and risks to address in program design:

1. **Picking "the wrong" winners or creating an unfair market.** Because upfront grants support selected firms before results are proven, they can give some suppliers an advantage over others and distort competition. Programs should use transparent eligibility and selection criteria, avoid over-subsidizing individual firms, and consider portfolio approaches that support multiple credible suppliers.[166]

2. **Grants may still be insufficient for companies to access private capital.** One-off grants are often too small or too brief to make companies investment-ready. Follow-on grants may be needed, along with TA and potentially RBF and credit lines.[167]

3. **Exit dependency.** Upfront grant programs should have an explicit graduation pathway toward RBF or supplier on-lending as market conditions improve. Program designers should set milestones for when this transition should occur and avoid subsidizing so-called "treadmill businesses" caught in perpetual grant cycles.[168]

> **"Choosing the financing instrument before the constraint is understood is one of the most common failure modes in PUE programming. An instrument that suits one market can fail in another".**

[164] Source: Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

[165] Source: World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026.

[166] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[167] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[168] Source: Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

3.3.3 EQUITY FINANCING TO SUPPLIERS

Equity suits suppliers whose binding constraint is the absence of an equity cushion and not the cost of capital. Public programs should generally avoid holding equity directly. As equity makes the investor a part-owner of selected firms, it requires specialist valuation, governance, and conflict-management arrangements.[169] Where programs cannot invest in equity at all, co-financing or referral to a development finance institution (DFI) may be more appropriate.

Evidence on equity investments in PUE programming remains thin. Examples include ElectriFI's quasi-equity investment in solar irrigation provider Simusolar[170] and Zafiri, launched in 2026 and backed by the World Bank Group and AfDB,[171] but published results are limited. Therefore, the guidance below draws on wider distributed renewable energy (DRE) and blended finance experience.

Equity financing is most effective when:

1. **The supplier has a viable business model and route to scale, but lacks the equity cushion to support further debt.** Equity is more appropriate where cash flows or leverage cannot support fixed repayments. Where the main constraint is the cost, tenor, or availability of lending, debt or risk-sharing instruments are generally better suited.[172]

2. **The market has moved beyond grant-dependent growth, but commercial equity remains scarce.** Public capital can bridge this gap while helping firms build the track record needed to attract later-stage investors.[173]

Key challenges and risks to address in program design:

1. **Investing in early-stage PUE companies requires picking winners and carries substantial risk.** PUE markets are often fragmented and potential investees have limited track records, making it difficult to identify which firms will scale and creating risks of unfair competition.[174] Programs need experienced investment management, transparent selection criteria, and sufficient risk tolerance.

2. **Catalytic capital may fail to crowd in commercial investors.** Programs should test additionality and limit concessionality to what is needed, rather than becoming a continuing substitute for commercial equity.[175]

3. **Exit may be difficult in shallow markets.** Few strategic buyers or later-stage investors are active in many PUE markets, which can leave stakes illiquid for longer than planned, so programs should assess plausible exit routes from the outset.[176]

[169] Source: See, for example, IFC, Fund Governance Document and Text Information Request List for Funds, 2019.

[170] Source: EDFI MC, Simusolar.

[171] Source: IFC, Zafiri Announces USD 176 Million Commercial Launch to Accelerate Energy Access via the Private Sector across Sub-Saharan Africa, 2026.

[172] Source: ESMAP, Funding the Sun - New Paradigms for Financing Off-Grid Solar Companies, 2020.

[173] Source: OECD, DAC Blended Finance Guidance, 2025; Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.

[174] Source: World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026.

[175] Source: OECD, DAC Blended Finance Guidance, 2025.

[176] Source: ESMAP, Funding the Sun - New Paradigms for Financing Off-Grid Solar Companies, 2020.

3.3.4 CREDIT LINES AND GUARANTEES

Credit lines provide local financial institutions (banks, MFIs, SACCOs) with low-cost loans and guarantees, to incentivize them to scale up lending to PUE suppliers, asset owners, or both. Credit lines can enable financial institutions to reduce interest rates, lengthen loan tenors, ease due diligence requirements, or start lending to the PUE sector for the first time.[177] On-lending is particularly relevant where the underlying investment is economically viable and affordable over time, but end users or suppliers are not bankable under prevailing lending conditions. Most PUE finance to date has been on the supply side: some banks have established dedicated renewable energy departments to finance manufacturers and distributors of equipment, but end user lending – especially to individual smallholder farmers – has lagged behind.[178] The energy and agricultural sectors have engaged the financial sector in different ways, each with trade-offs.

Energy sector supply-side approach:

The energy sector's dominant model focuses on the supply side, working through apex FIs. These are typically government-backed or DFI-backed entities that provide liquidity or de-risking instruments (guarantees or first-loss facilities) to local FIs, which then on-lend to asset owners or PUE suppliers.[179] Bangladesh's IDCOL exemplifies this: under the SHS program, IDCOL acted as a wholesale finance company, extending credit lines (and grants) to partner organizations, mostly NGOs and MFIs, which then extended micro-credit to households.[180]

Agriculture sector signaling and aggregation approach:

The agricultural sector has typically focused on the demand side, using signaling and aggregation to reduce local lenders' risk perception:

1. **Matching grants, which often include government-led site assessments and farmer vetting, signal bankability to lenders, and reduce the loan-to-asset ratio to more manageable levels.** Uganda's MSIP, for example, paired matching grants (with 25% co-payments) with district-led farmer screening and farm visits, and shared app data with FIs to strengthen loan applications (see Steps 3.1.2 and 3.3.5).[181]

2. **Aggregation through cooperatives.** Cooperatives with existing banking relationships allow lenders to underwrite a group rather than appraise individual farmers.

The energy sector supply-side approach is most effective where liquidity is the primary barrier and FIs have existing capacity, while the agriculture sector signaling and aggregation approach is more relevant where risk perception is the primary barrier and cooperative structures exist. Some programs combine both: an SWP program in Tanzania provided matching grants to Community-Based Water Supply Organizations (CBWSOs) acting as aggregators, which financed the co-payment on concessional terms from the government-owned TIB Development Bank.[182]

[177] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[178] Source: World Resources Institute, How Local Banks Can Unlock Africa's Clean Energy Future, 2024.

[179] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[180] Source: GPOBA, Lessons Learned - Bangladesh Rural Electrification and Renewable Energy Development, 2015.

[181] Source: MAAIF, A Guide for Financial Institutions, 2020; World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.

[182] Source: GPRBA, Lessons Learned - Accelerating Solar Water Pumping via Innovative Financing in Tanzania, 2025.

Credit lines and guarantees are most effective when:

1. **Accessibility and affordability are already addressed or being addressed, but low FI liquidity or risk appetite prevents access to credit.** If risk is a strong barrier, liquidity is unlikely to be sufficient on its own and credit lines should include guarantees or other risk mitigation tools.[183]

   » **Best practice.** Uganda's Agricultural Credit Facility (ACF) combined co-financing with risk sharing, enabling participating FIs to lend to SHFs at fixed rates of up to 12% per annum, well below prevailing commercial rates. Its 2018 Block Allocation model allowed small loans to use alternatives such as business cash flows, credit history, and group guarantees instead of relying on registered land as collateral, directly addressing a key barrier to borrowing by SHFs.[184]

   » **Pitfall to watch out for.** The Niger Solar Electricity Access Project shows that supplying credit lines to FIs in a market where end user affordability is unaddressed is insufficient. Despite capacity building support for FIs and a dedicated credit line, low rural purchasing power – compounded by competition from cheaper, lower-quality products – suppressed demand. Overall credit utilization reached 70% of the total target, and quality-verified product uptake reached only 28%.[185]

2. **A reasonably mature financial sector already exists or can be built.** In markets where FIs have limited experience lending for PUE equipment, programs may need to build their capacity alongside providing finance or risk-sharing. GreenMax's Green4Access facility, for example, combines first-loss protection with TA to help local FIs understand energy access lending and build pipelines, including for PUE equipment such as solar refrigeration and water pumps.[186]

3. **Program designers use not just banks but cooperatives and other community groups as lenders and aggregators.** Program designers should consider both (i) cooperatives as lenders, since in many African contexts cooperatives and MFIs lend at lower rates than banks[187] and can leverage existing client networks with equipment buyers;[188] and (ii) cooperatives as borrowers, drawing on the agricultural sector approach. GIZ's Access to Microfinance project in Côte d'Ivoire used a guarantee fund with 40% co-investment, channelled through an MFI, helping 17 Village Savings and Loan Associations finance PUE equipment at lower interest rates. However, implementation challenges in reaching an agreement with the MFIs suggest the model requires careful structuring and may be difficult to scale.[189]

[183] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[184] Source: Ministry of Finance, Planning and Economic Development, Uganda, Performance of the Agricultural Credit Facility in Uganda: What are the Trends?, 2019; Bank of Uganda, Supporting Agriculture Modernisation through the ACF, 2024; Ministry of Finance, Planning and Economic Development, Uganda, The Agriculture Credit Facility: What is Constraining Its Effective Implementation?, 2013; Bank of Uganda, The Agricultural Credit Facility - The Experience of the Central Bank in Enhancing Agricultural Finance, 2016.

[185] Source: World Bank Group, Implementation Completion and Results Report - Niger Solar Electricity Access Project, 2025.

[186] Source: EnDev, Innovative Finance for Energy Access, 2024.

[187] Source: Stakeholder consultations, 2026.

[188] Source: GET.invest, Financing and Scaling Productive Use of Energy, 2023.

[189] Source: GIZ, Access to Microfinance - Enabling Communities to Purchase Appliances for the Productive Use of Energy, 2023.

» **Insight from stakeholder.**

> *"Smallholder farmers and some small businesses are not typically bank customers... one of the big opportunities [in Africa] is tapping into farmer cooperatives and farmer groups, which already lend to smallholder farmers and at lower rates... A bank can lend to a smallholder farmer through a cooperative and they don't need to appraise the farmer at an individual level, as long as they are part of the cooperative."*
>
> **– PUE Expert (Global Energy Alliance for People and Planet - GEAPP)**

4. **Local FIs can provide local currency finance, reducing foreign exchange risk for companies whose revenues are earned in local currency.** Where suppliers earn revenues in local currency but borrow in hard currency, depreciation can increase the cost of servicing their debt. Local currency financing reduces this mismatch. World Bank Group-backed OGS credit lines increasingly incorporate local currency lending or other mechanisms that shift foreign exchange risk away from suppliers.[190]

Key challenges and risks to address in program design:

1. **Crowding out commercial lending.** Credit lines set below market rates risk delaying the development of sustainable commercial lending, creating expectations among borrowers that concessional rates are the norm and disadvantaging non-participating FIs.[191] While RBF and matching grants frequently have exit mechanisms built into their design (subsidy taper, program end), credit lines do not, and the expectation of concessional rates can persist beyond program end. Program designers should set an explicit pathway from concessional to commercial on-lending from the outset.[192]

2. **Slow setup and limited adaptability.** Credit lines can take significant time to establish and are slow to respond to rapidly changing market dynamics, which can limit their effectiveness in nascent or fast-evolving PUE sectors.[193]

3. **Credit lines may see low uptake if they are not sufficiently concessional or accessible to target firms.** Smaller and local companies can struggle to meet collateral, track-record, and due diligence requirements, while larger international companies are often better able to access cheaper capital from international sources.[194]

[190] Source: World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026.

[191] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022; I4CE, Using Credit Lines to Foster Green Lending: Opportunities and Challenges, 2017.

[192] Source: OECD, DAC Blended Finance Guidance, 2025; See, for example, World Bank Group, Republic of Kazakhstan - Financial Sector Assessment, 2024.

[193] Source: ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.

[194] Source: World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026; GET.invest, Financing and Scaling Productive Use of Energy, 2023; NREL and Energy 4 Impact, Productive Use of Energy in African Micro-grids, 2018.

3.3.5 MATCHING GRANTS TO ASSET OWNERS

A matching grant is a one-off, non-reimbursable transfer to asset owners conditional on the recipient making a specified co-payment (in cash or in kind) for the same purpose. Unlike permanent input subsidies, they are designed as time-limited instruments to compensate for the absence of suitable investment finance or to stimulate activity where asset owners face severe affordability constraints. The mechanism flows to the demand side, directly to farmers, water user associations, or MSMEs, rather than through suppliers. The co-contribution requirement (often set as a % of retail price) is the key design lever: it signals genuine demand, reduces elite capture risk, and nudges asset owners toward treating the asset as their own. Matching grants are a relatively well-tested intervention and are particularly common in agriculture.[195] Governments are often more comfortable with matching grants than with upfront grants to suppliers, since funds go to end users and are conditional on their own contribution. They can also be combined with supply-side instruments (see Step 3.3.1).

Additional resources

1. For deciding when matching grants are appropriate and understanding key success factors in agricultural programs: "How Can Matching Grants in Agriculture Facilitate Access to Finance?" (World Bank Group, 2019)
2. For designing and implementing matching grant schemes in agricultural programs: "Matching Grants: Technical Note" (IFAD, 2012)

Beyond affordability, matching grants can help address other constraints across access to finance. For example, they can promote demand for credit by demonstrating the profitability of investments and help develop end user skills to prepare business plans. They can also support FIs in capturing information on asset owners, help them gain know-how on credit for the particular use case, and provide assets to potential borrowers that can act as collateral. When co-payments encourage the use of credit or require asset owners to save money, they can also help build trust in FIs.[196]

Matching grants are most effective when:

1. **Co-payments are required, which can reduce stranded asset risk (at the cost of not reaching the poorest).** Co-payments strengthen ownership and commitment, reducing the risk that assets go unused or are resold. The World Bank Group's review of matching grants in agriculture found that co-payment should be set as high as is feasible to encourage ownership and crowd in commercial credit. However, the lowest-income segment may be less able to afford the co-payment.[197] In India's Chhattisgarh District Rural Poverty Project, even a modest 5% cash contribution caused implementation delays for the poorest participants.[198]

[195] Source: World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019.
[196] Source: World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019.
[197] Source: World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019.
[198] Source: World Bank Group, Implementation Completion and Results Report - Chhattisgarh District Rural Poverty Project, 2011.

» **Best practice.** Uganda's MSIP required a 5% down payment as part of a larger co-payment, which helped further increase commitment by farmers, while screening out farmers unlikely to commit to contracts. Crucially, to generate farmer interest, the down payment was preceded by significant awareness-raising activities and a farm visit.[199]

2. **Co-payments are tiered where reaching the poorest is a key program objective.** As with tiered RBF, this requires information about end user characteristics.

» **Best practice.** Argentina's Integrated Risk Management in the Rural Agro-industrial System project varies co-payments by bankability of the recipient farmers. The matching grants support climate-smart agricultural technologies (e.g., irrigation systems, machinery) for vulnerable farmers. The greater the bankability of the farmer, the higher the co-payment, increasing from 30% (non-bankable), to 60% (bankable), and 80% (already banked), as determined by the government implementation unit DiProSE.[200]

3. **Remaining financing constraints are addressed alongside the subsidy.** Where users can afford the investment over time but cannot finance the co-payment upfront, programs should ensure access to credit, installments, or other suitable financing mechanisms. For PM-KUSUM, which faced affordability challenges, eight out of nine farmers in Rajasthan who had not used the scheme stated they would apply if paying in installments were an option.[201] The lack of access to credit for co-payments in Uganda's MSIP was also described as a challenge to uptake.[202] The World Bank Group's review of matching grants in agriculture found the success of programs was positively correlated with accompanying access to finance components such as credit lines for FIs (see Step 3.3.4).[203]

» **Pitfall to watch out for.** Even when co-payments are set low to reach lower-income asset owners, banks may be reluctant to lend to them. India's Jawaharlal Nehru National Solar Mission (JNNSM) Phase II "Capital Subsidy Scheme for Solar PV Water Pumping Systems" targeted small and marginal farmers with an approximately 80% subsidy and solar loan financing. Despite this, the program reached only 700 farmers against a target of 30,000 SWPs deployed per year. The subsidy addressed the headline cost gap, but banks required collateral that small farmers could not provide, and many banks rescinded solar loans. This illustrates the distinction between affordability and bankability: even a large subsidy may not unlock uptake if asset owners cannot access credit for the remaining cost.[204]

[199] Source: World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.

[200] Source: World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019; World Bank Group, Project Appraisal Document - Integrated Risk Management in the Rural Agroindustrial System Project (Girsar), 2018.

[201] Source: Khanna, V., Implementation Challenges of the PM-KUSUM Scheme: Case Studies from Selected Indian States, 2024.

[202] Source: CGIAR, Uganda Intergovernmental Fiscal Transfers Reform Program, 2025.

[203] Source: World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019.

[204] Source: Yashodha et al., Solar Irrigation in India, 2021.

Key challenges and risks to address in program design:

1. **Suppliers may inflate prices knowing the subsidy covers a set share of cost. This unintended pass-through means subsidies go to suppliers rather than the intended asset owners.** Uganda's MSIP mitigated this risk by requiring local governments to procure on behalf of approved farmers in monthly batches, issuing requests for quotations to pre-qualified suppliers, checking technical and cost reasonableness, and selecting the lowest technically responsive quotation before farmer acceptance and co-payment.[205]

2. **Low additionality and market distortion. Matching grants can end up subsidizing investments that asset owners would have made anyway, or supporting commercially weak or non-viable projects.** Therefore, programs should have strict eligibility criteria, ensure co-payments are as high as feasible for target asset owners, and articulate a sound economic rationale identifying a specific market failure.[206] Conversely, higher co-payments increase the risks of excluding poorer users who are less likely to be able to afford them.[207]

3. **Asset under-use and weak sustainability after the grant.** Working capital needs among end users are often overlooked and can lead to under-use of fixed assets (for example, a pump can sit idle when the owner cannot afford inputs) and undermine profitability. Similarly, end users need TA (commercial and technical skills) to operate and maintain equipment effectively.[208] See Step 3.2.1 on TA to asset owners and end users. Without other interventions supporting suppliers, the market may also fail to remain viable after the program ends.

[205] Source: MAAIF, Micro-Scale Irrigation Program: Technical Guidelines, 2022.

[206] Source: Fruman, C., and Hristova, D., How to Make Grants a Better Match for Private Sector Development, 2017; World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019.

[207] Source: IFAD, Matching Grants: Technical Note, 2012.

[208] Source: IFAD, Matching Grants: Technical Note, 2012; GIZ, Productive Use of Energy (PUE) in the Agricultural Sector, 2024.

3.3.6 UTILITY OR DEVELOPER-BASED FINANCING

Utility- or developer-based financing involves utilities and mini grid developers extending credit directly to PUE customers to finance equipment, or working with third-party financial institutions to do so – with repayments typically embedded into electricity bills (on-bill financing). The commercial case for utilities and mini grid developers is direct: financed PUE equipment raises electricity demand and therefore sales revenue. Utilities and mini grid developers have customer data, billing systems, local networks, and payment infrastructure, which can support customer targeting, appliance financing, and supplier partnerships.[209] CrossBoundary's Mini Grid Innovation Lab found average electricity consumption per user was 48% higher at sites offering appliance financing, increasing overall mini grid profitability. The same research found that this effect held only when the equipment financed was productive; financing household appliances reduced average consumption per user.[210] Mexico's Eco-Crédito Empresarial Masivo program showed that on-bill financing for MSME equipment on the main grid can achieve wide uptake when repayments are simplified and customers are shown credible return projections upfront.[211]

» **Insight from stakeholder.**

> *"The developer-led lens works best because they are really closest to the communities. They know the communities intimately. They know the needs. They know who pays. They know who doesn't pay. They know the businesses that are doing well."*
>
> **– Mini Grid Expert (Investment and Advisory Firm)**

On-bill financing requires clear financing roles and an enabling regulatory framework. Programs can bring utilities and financial institutions together to determine who provides capital, assesses customers, collects repayments and bears credit risk, and, where permitted, enable billing or consumption data to support credit assessment.[212] They should also establish early whether utilities may lend or collect repayments for third parties, what licensing or regulatory approvals apply, how defaults and partial payments are treated, whether financed equipment can be used as security, and what consumer protection and data sharing rules apply. Where these rules are unclear or constrain an otherwise viable model, programs can support regulators, utilities and financial institutions to clarify requirements and put appropriate safeguards or reforms in place.[213]

Utility- or developer-based financing is most effective when:

1. **Utility appetite exists, or can be built through non-financial support.** Utilities and mini grid developers may be unwilling to provide financing, or partner with others to do so, due to financial risk, administrative burdens, or low perceived returns.[214] Programs need to engage utilities and mini grid developers as commercial partners from the outset, understanding their liquidity position, existing customer relationships, and risk tolerance, before designing financing structures. Non-financial support can matter as much as access to capital.

[209] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.

[210] Source: CrossBoundary, Appliance Financing 3.0 Innovation Insight, 2023.

[211] Source: Revista CANAME, Eco-Business Mass Credit, 2023.

[212] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.

[213] Source: Stakeholder consultations; World Bank Group, Accelerating the Productive Use of Electricity, 2023.

[214] Source: Stakeholder consultations, 2026.

» **Best practice.** IDCOL in Bangladesh provided mini grid developers with concessional financing and also invested heavily in building developers' own business development capacity through skills training for mini grid managers, and paired financing with intensive customer-awareness campaigns. These measures helped make the financing proposition credible and manageable for developers.[215]

2. **Energy markets are relatively mature, with utilities and mini grid developers able to absorb significant working capital and credit risks.** This is manageable for utilities and developers with access to commercial capital, but is often prohibitive for those with weaker balance sheets and more limited access to finance.[216] In nascent markets, this has led to limited or uneven uptake. Programs can address this through concessional credit lines, first-loss guarantees on their PUE loan portfolios, or partial payment models that reduce upfront capital exposure. These mechanisms should be designed after assessing utilities' and mini grid developers' financial and operational maturity.[217]

3. **Grid supply is reliable.** Evidence from CrossBoundary's Mini Grid Innovation Lab showed that sites with high reliability consumed more than ten times as much electricity as low-reliability sites.[218] Where grid reliability is low, programs should assess whether reliability investments (or mini grid operational support) are a prerequisite before utility-based financing can function. Unreliable grids will suppress appetite for utility-based financing, both among utilities and potential asset owners. Program designers should therefore assess grid reliability, as well as utilities' financial and operational maturity, early in the design process and calibrate the level of programmatic support accordingly.

» **Insight from stakeholder.**

> *"Before we even think about doing appliance financing again, we must focus on providing reliable connections across our sites."*[219]
>
> **– Mini Grid Operator (from CrossBoundary's Research)**

» **Best practice.** Uganda's Utilities 2.0 pilot combined electricity supply, appliance financing, and business support: productive loads helped demand reach 75% of mini grid capacity, and businesses accessing appliance finance consumed 75% more electricity.[220]

[215] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.

[216] Source: IGC, Driving Productive Use of Energy in Fragile Contexts, 2024; GET.invest, Financing and Scaling Productive Use of Energy, 2023.

[217] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.

[218] Source: CrossBoundary, Appliance Financing 3.0 Innovation Insight, 2023.

[219] Source: CrossBoundary, Appliance Financing 3.0 Innovation Insight, 2023.

[220] Source: Power for All, Utilities 2.0: How Integrated Energy Accelerates Global Access, 2025.

Key challenges and risks to address in program design:

1. **Concentration risk.** Utility- or developer-based financing tends to favor larger, better-capitalized operators. In markets with small or fragmented mini grid sectors, the intervention may not reach most PUE users without deliberate inclusion mechanisms for smaller ones.[221]

2. **Dependency.** Financing supply is contingent on utility or mini grid developer participation. If they exit, the market-building effect is much weaker than for RBF or credit lines to FIs.[222]

3. **Institutional and political barriers can limit utilities' engagement.** National utilities often view PUE equipment promotion as outside their mandate, and their incentive structures may not reward it (see the Indonesia pitfall in Step 2.2). Development finance actors have also been reluctant to provide concessional consumer financing in grid-connected settings for fear of market distortion.[223]

[221] Source: Stakeholder consultations, 2026.

[222] Source: Stakeholder consultations, 2026.

[223] Source: Stakeholder consultations, 2026. See also: World Bank Group, Raising Rural Productive Uses of Electricity, 2021.

photo credit: Joel Mulwa for GOGLA

3.4 Policy and Regulation

INTERVENTIONS COVERED IN THIS SECTION: Import and tax policy | Mechanisms for cross-sectoral collaboration | Tariff design and cross-subsidization for PUE

Policy and regulation are important long-run building blocks for scaling PUE. They shape the operating context for stakeholders, and influence whether other interventions can be effective. Even strong subsidies or TA will have limited impact if the wider policy environment is unclear, fragmented, or restrictive. Governments and regulators lead policy reform, but other actors can help shape workable reforms by providing evidence, dialogue, and implementation support.

Policy and regulatory change often takes time, so programs may need temporary measures while longer-term systems are built. Short-term actions, such as program-specific tax exemptions, temporary customs facilitation, or targeted regulatory waivers, can help reduce immediate barriers. However, building the institutional, regulatory, and coordination infrastructure needed for a mature PUE market is usually a longer-term process.

Policy stability is often as important as policy design, as instability can pose a risk to programs. Sudden or unpredictable changes in taxes, import rules, subsidy schemes, tariffs, or licensing requirements can shift companies from growth mode to survival mode. A predictable policy environment may therefore be more valuable than an ideal but unstable one.

» **Pitfall to watch out for.** Strong program design cannot fully compensate for an unstable policy or market environment. In India's Financing Energy Efficiency at MSMEs Project, unanticipated market and regulatory changes meant that in 4 of 26 selected clusters, no energy efficiency investments were made because MSMEs were focused on survival rather than growth or improved business practices. PUE programs should therefore treat policy stability as a core risk to scale, build flexibility into implementation, and coordinate with policymakers.[224]

Evidence regarding tariff reform and on-bill financing for PUE remains limited, particularly across different grid and mini grid contexts. More comparative case studies are needed to understand their effects on productive use, customer affordability, and utility and developer economics.

[224] Source: World Bank Group, Implementation Completion and Results Report - Grant to the Republic of India, 2019.

3.4.1 ESTABLISHING MECHANISMS FOR CROSS-SECTORAL / INTER-MINISTERIAL COLLABORATION

Without formal mechanisms for cross-sectoral and inter-ministerial collaboration (see the Cross-sectoral principle), PUE programs often become siloed into energy access targets without the buy-in of relevant non-energy ministries, procurement ends up technology-focused, and the same supplier base receives duplicative TA from multiple donors.

Four mechanisms are critical. Policy dialogue and co-design and co-delivery generally need to happen before PUE is embedded in development plans, while coordination platforms become more relevant as implementation scales:

1. **Policy dialogue to create an enabling environment for scaling PUE.** For example, Powering Agriculture identified four policy areas to focus on, through more than 30 interviews and a policy dialogue with businesses and other stakeholders,[225] while Water and Energy for Food (WE4F) continues these dialogues to strengthen the enabling environment.[226] The Community of Champions brings together governments, private sector actors, and development partners to exchange experience on policy and regulatory barriers in PUE.[227] PUE program design should help shape policy dialogue by generating evidence and creating platforms for actively involving stakeholders.

2. **Co-design and co-delivery of programs, through working groups, joint technical committees, public-private consultation processes, and more.** Prominent examples include WE4F's Regional Innovation Hubs, which involve development partners and companies in collaboration with national governments,[228] and the CROWD Working Group, which coordinates funders and TA providers supporting early-stage and locally led PURE companies.[229] Programs should build co-design and co-delivery into their governance from the outset, so that energy and non-energy partners make decisions together.

3. **PUE should be embedded in development plans (e.g., agriculture, climate resilience, electrification, food security, MSME, rural development).** Because PUE sits across sectors, without a clear policy home it risks staying fragmented, donor-led, or limited to pilots. National or sub-national strategies and roadmaps provide a common framework for prioritization and coordination (see Steps 1.1 and 2.2). Examples include India's framework for DRE livelihood applications,[230] Kenya's National Roadmap on Scaling Up PURE,[231] Kenya's National PUE Strategy, Uganda's National Roadmap for Productive Use of Solar Energy, and the inclusion of PUE in several energy compacts such as those of Ghana,[232] Kenya,[233] and Lesotho.[234] Programs can support this by building the evidence base for policy uptake and clarifying where PUE fits in national priorities, which agency should lead, and how PUE is reflected in budgets and plans. Integrating PUE into public budgets, including through ministries of finance, allows public funds to back credit lines and co-financing. Over time it can make government a significant PUE investor, particularly where PUE is built into adjacent programs such as food systems or irrigation.

[225] Source: Powering Agriculture, Navigating Policy and Regulation in the Clean Energy-Agriculture Nexus, 2020.
[226] Source: Powering Agriculture, Navigating Policy and Regulation in the Clean Energy-Agriculture Nexus, 2020.
[227] Source: GOGLA, Community of Champions.
[228] Source: WE4F, Who We Are.
[229] Source: Efficiency for Access, About the CROWD Working Group.
[230] Source: Ministry of New & Renewable Energy of India, Promoting Decentralised Renewable Energy Livelihood Applications, 2022.
[231] Source: Ministry of Energy and Petroleum of Kenya, National Road Map on Scaling Up Productive Use of Renewable Energy, 2023.
[232] Source: Mission 300, National Energy Compact for the Republic of Ghana, 2025.
[233] Source: Mission 300, National Energy Compact for the Republic of Kenya, 2025.
[234] Source: Mission 300, National Energy Compact for the Kingdom of Lesotho, 2025.

4. Coordination between governments and development partners. PUE cuts across sectors and is easily weakened by duplication, inconsistent intervention approaches, or fragmented support to the same companies and markets. Promising coordination platforms include the Agri-Energy Coalition, which brings together actors across energy, agriculture, water, climate, nutrition, and finance;[235] and the GEAPP/World Bank Group Center of Excellence on PUE under Mission 300. Programs should formalize these platforms, with a clear mandate and convener, rather than leave coordination to ad hoc contact.[236]

Additional resources

1. For structuring collaboration across energy and food system actors: "Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar" (Agri-Energy Coalition, 2025)
2. For structuring inter-ministerial policy dialogue and identifying policy reform priorities: "The Off-Grid Solar Policy Toolkit" (Lighting Global/ESMAP, PPIAF, DDP, 2024)
3. For practical tools to assess trade-offs and support integrated planning across water, energy, and food systems: "A Roadmap and Tools for Water-Energy-Food Nexus Security in South Asia" (IWMI/CGIAR), and the associated WEF-Nexus Decision Support System
4. For aligning country-level energy reforms, investment, and partner support: Mission 300 National Energy Compacts and the wider Mission 300 platform

> **"A predictable policy environment may therefore be more valuable than an ideal but unstable one".**

[235] Source: Agri-Energy Coalition.

[236] Source: GEAPP, Center of Excellence on Productive Use of Energy.

3.4.2 IMPORT AND TAX POLICY

Import and tax policy can support PUE markets by reducing the cost and uncertainty of supplying PUE equipment, thereby lowering prices faced by asset owners.[237] Uncertainty arises when customs classify equipment inconsistently, when duty and VAT exemptions cover solar products but not the appliances and machinery they power, or when rules change without notice. Suppliers then cannot price stock or plan orders with confidence. PUE program designers should treat these policies as important tools that can help make other interventions addressing affordability or supply (including quality) more effective. This section focuses on common import and tax policy interventions for PUE, though there is a wider range of policy tools not covered (e.g., local content requirements, graduated tariffs, or incentives for local assembly and servicing). Import measures matter most in countries without a local manufacturing base.

Interventions that can support PUE include (non-exhaustive):

1. **Clear and consistently applied value-added tax (VAT) and import duty exemptions.** While solar panels are exempt in many countries, PUE equipment and components often incur duties and/or taxes, and where exemptions are in place they are not always consistently applied.[238] VAT can be especially challenging for PAYG models, since under standard VAT rules, suppliers pay full tax on equipment value at the point of sale, while it takes years to recover payments through PAYG.[239] This creates a cash flow deficit that can make the PAYG model commercially unviable in some high-VAT environments. Potential losses of tax revenue from exemptions should be weighed against productive gains (e.g., economic growth, more exports).[240]

   » **Best practice.** In Togo, the CIZO solar-irrigation program shows how VAT and import duty exemptions can be coordinated with wider program interventions to help kick-start uptake of PUE equipment in nascent and import-dependent markets. As part of a deliberate strategy to reduce upfront costs, the government paired VAT and import duty exemptions on eligible SWPs with a 50% end user subsidy.[241]

2. Linking import policy to QA. Exemptions can unintentionally encourage imports of low-quality or counterfeit equipment if there is no quality filter. At the same time, overly strict import standards can block emerging PUE equipment. Where QA frameworks are immature, exemptions should be phased alongside voluntary certification rollout, with eligibility conditions tightened as the market matures. Mature equipment should be subject to voluntary or mandatory quality standards (see Step 3.1.1).[242]

   » **Pitfall to watch out for.** Taxes on imports can hamper the development of nascent PUE markets, especially for high-quality goods. In Benin, high customs duties reduced imports of the good-quality solar PUE equipment the Green People's Energy program was introducing (see Step 3.1.1).[243]

[237] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.

[238] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023. See also Tetra Tech, Scaling Productive Use of Energy Solutions in Sub-Saharan Africa, 2023.

[239] Source: ACE TAF, Ethiopia - Impact Assessment of Value Added Tax and Duty Exemptions, 2021.

[240] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.

[241] Source: GOGLA, Togo Country Brief, 2024; SunCulture, Improving Accessibility of Productive-Use Solar Products, 2023; IFC, Creating Markets in Togo, 2023.

[242] Source: GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.

[243] Source: GIZ, Productive Use of Energy (PUE) in the Agricultural Sector, 2024; Energypedia, Results-Based Financing Mechanism for Productive Equipment Sales in Benin, 2026.

3.4.3 TARIFF DESIGN AND CROSS-SUBSIDIZATION FOR PUE

Tariff design can enable or constrain the commercial viability of PUE, but lower tariffs are not an objective in themselves. PUE programs rarely set tariffs directly. They should establish whether tariffs are a material constraint and, if so, support utilities, regulators, or mini grid developers in assessing reforms that improve PUE economics while preserving utility and developer cost recovery.

Interventions that can support PUE include (non-exhaustive):

1. **Assess whether tariff design is a material constraint.** Use representative bills and load profiles to assess how volumetric tariffs, fixed or demand charges, customer classification, and time- or season-based pricing affect productive users. Compare the resulting cost with alternatives such as diesel, adjusting for reliability, and use evidence on affordability and price sensitivity to judge whether tariffs materially constrain productive use.[244]

2. **Evaluate feasible tariff options with the utility, mini grid developers, or regulator.** Where tariff design is a material constraint, programs can explore options such as customer reclassification, time-of-use tariffs, seasonal rebates, or other targeted incentives. This should include examining existing cross-subsidies (commercial and industrial users can face higher tariffs than other customer classes even where their cost-to-serve is similar or lower) and who would bear the cost of any preferential PUE tariff. Any reform should balance productive demand and affordability with utility and developer cost recovery and financial sustainability.[245,246]

3. **Test alternative structures where the case for reform is uncertain.** Where utilities, mini grid developers, and regulators are willing, programs can support pilots before wider reform. These should track changes in consumption and load patterns alongside productive use, customer bills, and utility or developer revenues, costs, and cost recovery. CrossBoundary's mini grid tariff-reduction pilots in Tanzania found that customers sustained 1.5–3x their baseline consumption more than three years after tariff cuts of 50–75%.[247]

[244] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.

[245] Source: World Bank Group, Accelerating the Productive Use of Electricity, 2023.

[246] Source: World Bank Group, Falling Short - A Global Survey of Electricity Tariff Design, 2020.

[247] Source: CrossBoundary, Mini-Grid Tariff Reduction Innovation Insight, 2022.

Chapter 3:
Conclusion and Further Research

photo credit: Joel Mulwa for GOGLA

Conclusion

Productive use of energy sits at the intersection of every sector this guide has touched – energy, agriculture, water, finance, and enterprise. The guidance in the preceding chapters follows from that. Start from the outcome, not the technology. Build on what is already known rather than waiting for perfect evidence. Bring the right stakeholders in from the outset, before design choices are locked in. Address the full set of constraints that end users face, not only access to energy. And design for the point where program support ends, not just the point where it begins. None of this happens by default. It happens when program designers treat productive use as core to their strategies, not as an add-on to an electrification target.

Mission 300's commitment to connect 300 million people in sub-Saharan Africa by 2030 extends beyond household connections to productive uses of energy. That ambition will only translate into lasting jobs, income, and resilience if productive use is built into program design from the start. This guide offers a practical foundation for that work. This final chapter sets out a research agenda that – if undertaken – would support more informed decision-making by program designers, accelerate the diffusion of best practice across countries and sectors, and enable continuous improvement in PUE program design over coming years.

Areas for Further Research

The recommendations in this guide rest on evidence that is firmer in some areas than others. In several places, the guide describes trade-offs qualitatively and leaves thresholds unspecified because the evidence needed to quantify them does not yet exist. Program designers are both the main users of this evidence and its main potential source. The gaps will close only if the programs now being designed generate evidence that can be compared across them.

To date, PUE programming has under-invested in monitoring, evaluation, and learning (MEL). It has often produced accounts of activity rather than measures of outcomes. The field has accumulated many case studies but little evidence that can be compared across them. Programs in similar contexts using similar instruments often cannot be set side by side because their indicators differ, and the counterfactual evidence needed to attribute impact with confidence is rarely collected. Program designers can change this through (i) setting and tracking clear indicators, ideally at portfolio-level to facilitate comparison of individual projects; (ii) reserving an adequate share of the budget for independent evaluation; and (iii) disclosing results publicly, including – or especially – those that fall short of expectations, since these are often the most instructive for future programs.

Table 4 sets out the questions where evidence gaps most constrain program decisions. Each question states the decision it would inform, the gap in current evidence, and how the gap might be addressed. Program designers can use the table to identify which questions their MEL framework could help answer. For example, a program deploying irrigation and cold storage across areas with different demand densities could track the cost per unit of productive output that question A3 is focused on.

Table 4: Further research questions for PUE

Question		Decision it informs, and the gap in current evidence	How it might be addressed
A. Identifying where to focus			
A1	What is the cost-benefit profile of specific PUE interventions, and what methodologies can better model the economic and fiscal impact of PUE programming at scale?	Informs investment prioritization and the case for PUE within energy access portfolios. Evidence on cost per unit of productive output and macroeconomic returns to PUE investment is limited, making it difficult to compare interventions or make the case for scaled allocation.	Review documented program data on costs and outputs; develop and test modeling methodologies in collaboration with government planning and finance ministries.
A2	How can existing geospatial data reliably identify the highest-potential sub-national areas for PUE uptake?	Informs geographic targeting. National-level PUE market estimates exist in several contexts, but programs often lack the disaggregated evidence needed to allocate resources across regions. As a result, targeting decisions still rely heavily on designers' judgment.	Test whether existing datasets on productive activity, energy access, and financial inclusion can be combined into a reliable targeting layer, and define the minimum data required.
A3	At what demand scale does grid or mini grid supply become more cost-effective than standalone off-grid generation for specific PUE applications?	Informs the choice of power supply setting. This guide describes the trade-off between grid, mini grid, and off-grid supply qualitatively, but program designers often lack practical thresholds for when the preferred supply option changes.	Model cost per unit of productive output across representative use cases, such as irrigation, cold storage, and agro-processing, at different demand densities and in different country energy-sector contexts.

Question		Decision it informs, and the gap in current evidence	How it might be addressed
B. Reaching commercial viability			
B1	Which PUE supplier business models can sustain sales or service delivery without continued subsidy, and how does this differ by asset scale?	Informs business-model support and the distinction between small-scale assets and shared infrastructure. Evidence exists for some asset classes and contexts, but it is not yet comparative enough for teams designing support in new geographies or use cases.	Compare documented experience with pay-as-you-go, fee-for-service, cooperative, and other deployment models, segmented by asset scale and productive-use category.
B2	Which artificial intelligence and digital tools measurably improve PUE outcomes, and under what conditions can they scale?	Informs whether and how to fund digital components. Digital tools are increasingly used for finance, targeting, training, remote monitoring, predictive maintenance, and after-sales support, but evidence of their effect on outcomes remains limited.	Review evidence function by function, and identify the connectivity, data, institutional, and regulatory conditions required for reliable deployment at scale.
B3	What role can B2B partnerships play in addressing financing, capacity, and market-linkage constraints?	Informs whether programs should broker partnerships or address constraints through direct support. Market linkage is often identified as a binding constraint, but there is limited systematic evidence on which partnership models work, for whom, and under what conditions.	Develop a typology of partnerships between suppliers, aggregators, financial institutions, cooperatives, and off-takers, identifying common success conditions and failure points.
B4	What role can carbon finance play in supporting commercially viable PUE business models?	Informs whether revenues from carbon credits can materially improve PUE affordability or business model viability. Evidence remains early-stage, and further research is needed on which use cases can generate sufficient emissions reductions and carbon revenues to justify measurement, verification, transaction, and certification costs.	Track and compare emerging PUE carbon-finance pilots across use cases, assessing carbon revenue potential, transaction and verification costs, and effects on end user affordability and supplier viability.

	Question	Decision it informs, and the gap in current evidence	How it might be addressed
	C. Program design best practice		
C1	Which cross-sectoral government coordination mechanisms remain effective through political or administrative transitions?	Informs governance design. Coordination across energy, agriculture, finance, and planning functions is widely cited as important for PUE programs, but the features that make coordination durable have not been systematically documented.	Compare coordination arrangements across programs that have experienced government transitions, distinguishing those that maintained continuity from those that did not.
C2	How should financing and subsidy instruments be designed, sequenced, and phased out as PUE markets develop, and what financing structures are needed to sustain commercially viable suppliers and end users at different stages of market development?	Informs the sequencing of financial support, subsidy exit, and the financing structures needed at different stages of market development. Evidence remains limited on how grants, RBF, concessional debt, and risk-sharing instruments can move PUE markets toward commercial viability without distorting incentives, and on what financing terms and structures suppliers and end users require as markets mature.	Compare sequencing across documented PUE programs, including cases where instrument design affected market behavior, and align the analysis with current work on subsidy design in off-grid solar. Identify financing structures that have supported supplier and end user viability beyond the subsidy period, including on-lending facilities, credit lines, and risk-sharing mechanisms.
C3	What outcome indicators and measurement approaches should PUE programs use to assess development outcomes consistently across sectors and use cases?	Informs the design of monitoring, evaluation, and learning frameworks. PUE programs often track deployment and energy metrics, but there is less consistency in measuring outcomes such as productivity, income, jobs, resilience, business performance, and sustained use. Existing methodologies cover some outcomes, but there is no widely adopted framework for measuring the broader range of PUE outcomes.	Review existing PUE and sector-specific monitoring, evaluation, and learning approaches and identify a practical core set of outcome indicators. Test these across representative programs and use cases, distinguishing indicators that can be tracked through routine program monitoring from those that require dedicated evaluation.
C4	Which practical tools would help task teams apply this guide, and compare and prioritize competing opportunities?	Informs how teams move from the guide's principles to day-to-day design and delivery decisions. The guide sets out decision criteria and evidence requirements, but these are not yet consolidated into compact tools such as a stakeholder interview guide or a minimum-evidence checklist. The guide is also stronger at deciding how to support an identified opportunity than at deciding which of several competing opportunities should receive priority investment.	Develop and test ancillary resources, for example through the PUE Center of Excellence: a stakeholder interview guide; a minimum-evidence checklist for key design decisions; a method for scoring and ranking opportunities, with indicative thresholds linked to resource allocation; and delivery templates such as governance models, responsibility matrices, and stage gates.

“Energy investments provide the most value when they translate connections into development objectives, including higher productivity, incomes, jobs, and resilience”.

Appendix I:
Challenges with the term PUE and interchangeable alternatives to resonate with cross-sectoral audiences

"PUE" refers to the productive use of energy and is most commonly used within the distributed renewable energy (DRE) sector. It is not a term that is commonly used in other key sectors, such as agriculture, water, environment, and enterprise or industrial development. Other sectors tend to refer to specific equipment (e.g., SWPs, refrigerators), processes (e.g., irrigation, cooling), or their own sectoral terms (e.g., agricultural mechanization/modernization). Many have attempted to create a standardized definition for PUE, yet none are widely accepted. A non-exhaustive list of definitions, based largely on a list developed previously by EnDev, is shown in Table 5.

Table 5: Non-exhaustive list of PUE definitions

Definitions of PUE	Source
Productive uses involve inputs of electricity in any income-generating activity that produces goods or services. Productive uses are defined as having an economic benefit and a direct impact on income.	Energy Sector Management Assistance Program (ESMAP). 2023. Accelerating the Productive Use of Electricity: Enabling Energy Access to Power Rural Economic Growth (ESMAP Paper). Washington, DC: World Bank Group, p. 1.
Any agricultural, commercial, or industrial activity that uses solar energy as a direct input to the production of goods or provision of services. Also called Productive Use Leveraging Solar Energy (PULSE).	IFC (2019). Productive Uses Leveraging Solar Energy (PULSE). Washington, DC: International Finance Corporation / Lighting Global.
Activities that involve the utilization of energy - both electric and non-electric energy in the forms of heat, or mechanical energy - for activities that enhance the income and welfare in rural contexts. These activities are typically in the sectors of agriculture, rural enterprise and education.	Kapadia, K. (2004). Productive Uses of Renewable Energy: A Review of Four Bank-GEF Projects. Washington, DC: World Bank Group / Global Environment Facility.
Projects that aim at enhancing income generation opportunities and productivity in rural areas [...] to improve quality of life and increase local resilience and self-reliance.	Etcheverry, J. (2003). Renewable Energy for Productive Uses: Strategies to Enhance Environmental Protection and the Quality of Rural Life. Toronto.
Activities that involve the application of energy [...] to create goods and/or services either directly or indirectly for the production of income or value. The production of income or value is understood to be achieved by selling products or services at greater than their cost of production, resulting in an increase in the net income of the enterprise or the entrepreneur.	White, R. (2003). GEF-FAO Workshop on Productive Uses of Renewable Energy - Synthesis and Report. Rome: Global Environment Facility / Food and Agriculture Organization.
Agricultural, commercial and industrial activities involving electricity services as a direct input to the production of goods or provision of services.	Rüderle, A., Attigah, B., and Bodenbender, M. (2011). Productive Use of Energy (PRODUSE) - A Manual for Electrification Practitioners. Eschborn: EUEI PDF and GIZ

Source: EnDev, Productive Use of Energy: Moving to Scalable Business Cases, 2021.

Creating a stronger shared understanding of PUE, both within and across sectors, could facilitate cross-sectoral collaboration, strengthen the ability to share lessons across programs, and increase the visibility of PUE as an investment opportunity. Table 6 supports shared understanding by outlining some of the alternative terms that are used to describe PUE primarily by non-energy sectors. These terms encompass a more nuanced, and often broader, view of how energy can serve objectives such as income generation, job creation, social development, and food security. Many of them are also tailored to specific audiences to enable cross-sectoral collaboration and understanding.

Table 6: Interchangeable alternatives to the term "PUE" that shift the focus away from energy as the outcome

Complementary term	Used by…	How it differs from PUE
Climate-smart energy technology	Climate, food security, nutrition, investors	Focuses on the underlying innovation and its potential environmental benefits, while retaining the link to energy
Income-generating uses of energy	Energy access, investors	Shifts from "productive" to "income-generating", clarifying the scope (e.g., not social infrastructure) while more clearly including activities beyond production, such as services or commerce
Income-generating machinery	Asset financing, private sector	Shifts from "productive" to "income-generating", excluding electrification of social infrastructure (e.g., schools, clinics) from its scope. "Machinery" narrows the scope to typically larger equipment used in production processes within agriculture or industry.
Machinery and equipment to upgrade value chains	Agriculture, industrial policy actors	Narrows the scope to typically larger equipment within agricultural or industrial value chains, emphasizing additional value that can be captured locally
Mechanized equipment	Agriculture	Leverages the vocabulary of agricultural modernization, narrowing the scope to typically larger agricultural equipment that increases output and/or reduces the need for manual labor
Stimulating economic growth with improved energy services	Governments, multilateral actors	Broadens the scope to a wide range of use cases, including social infrastructure. Emphasizes the benefits to economic and social development through increased use of modern energy and accompanying services. Speaks to both government and multilateral priorities, such as the Sustainable Development Goals.

Source: Stakeholder consultations, 2026.

Appendix II:
Stakeholder consultations as part of this guide

Table 7: Stakeholder consultations that have informed this guide (held in early 2026)

World Bank Group Teams	Development Partners	Private sector and ecosystem experts
• Regional ASCENT project • ESMAP Mini Grid team • Regional DARES Project • West Africa Agriculture • East Africa Agriculture • Honduras Agriculture • Water GP	• GIZ/EnDev • SNV • CLASP • GEAPP • PREO • Selco Foundation • SwitchON Foundation • Council on Energy, Environment and Water (CEEW) • Shell Foundation • Gates Foundation	• Wageningen University • GOGLA • AMDA • CrossBoundary • SokoFresh • SOSAI • Acumen

Appendix III:
Case study on Uganda: from PUE market assessment to program design[248]

Context and purpose. Uganda's 2022 PULSE market assessment examined where standalone solar could support productive activity, the constraints to scale, and which actors were addressing them. The assessment informed the design of the PUE component of the Uganda Electricity Access Scale-up Project (EASP). The program was approved in March 2022 and is expected to close in June 2027. EASP's design therefore predates this guide. Nonetheless, the case study maps PULSE/EASP against the guidance compiled in this guide to illustrate how a similar approach worked in practice.

Starting point. EASP was an energy access project aimed at increasing access to energy for households, enterprises, industrial parks, and public institutions. Within that wider objective, the PUE work initially focused on how SWPs and refrigeration could contribute to agricultural productivity and value addition. However, the scope evolved substantially during implementation.

Step 1: Undertake Broad Situation Analysis

Step 1 started with a broad scan across potential PUE technologies, business models and value chains in Uganda before narrowing to focus on specific use cases, market segments, and financing and support needs. The analysis progressively concentrated effort where near-term productive and commercial potential appeared strongest.

1.1 Gather cross-sectoral intelligence from stakeholders and existing programs.
PULSE reviewed around 70 publications and interviewed around 50 stakeholders, including suppliers, end users, industry associations, agricultural aggregators, government and development partners. This demonstrated Cross-sectoral and Agile design: it combined existing evidence with market knowledge on demand, capabilities, barriers, and planned initiatives.

1.2 Map opportunities to electrify activities for priority sectors and value chains based on demand and business case.
The assessment looked across productive use applications and value chains, then concentrated its detailed analysis on SWPs and solar refrigeration, which it identified as leading near-term PULSE opportunities. It assessed market size, economics, and demand. EASP subsequently linked these applications to agricultural productivity and value addition. In prioritizing opportunities, the project demonstrated Outcome-led design: it focused on applications with a clear commercial case.

1.3 Scope potential equipment, power supply, business models and financing mechanisms to identified opportunities.
PULSE examined supplier readiness, technology maturity, prices, business models, customer affordability, and existing finance. It found that only a small share of SHFs could afford SWPs or refrigeration units at prevailing prices, and identified financing needs for both end users and suppliers.

[248] Sources: Stakeholder consultations, 2026; Lighting Africa, The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Uganda, 2022; World Bank, Project Appraisal Document - Grants to the Republic of Uganda, 2022; UECCC, Credit Support Facility Manual, 2023; World Bank, Project Restructuring Paper - Republic of Uganda, 2025.

Where the approach differed from this guide: PULSE's standalone-solar scope was defined before the assessment, so grid and mini grid alternatives were not compared. This guide, in contrast, suggests evaluating all relevant power supply settings.

During implementation, EASP broadened its approach and embraced outcome-led design. Reflecting government priorities to increase grid utilization and changing sector demand, EASP included grid-connected equipment where supply was reliable, solar mills in weak-grid areas, and solar water heaters in areas with tourist activity. The final design therefore matched equipment to different power supply settings and sector needs, as this guide recommends.

Step 2: Assess Building Blocks and Assign Roles

Step 2 turned the opportunity analysis into a diagnosis of the enabling environment. It helped identify which barriers were preventing the priority applications from scaling, which could be handled by existing actors, and where support was needed.

2.1 Map the current state of each building block.

Finance was a major constraint identified by the 2022 PULSE Uganda Report, and EASP subsequently established a strong financial intermediation role through the Uganda Energy Credit Capitalisation Company (UECCC) and participating financial institutions. Technology maturity was mixed at the time of assessment and continued to evolve during implementation, with new suppliers, lower-cost SWP capacities, PAYG models, and additional technologies emerging. Market and business development gaps remained substantial, although implementation strengthened market actors, generated new demand, and enabled new business models and technologies to enter the market. Table 8 shows what an application of this guide's framework would have looked like, based on the situation analysis presented in the 2022 PULSE Uganda assessment.

Table 8: Illustrative scoring of PUE components from 2022 PULSE Uganda: Quick sheet for comparing strength levels and program capabilities

	Level of strength	Program capabilities
Access to Finance	Low (1)	High (3)
Technology & Innovation	Medium (2)	Medium (2)
Market & Business Development	Low (1)	Medium (2)
Policy & Regulation	Medium (2)	Medium (2)

2022 PULSE Uganda identified barriers spanning affordability and finance, consumer awareness, last-mile distribution, demand aggregation, supplier capability, product quality and standards, and policy. It also distinguished where energy-sector expertise, agriculture or water-sector expertise, or joint action was needed. This demonstrated a Holistic diagnosis: the assessment mapped constraints across all building blocks.

By implementation, however, the market had evolved. New suppliers and lower-cost SWPs emerged, PAYG became more available, and demand developed for additional PUE technologies. This showed that the assessment could not be treated as a one-off diagnosis or fixed sequence. Market intelligence and implementation experience needed to inform continued adaptation.

2.2 **Identify which actors are best placed to lead or support on addressing each building block.** The assessment mapped existing donor activity and market actors against the gaps it had identified. It set out roles for UECCC, banks, MFIs and SACCOs, suppliers, cooperatives and off-takers, government bodies, and development partners, while taking account of support already available from other programs (including other World Bank Group projects) and financiers. This helped focus new support on genuine gaps, reduce duplication, and use existing delivery channels. EASP then operationalized part of this architecture. UECCC became a key financial intermediary, participating financial institutions delivered finance, and private companies supplied equipment. The institutional and delivery architecture also evolved as new actors and financing models emerged. Building on existing institutions reflected the Agile and Lasting principles, increasing local ownership and reducing reliance on parallel structures while retaining flexibility to respond to market change.

The policy and regulatory dimension shows how program capabilities evolved beyond what 2022 PULSE Uganda had anticipated. The report identified policy and regulatory gaps, but policy reform and sector coordination were not initially conceived as core to the PUE component. During implementation, EASP's Programmatic Advisory Services and Analytics (PASA) supported the Ministry of Energy and Mineral Development (MEMD) on policy and regulatory work, including the development of a national PUE strategy. While progress has been slow, MEMD has proactively integrated PUE across electrification policy. In parallel, UECCC became an active participant in the quarterly PUE working group led by National Renewable Energy Platform, the Uganda Solar Energy Association, and MEMD, which addresses sector issues, raises awareness, and brings together actors beyond energy, including the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), trade, and the Ministry of Water and Environment (MWE).

This broader ecosystem was not envisaged at the time of the PULSE assessment. As PUE gained visibility, additional actors, including SNV, GOGLA, and the IKEA Foundation became active in policy development, market awareness, and sector coordination. This experience shows that the initial diagnosis provided an important foundation, but could not anticipate how the institutional ecosystem would develop. Program capabilities, stakeholder roles, and interventions all evolved as new actors entered, market conditions changed, and new opportunities and constraints emerged.

Outcome of market assessment

Prioritized use cases: SWPs and solar refrigeration
Interventions that could address market failures: Demand aggregation; access to finance, including consumer finance, supplier working capital, and RBF; product development; consumer education, including end user training and awareness; market intelligence; supplier business development; quality assurance; and policy development.

Step 3: Select and Design Interventions

Step 3 translated the diagnosis into a package of interventions. Finance became a core response to affordability and liquidity constraints through EASP Component 2, complemented by quality assurance, market intelligence, awareness, and TA. This reflected the guide's Holistic principle: the program combined multiple instruments and adapted them as implementation generated new experience and evidence.

3.1 Technology and Innovation

PULSE identified needs around product development and quality assurance, and EASP included a quality assurance framework for PUE equipment. Technology support evolved as new suppliers entered and technologies became more affordable or viable, including lower-cost SWPs, solar water heaters, and solar dryers.

3.2 Market and Business Development

PULSE recommended demand aggregation, consumer awareness and training, supplier business support, and continued market intelligence, which EASP subsequently incorporated. Implementation generated further intelligence on suppliers, business models and demand, informing subsequent adjustments.

3.3 Access to Finance

PULSE recommended consumer finance, supplier working capital, risk mitigation, leasing, and results-based support. It directly informed EASP Component 2, which financed end users and suppliers through UECCC and participating financial institutions, alongside grants and risk-sharing instruments. The initial financing offer focused strongly on PULSE-identified products, contributing to slow uptake. As new applications, lower-cost technologies, and PAYG models emerged, and customer demand evolved, EASP introduced greater flexibility and additional market and pricing analysis. PUE sales subsequently increased alongside greater mobilization of commercial and private finance.

3.4 Policy and Regulation

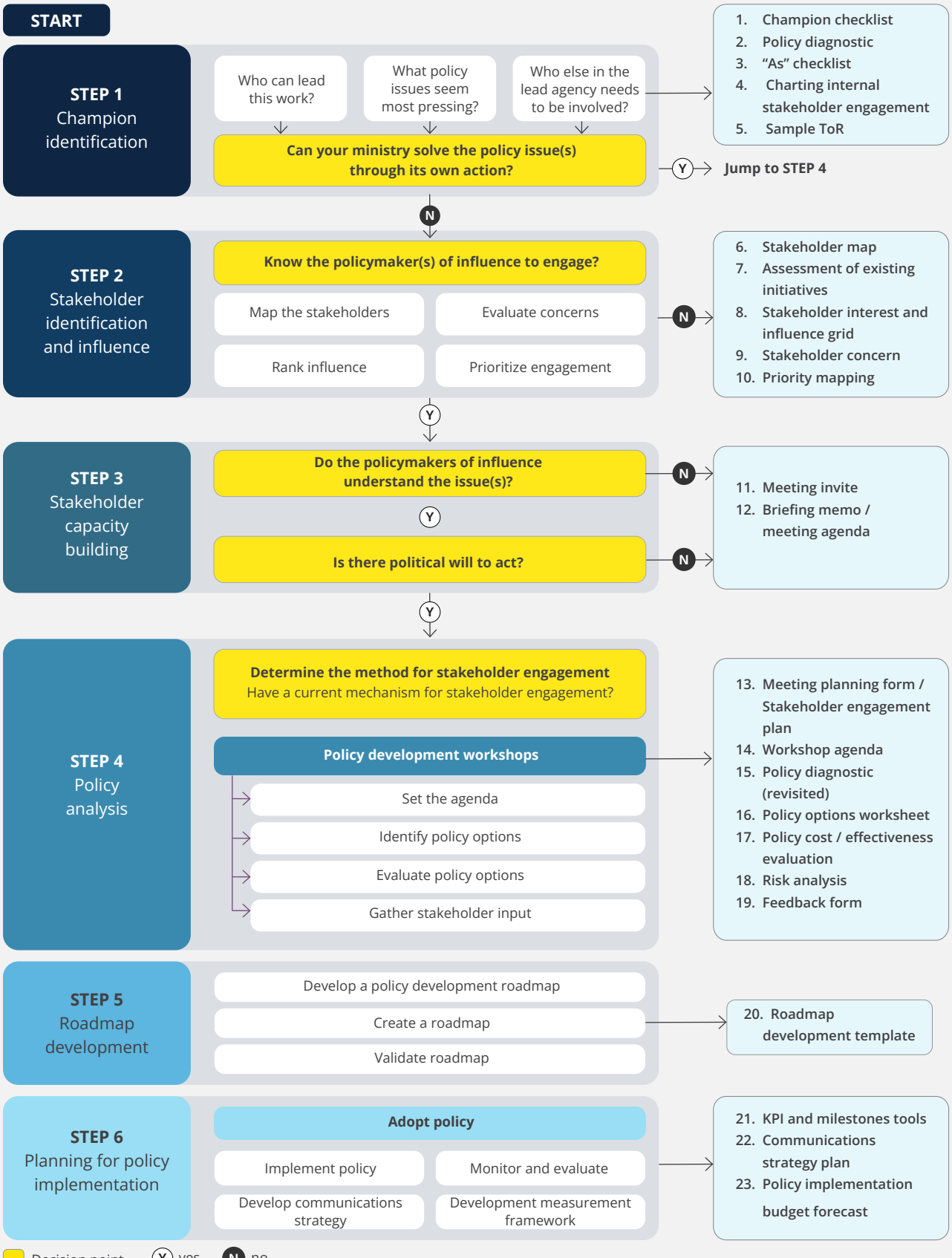
PULSE identified policy and regulatory constraints, although policy reform was not initially a major direct function of the PUE component. During implementation, EASP's PASA supported MEMD on a national PUE strategy and UECCC joined the quarterly PUE working group, while additional development and industry actors became active. This expansion of the program's policy and coordination role illustrates how intervention responsibilities can evolve with the wider market.

Overall lesson. Viewed through the lens of this guide's program design process, this case study shows how the design question narrowed from promising PUE opportunities, to barriers to scale, to which actors were best placed to respond, and finally to interventions. But this was not a linear process. Implementation generates new information, new suppliers and technologies enter the market, business models change, demand develops, and new public and development sector actors become engaged. Programs therefore need to retain sufficient flexibility to incorporate lessons and adjust interventions over time.

PULSE and EASP illustrate Cross-sectoral, Agile, and Holistic design, while EASP's broader technology mix strengthened its Outcome-led approach and delivery through local institutions supported the Lasting principle. The central lesson is that good design depends not only on initial conditions, but also on the ability to adapt as conditions evolve.

Appendix IV

Figure 11: Decision tree for advancing policy reform



Source: Lighting Global/ESMAP, PPIAF, DDP, The Off-Grid Solar Policy Toolkit, 2024.

Appendix V: Bibliography

- 60 Decibels, Disability Insights Report: Transforming Energy Access, 2023.
- 60 Decibels, Why Off-Grid Energy Matters, 2024.
- 60 Decibels and Efficiency for Access, Appliance Impacts Over Time, 2023.
- A2EI, Year in Review, 2026.
- ACE TAF, Ethiopia - Impact Assessment of Value Added Tax and Duty Exemptions, 2021.
- ADB, Road Map to Scale Up Solar Irrigation Pumps in Bangladesh, 2023.
- AECF, Energy for Green Growth and Sustainability in Kenya, 2025.
- AECF, Innovation Fund.
- Agri-Energy Coalition.
- Agri-Energy Coalition, Beyond Silos: Strengthening Nexus Collaboration to Power Food Systems with Off-Grid Solar, 2025.
- AMDA, Productive Use of Electricity is Key to Growing the Load for Minigrids, 2023.
- Bank of Uganda, Supporting Agriculture Modernisation through the ACF, 2024.
- Bank of Uganda, The Agricultural Credit Facility - The Experience of the Central Bank in Enhancing Agricultural Finance, 2016.
- BCCRF, Annual Report, 2014.
- BGFA, Application Guidelines, 2024.
- BID, Rural Electrification Program II, 2016.
- Burney et al., Solar-powered Drip Irrigation Enhances Food Security in the Sudano-Sahel, 2010.
- Caribou, Clean Energy as a Catalyst for Women's Economic Empowerment, 2026.
- CGAP, Getting Repaid in Asset Finance, 2021.
- CGIAR, Safaricom DigiFarm.
- CGIAR, Uganda Intergovernmental Fiscal Transfers Reform Program, 2025.
- CLASP, CLASP and GEAPP Expand Access to Affordable, Energy-Efficient Appliances in Africa, 2025.
- CLASP, Productive Use Appliance Financing Facility Frequently Asked Questions, 2021.
- CLASP, Productive Use Financing Facility (PUFF) Terms and Conditions, 2026.
- Climate Compatible Growth, Current Practices in Results-Based Financing for Energy Access, 2025.
- Colenbrander, E., et al., Five Hurdles to Getting Productive Use of Energy Products to the Last Mile, 2022.
- CrossBoundary, Appliance Financing 3.0 Innovation Insight, 2023.
- CrossBoundary, Mini-Grid Tariff Reduction Innovation Insight, 2022.
- CrossBoundary, Tariff Reduction Innovation Insight, 2020.
- Development Bank of Rwanda, Productive Use of Energy Results-Based Financing Operations Manual, 2026.
- Dittmer, et al., Principles for Socially Inclusive Digital Tools for Smallholder Farmers: A Guide, 2024.
- EDFI MC, Simusolar.
- EEP Africa, Building an Effective Technical Assistance Ecosystem to Further Clean Energy Access, 2025.
- Efficiency for Access, About the CROWD Working Group.
- Efficiency for Access, Business Model Innovations Addressing Affordability: Case Studies, 2021.
- Efficiency for Access, Green Jobs for Rural Youth: Unlocking Renewable Energy's Potential in Agriculture, 2024.
- Efficiency for Access, How Can Energy Access Programmes Address the Needs of People with Disabilities?, 2021.
- Efficiency for Access, Lessons Learned from IFAD Green Technologies Project, 2021.
- Efficiency for Access, Lighting a Path to Affordability, 2026.
- Efficiency for Access, Promoting High-Performing Off-Grid Appliances, 2019.
- Efficiency for Access, Scaling Potential: Insights and Recommendations to Strengthen Early-Stage Support for Productive Use of Renewable Energy Companies, 2026.
- Efficiency for Access, Solar Water Pump Outlook 2019: Global Trends and Market Opportunities, 2019.
- EnDev, Adoption and Use of Solar Water Pumps in Kenya, 2023.

- EnDev, Energising Development Progress Report, 2024.
- EnDev, Exit Evaluation of EnDev Bolivia - Grid Densification and PUE, 2024.
- EnDev, How Shifting to a Pro-Poor Approach Accelerated Energy Access in Rwanda, 2026.
- EnDev, How Solar Technologies are Reshaping Farming for Uganda's Smallholders, 2024.
- EnDev, Incentives for the Private Sector to Promote Solar-Powered Irrigation, 2024.
- EnDev, Innovative Finance for Energy Access, 2024.
- EnDev, Market Development Scorecard, 2019.
- EnDev, Productive Use of Energy: Moving to Scalable Business Cases, 2021.
- EnDev, Productive Use of Energy (PUE): Findings of the EnDev Indonesia Pilot Project, 2013.
- EnDev, Reaching the Bottom of the Pyramid with RBF - Wishful Thinking or Reality?, 2020.
- EnDev, Results-Based Financing for Energy Access, 2018.
- EnDev, Transforming Energy Access Markets with Results-Based Financing, 2021.
- EnDev, Transforming Mindsets to Spark Demand for Solar PU, 2024.
- Energy 4 Impact, Solar Irrigation Rwanda: Developing a New Market for Smallholder Farmers, 2021.
- Energy Access Explorer, About.
- Energypedia, Making Solar Equipment for Productive Use Available in Rural Areas in Ivory Coast, 2026.
- Energypedia, Results-Based Financing Mechanism for Productive Equipment Sales in Benin, 2026.
- ESMAP.
- ESMAP, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022.
- ESMAP, Funding the Sun - New Paradigms for Financing Off-Grid Solar Companies, 2020.
- EUEI PDF and GIZ, PRODUSE Manual for Electrification Practitioners, 2011.
- FAO, Guide on Digital Agricultural Extension and Advisory Services, 2023.
- Fruman, C., and Hristova, D., How to Make Grants a Better Match for Private Sector Development, 2017.
- GEAPP, Center of Excellence on Productive Use of Energy.
- GET.invest, Financing and Scaling Productive Use of Energy, 2023.
- GET.invest, GET.invest and A2EI Launch Global Open-source Data Platform PROSPECT, 2022.
- GET.transform, Energy for Rural Industrialisation Productive Use of Energy 2.0, 2022.
- GIZ, A Report on End user Finance and Payment Systems to Improve Access to Reliable, Sustainable, and Modern Energy Products in Displacement Settings (Uganda), 2021.
- GIZ, Access to Microfinance - Enabling Communities to Purchase Appliances for the Productive Use of Energy, 2023.
- GIZ, Productive Use of Energy (PUE) in the Agricultural Sector, 2024.
- Global Distributors Collective, Productive Use of Renewable Energy (PURE) Distribution Innovation Lab, 2026.
- GOGLA, After the Dip: Off-Grid Solar's Defining Moment, 2025.
- GOGLA, Community of Champions.
- GOGLA, Off-Grid Solar: Powering Climate Resilience, 2025.
- GOGLA, Powering Lives and Livelihoods: Scaling Productive Uses of Renewable Energy, 2023.
- GOGLA, Powering Protection: Navigating Consumer Risks in the PURE Sector, 2025.
- GOGLA, Togo Country Brief, 2024.
- GOGLA, Unlocking Off-Grid Solar: How Results-Based Financing is Driving Energy Access and Powering Productivity, 2023.
- GPA, Transforming Humanitarian Energy Access (THEA), 2023.
- GPOBA, Lessons Learned - Bangladesh Rural Electrification and Renewable Energy Development, 2015.
- GPRBA, Lessons Learned - Accelerating Solar Water Pumping via Innovative Financing in Tanzania, 2025.
- Greencroft Economics, Ex-post Evaluation of the Beyond the Grid Fund for Zambia (BGFZ), 2024.
- Hellqvist, L. and Heubaum, H., Setting the Sun on Off-Grid Solar? : Policy Lessons from the Bangladesh Solar Home Systems (SHS) Programme, 2021.
- Hystra, Market Access for Agro-PURE Companies, 2025.

- I4CE, Using Credit Lines to Foster Green Lending: Opportunities and Challenges, 2017.
- IDA, A Review of the Use of Output-Based Aid Approaches, 2009.
- IEA, IRENA, UNSD, World Bank Group, WHO, Tracking SDG 7: The Energy Progress Report, 2026.
- IFAD, Burundi Value Chain Development Programme Phase II, 2022.
- IFAD, How to Do Public-Private-Producer Partnerships (4Ps) in Agricultural Value Chains, 2016.
- IFAD, Matching Grants: Technical Note, 2012.
- IFAD, Sustainable Inclusion of Smallholders in Agricultural Value Chains, 2015.
- IFAD, Toolkit: Commodity value chain development projects, 2014.
- IFC, Creating Markets in Togo, 2023.
- IFC, Fund Governance Document and Text Information Request List for Funds, 2019.
- IFC, Zafiri Announces USD 176 Million Commercial Launch to Accelerate Energy Access via the Private Sector across Sub-Saharan Africa, 2026.
- IGC, Driving Productive Use of Energy in Fragile Contexts, 2024.
- IGC, Transforming Livelihoods through Scaling Up the Productive Use of Energy, 2025.
- IIED, Productive Uses of Energy for Resilient Livelihoods in LDCs, 2021.
- IWMI, Solar Irrigation in Bangladesh, 2021.
- IWMI/CGIAR, A roadmap and tools for water-energy-food nexus security in South Asia, 2026.
- Jouanjean, M. et al., Issues around Data Governance in the Digital Transformation of Agriculture, 2020.
- Khanna, V., Implementation Challenges of the PM-KUSUM Scheme: Case Studies from Selected Indian States, 2024.
- TFE, Cracking the Code, 2025.
- Lighting Africa/ESMAP, The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Uganda, 2022.
- Lighting Global/ESMAP, Designing Responsible End-User Subsidies for Energy Access, 2024.
- Lighting Global/ESMAP, PPIAF, DDP, The Off-Grid Solar Policy Toolkit, 2024.
- Lighting Global/ESMAP, The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa, 2019.
- MAAIF, A Guide for Financial Institutions, 2020.
- MAAIF, Design, Supply and Installation of Micro-Scale Irrigation Equipment and Related Services, 2023.
- MAAIF, Micro-Scale Irrigation Program: A Guide for Smallholder Farmers, 2020.
- MAAIF, Micro-Scale Irrigation Program: Technical Guidelines, 2022.
- Mercy Corps AgriFin, The Impact of DigiFarm on Smallholder Farmers, 2021.
- Ministry of Energy and Petroleum of Kenya, National Road Map on Scaling Up Productive Use of Renewable Energy, 2023.
- Ministry of Finance, Planning and Economic Development, Uganda, Performance of the Agricultural Credit Facility in Uganda: What are the Trends?, 2019.
- Ministry of Finance, Planning and Economic Development, Uganda, The Agriculture Credit Facility: What is Constraining Its Effective Implementation?, 2013.
- Ministry of New and Renewable Energy of India, PM-KUSUM.
- Ministry of New & Renewable Energy of India, Promoting Decentralised Renewable Energy Livelihood Applications, 2022.
- Mission 300.
- Mission 300, Compacts.
- Mission 300, National Energy Compact for the Kingdom of Lesotho, 2025.
- Mission 300, National Energy Compact for the Republic of Ghana, 2025.
- Mission 300, National Energy Compact for the Republic of Kenya, 2025.
- NREL and Energy 4 Impact, Productive Use of Energy in African Micro-grids, 2018.
- Odyssey, DARES - NEP Legacy Projects, 2026.
- Odyssey, How the Rural Electrification Agency of Nigeria Uses the Odyssey Platform to Bring Distributed Energy to 7M+, 2023.

- Odyssey, Odyssey Selected as Digital Platform for DARES Nigeria: Scaling Clean Energy Access for 17.5 Million Nigerians, 2025.
- OECD, DAC Blended Finance Guidance, 2025.
- Oorja, Oonnati.
- Polastri and Savastano, Results-Based Financing: A Potential Game-Changer for IFAD's Future Operations, 2020.
- Power for All, Utilities 2.0: How Integrated Energy Accelerates Global Access, 2025.
- Powering Agriculture, Navigating Policy and Regulation in the Clean Energy-Agriculture Nexus, 2020.
- Practical Action, Poor People's Energy Outlook 2018: Achieving Inclusive Energy Access At Scale, 2018.
- PREO, PREO's Blended Finance Strategy Sets Tone for Private Capital Investment for Early-Stage Companies In Africa, 2024.
- PREO, Technical Assistance.
- REA, Blueprints for Scale: Embedding Sustainability, Achieving Impact, and Systemic Change in Africa's Next Electrification Frontier, 2026.
- REEEP, Pure Growth Fund Application Guidelines, 2025.
- Revista CANAME, Eco-Business Mass Credit, 2023.
- RMI, Harvesting Sunshine - How Productive Uses of Minigrid Electricity Make Farmers Richer and Energy Cheaper, 2024.
- RMI, Nigerian Businesses, RMI, and the Global Energy Alliance for People and Planet Collaborate to Empower Women and Youth Through Renewable Technology, 2026.
- ROGEAP Project Fund Manager, Context and Objectives.
- Rural Electrification Authority of Zambia, Powering Zambia's Future: Government Launches REMP 2.0, 2026.
- SEforALL, Empowering Consumers to Accelerate 24/7 Carbon-Free Energy, 2023.
- Shell Foundation, Exploring the Potential of Under-researched Productive Uses of Energy, 2025.
- Shell Foundation, Productive Use of Energy Solutions for Microenterprises, 2025.
- SNV, Harvesting the Sun: Challenges and Opportunities in Solar-Powered Agriculture, 2023.
- SNV, Why Localisation Matters for Financing Off-Grid Energy, 2021.
- SokoFresh.
- SunCulture, Improving Accessibility of Productive-Use Solar Products, 2023.
- TEA and Shell Foundation, Results Based Financing for Productive Use Appliances to Promote Gender Outcomes, 2024.
- Tetra Tech, Scaling Productive Use of Energy Solutions in Sub-Saharan Africa, 2023.
- Transforming Energy Access, Odyssey: How Digital Financing is Enabling the Epic Journey to Universal Energy Access, 2026.
- UECCC, Credit Support Facility Manual, 2023.
- UNIDO, Energy Efficiency for Sustainable Livelihoods in Africa (EELA) - Regional Project, 2024.
- van der Lee, J., Building Rural Income through Inclusive Dairy Growth in Ethiopia (BRIDGE), 2026.
- VeraSol, Appliance Testing.
- VeraSol, Appliance Testing Process for the Productive Use Financing Facility, 2025.
- VeraSol, Database.
- VeraSol, Test Methods.
- Wageningen Food & Biobased Research, Postharvest Assessment Methodology, 2022.
- Wageningen University and Research, Postharvest Interventions, Key for Improvement of Food Systems, 2020.
- WE4F, Who We Are.
- WEF-Nexus Decision Support System.
- World Bank Group, Accelerating Sustainable and Clean Energy Access Transformation (Ascent) In Eastern and Southern Africa, 2024.
- World Bank Group, Accelerating the Productive Use of Electricity, 2023.
- World Bank Group, AgriConnect.
- World Bank Group, Falling Short - A Global Survey of Electricity Tariff Design, 2020.
- World Bank Group, How Can Matching Grants in Agriculture Facilitate Access to Finance?, 2019.

- World Bank Group, Implementation Completion and Results Report - Accelerating Solar Water Pumping via Innovative Financing, 2023.
- World Bank Group, Implementation Completion and Results Report - Chhattisgarh District Rural Poverty Project, 2011.
- World Bank Group, Implementation Completion and Results Report - Grant to the Republic of India, 2019.
- World Bank Group, Implementation Completion and Results Report - Niger Solar Electricity Access Project, 2025.
- World Bank Group, Implementation Completion and Results Report - Rural Electrification and Renewable Energy Development II, 2024.
- World Bank Group, Implementation Completion Report (ICR) Review - Niger Solar Electricity Access Project, 2026.
- World Bank Group, Jobs For A Livable Planet, 2023.
- World Bank Group, Learning Note on the Design and Rollout of the Uganda Micro-Scale Irrigation Program, 2025.
- World Bank Group, Madagascar: New World Bank Group Program Set to Provide Reliable and Affordable Energy to Over 2.5 Million People by 2030, 2026.
- World Bank Group, Project Appraisal Document - Distributed Access through Renewable Energy Scale-Up Project, 2023.
- World Bank Group, Project Appraisal Document - Grants to the Republic of Uganda, 2022.
- World Bank Group, Project Appraisal Document - Integrated Risk Management in the Rural Agroindustrial System Project (Girsar), 2018.
- World Bank Group, Project Information Document - Regional Program for Distributed Access Through Renewable Energy Solutions, 2026.
- World Bank Group, Project Paper - Rural Electrification and Renewable Energy Development II, 2014.
- World Bank Group, Project Paper, Report No. PPIAF000012 (Regional Off-Grid Electricity Access Project, P160708), 2025.
- World Bank Group, Project Performance Assessment Report - Peru Rural Electrification Project, 2017.
- World Bank Group, Project Restructuring Paper - Republic of Uganda, 2025.
- World Bank Group, Promoting Productive Uses of Electricity in Rural Areas of Peru, 2012.
- World Bank Group, Promoting Productive Uses of Electricity in Rural Electrification Programs, 2017.
- World Bank Group, Raising Rural Productive Uses of Electricity, 2021.
- World Bank Group, Reaching the Full Potential of Standards with Quality Infrastructure, 2025.
- World Bank Group, Republic of Kazakhstan - Financial Sector Assessment, 2024.
- World Bank Group, Roadmap for the Implementation of Energy Efficiency in Public Buildings of the Kyrgyz Republic, 2019.
- World Bank Group, Solar-Powered Pumps Reduce Irrigation Costs in Bangladesh, 2015.
- World Bank Group, The Farmer-Led Irrigation Development Guide, 2021.
- World Bank Group, Water Forward.
- World Bank Group, Working with Smallholders: A Handbook for Firms Building Sustainable Supply Chains, 2013.
- World Bank Group/Dalberg, Off-Grid Solar Market Trends Report, 2026.
- World Resources Institute, How Local Banks Can Unlock Africa's Clean Energy Future, 2024.
- WWF and Open Capital Advisors, Cold Chain for Ocean Communities: A Playbook for Project Developers and Investors, available as of late 2026.
- Yashodha et al., Solar Irrigation in India, 2021.
- Zambia Agribusiness & Trade Project II.

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