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REPORT

SUSTAINABLE ENERGY FOR SCHOOLS AND HEALTH CENTERS:

PUBLIC–PRIVATE PARTNERSHIPS FOR PEOPLE'S PROSPERITY

WORLD BANK GROUP

ESMAP
Energy Sector Management Assistance Program

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About ESMAP

The Energy Sector Management Assistance Program (ESMAP) is a partnership between the World Bank and over 20 partners to help low- and middle-income countries reduce poverty and boost growth through sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector. Through the World Bank Group (WBG), ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable, and modern energy for all. It helps to shape WBG strategies and programs to achieve the WBG Climate Change Action Plan targets. Learn more at: https://esmap.org

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Abbreviations

5P	Public-Private Partnership for People's Prosperity
AC	alternating current
AfDB	African Development Bank
ASCENT	Accelerating Sustainable and Clean Energy Transitions
CAPEX	capital expenditures
DARES	Distributed Access through Renewable Energy Scale-up
DC	direct current
DECIM	Digital and Energy Connectivity for Inclusion in Madagascar
DFI	development finance institution
DOD	depth of discharge
DRE	distributed renewable energy
Ea	available energy
EaaS	energy-as-a-service
EASP	Electricity Access Scale-Up Project
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EPC	Engineering, Procurement, and Construction
ERT	Energy for Rural Transformation
ESA	energy service agreement
ESCO	energy service company
ESMAP	Energy Sector Management Assistance Program
FCV	fragility, conflict, and violence
GEP	Global Electrification Platform
GHO	Global Health Observatory
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOGLA	Global Off-Grid Lighting Association
GSM	global system for mobile communications
ICT	information and communications technology
IFC	International Finance Corporation
IPP	independent power producer
KPI	key performance indicator
LESSAP	Liberia Electricity Sector Strengthening and Access Project
MIGA	Multilateral Investment Guarantee Agency
MoH	Ministry of Health
MTF	Multi-Tier Framework
NEP	National Electrification Plan
O&M	operations and maintenance
OGS	off-grid solar
OPEX	operational expenditures

PPP	public-private partnership
PV	photovoltaic
QA	quality assurance
RBF	results-based financing
RREA	Rural and Renewable Energy Agency of Liberia
ROGEAP	Regional Off-Grid Electricity Access Project
SDD	solar direct drive
SDG	Sustainable Development Goal
SEforALL	Sustainable Energy for All
SIDS	small island developing states
SMEs	small and medium enterprises
SWF	Sovereign Wealth Fund
UECCC	Uganda Energy Credit Capitalization Company
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNOPS	United Nations Office for Program Operations
USAID	United States Agency for International Development
WASH	water, sanitation, and hygiene
WHO	World Health Organization

All currency is in United States dollars (US$) unless otherwise indicated.

Key Definitions

Capital Expenditure (CAPEX)	Costs associated with the procurement, transportation, and installation of infrastructure such as solar photovoltaic (PV) systems, battery storage, inverters, and other required equipment. These typically require significant upfront costs, especially in remote or off-grid areas.
Energy-as-a-Service	Service delivery model widely used in the energy sector. In this business model, a third-party service provider installs, operates, and maintains an energy system, such as an off-grid solar solution, while end-users (for example, households, businesses, or public institutions) pay for the energy consumed or for service access over time.
EPC Approach	Under the EPC (Engineering, Procurement, and Construction) approach, the government or a donor finances the full upfront cost of the electrification system (for example, a solar PV installation for a school or health center). A private company is contracted to design, procure, and install the system, handing it over once construction is complete. The institution or the beneficiary ministry then owns the system and is responsible for operations, maintenance, and replacement over time. While EPC ensures quick deployment and full ownership by the public sector, challenges often arise around long-term sustainability, since the local institution may lack the budget, capacity, or technical expertise to maintain the system once warranties expire.
Genset (Diesel Generator)	A self-contained electricity generation unit powered by diesel fuel, often used in remote or off-grid areas. While deployable quickly, gensets present challenges such as high fuel costs, noise, pollution, and poor reliability.
Integrated Electrification Planning	A government strategy that explicitly integrates grid, off-grid, and other renewable energy solutions to expand energy access. Beyond households, integrated electrification planning can also include electrification of public institutions.
Key Performance Indicators (KPIs)	Structured metrics (for example, system uptime, energy availability) used to track and enforce performance over long-term energy service contracts.
Mini Grid	A low- or medium-voltage distribution grid that receives electricity from one or more small generators and supplies electricity to a target group of consumers. It is typically located near the loads that it serves. A mini grid can be fully isolated from the national grid or interconnected with it.

Mission 300	A joint initiative launched in 2024 by the World Bank Group and the African Development Bank to connect 300 million people living in Sub-Saharan Africa to electricity by 2030, with a strong focus on electrifying schools, health centers, and local infrastructure alongside households.
Off-Grid Solar System	A standalone solar PV system, often paired with batteries, that provides electricity to institutions, households, small businesses, or communities not connected to the national grid.
Operational Expenditure (OPEX)	Costs associated with Operations and Maintenance (below).
Operations and Maintenance (O&M)	The ongoing activities required to ensure that a system functions reliably over time, including routine servicing, repairs, and replacement of components.
Public Institutions	Entities established or controlled by the central or local government that deliver public services like education, health, or other community benefits. Public institutions can include schools, health centers, community centers, government buildings, and more. This report focuses on educational and health facilities.
Public-Private Partnership for People's Prosperity (5Ps)	An inclusive framework designed to benefit the most vulnerable populations by leveraging private investment and expertise in the delivery of infrastructure and services. It explicitly recognizes that public and donor capital must be used to close affordability gaps and ensure that service reaches and sustains those most in need.
Results-Based Financing (RBF)	A range of financing mechanisms in which payments or financial or other rewards are given only after the achievement and independent verification of pre-agreed results. These results can be outputs, intermediate outcomes, or final outcomes.
SDG7	United Nations Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all.
Service Delivery Model (or Service-Based Model)	A structured approach to providing essential goods or services—such as electricity, water, health care, or education—through ongoing, performance-based arrangements rather than one-off interventions. Under this model, specialized providers deliver services over time, while users, governments, or donors ensure predictable funding or payments linked to results. In the energy sector—particularly for off-grid solar systems—such a model is referred to as "energy-as-a-service" (see above).

Foreword

Over more than twenty years, ESMAP has played a pioneering role in advancing off-grid solar solutions. This includes the landmark Lighting Africa initiative, launched in 2008, which catalyzed the off-grid solar market by supporting innovation, quality standards, and market development. Lighting Africa's success inspired similar programs across Asia and other regions.

ESMAP's sustained focus on off-grid solar solutions has been instrumental in laying the foundation for the World Bank Group's Mission 300, which aims to provide 300 million people with access to electricity. ESMAP now continues to play a pivotal role in advancing Mission 300 by providing substantial financial support as well as comprehensive technical assistance. So far, these efforts have led to the creation of 30 National Energy Compacts across Africa, and, as of March 2026, the connections of nearly 40 million people.

This report provides an important tool for the implementers of Mission 300. It points to a critical challenge in the electrification of schools and health centers that are not connected to the grid. While solar systems bring a remarkable change to these public institutions – allowing them to use electric equipment, to operate for longer hours - the installation of solar panels alone is not enough. Like all infrastructure, solar systems require ongoing maintenance: cleaning panels, replacing batteries, and monitoring performance.

The report finds that too often, this burden falls on local schools or clinics with limited expertise and shrinking budgets. This leads to systems break down and undermines the reliability of the electricity connections.

To truly deliver sustainable electricity, a new approach is needed: a Public-Private Partnerships for People's Prosperity (5P) framework offers a practical solution. This means contracts between governments and private solar provides which include maintenance and service into long-term agreements. Instead of simply buying equipment, public authorities procure reliable electricity as a service—leveraging scarce public resources to attract private capital.

This is the kind of actionable expertise that ESMAP provides to advance Mission 300. Reliable electricity is the cornerstone of development. The education and well-being of the 1.2 billion young people preparing to join the workforce are built on modern infrastructure. Access to dependable energy drives the creation of more—and better—jobs. By working together through partnerships, fostering innovation, and prioritizing sustainable approaches, we can seize this opportunity.

Fanny Missfeldt-Ringius
Manager
Energy Sector Management Assistance Program

Key Findings

1. **Electrifying public institutions is a high-impact investment in human capital, yet progress remains far too slow.** Reliable electricity for schools and health facilities is foundational for delivering quality education and healthcare. Still, nearly 1 billion people depend on unelectrified health facilities, and thousands of schools operate without power. Funding remains deeply insufficient: annual spending of roughly $120 million falls far short of the estimated $2.4 billion required by 2030 for facilities best served by off-grid solar solutions. Persistent data gaps further obscure needs and hinder effective planning.

2. **The primary barrier is not technology—it is sustainability.** Most electrification programs rely on Engineering, Procurement, and Construction (EPC) approaches that finance one-time solar installations without ensuring long-term maintenance, replacement, or performance. As seen in many countries, systems frequently fail due to the absence of maintenance budgets and accountability mechanisms. This "install-and-forget" cycle wastes public investment and undermines service delivery.

3. **The Public-Private Partnerships for People's Prosperity (5P) framework offers a pathway to ensure reliable electricity for public institutions through service-based models enabled by the private sector.** Electrification programs must shift from asset procurement to service delivery. Long-term contracts with energy service companies—linked to measurable KPIs and supported by remote monitoring—align incentives toward system performance and reliability. With recent advances in solar technology, battery storage, and digital monitoring, multiple institutions can be bundled into scalable contracts that attract private investment while ensuring sustained service.

4. **Closing the affordability gap requires blending public finance with private investment.** Schools and health facilities—and their line ministries—cannot cover the full commercial cost of electrification. The 5P framework demonstrates how predictable, long-term public funding, combined with donor support through subsidies, concessional finance, and guarantees, can make service contracts bankable. This approach can crowd in private investment while protecting public budgets.

5. **Sustainable electrification of public institutions is a cross-sectoral development priority.** Reliable electricity enables vaccine storage, digital learning, water pumping, connectivity, and the productive use of energy. Electrifying schools and health facilities therefore advances SDG targets across energy, health, education, and economic development. Achieving scale will require strong cross-sector collaboration among energy, health, education, and digital ministries.

Executive Summary

Around the world, patients receive care in health centers where medical equipment cannot be used due to lack of electricity, and children study in classrooms without light or digital connectivity. This silent crisis affects hundreds of millions, undermining health care, education, and human potential in the very places where it is needed most.

Despite years of investment in electrification of public institutions, progress remains far too slow: nearly 1 billion people still depend on unelectrified health facilities, and thousands of schools continue to operate in the dark. Funding remains deeply inadequate: annual spending of about $120 million falls far short of the $2.4 billion needed by 2030 to electrify public facilities best served by off-grid solar (OGS) solutions. Reliable country-level data on electrification status and needs are also scarce and fragmented.

The largest barrier, however, is sustainability. Donor- and government-funded projects typically use an Engineering, Procurement, and Construction (EPC) approach, which emphasizes one-time solar system installations, leaving no resources or incentives for repairs, servicing, or component replacement. Governments rarely allocate sufficient budgets for maintenance, leading to premature system failures and wasted reinvestments.

Closing the electrification gap requires a fundamental shift: from one-off installations to service-based, performance-driven models, which ensure long-term, reliable electricity services.

A service-based model is the most common structure used for delivering essential services such as electricity, water, and internet. Instead of purchasing infrastructure, customers pay predictable recurring fees to access services. While this model is widely applied to deliver electricity through grid or mini grid networks worldwide, its application has been limited for dispersed rural customers with low electricity demand, including public institutions, due to the lack of economies of scale. With recent innovations in solar, battery, digital connectivity, and remote monitoring technologies, many public institutions can be bundled under one service-based contract to provide the needed economies of scale— service delivery models could significantly improve the reliability of electricity services to public institution. However, a structural barrier still prevents its adoption: the affordability gap, where schools and health centers in developing countries—and even their line ministries—cannot cover full commercial costs, due to severe budget constraints. This challenge is compounded by a broader financing gap: even public funds and donor resources combined are insufficient to achieve universal electrification, and private sector investment is needed to bridge the shortfall.

The 5P framework—Public–Private Partnerships for People's Prosperity—addresses the critical gaps needed to scale service delivery models in underserved contexts.

Under the 5P framework, true success means providing ongoing, reliable service—not just delivering systems—to the poorest people. This framework combines the principles of service delivery models with lessons learned from other proven approaches such as public-private partnerships (PPPs), where governments enter long-term contracts with private providers that assume substantial risks and management responsibilities, with compensation tied to performance. The 5P also incorporates learnings from results-based financing (RBF), which fulfills incentives only upon verification of pre-agreed results in order to address the affordability gap while working with private sector players.

These institutional elements create the foundation for the two building blocks of the 5P model. First, the 5P model prioritizes sustained service delivery over asset deployment. This is achieved through clear, long-term service contracts between a public sector client—typically a line ministry or agency overseeing schools and health centers—and a private operator (an energy service company, or ESCO) responsible for delivering reliable electricity services in line with trackable key performance indicators (KPIs), measured through remote monitoring and standardized quality assurance. Second, the 5P model mobilizes public and concessional finance to crowd in private investment. Predictable, performance-linked payments from a line ministry or relevant agency would make these schemes bankable, as they would provide the revenue stability that ESCOs need to invest in OGS systems to electrify many public schools and health centers and recover investment costs over time.

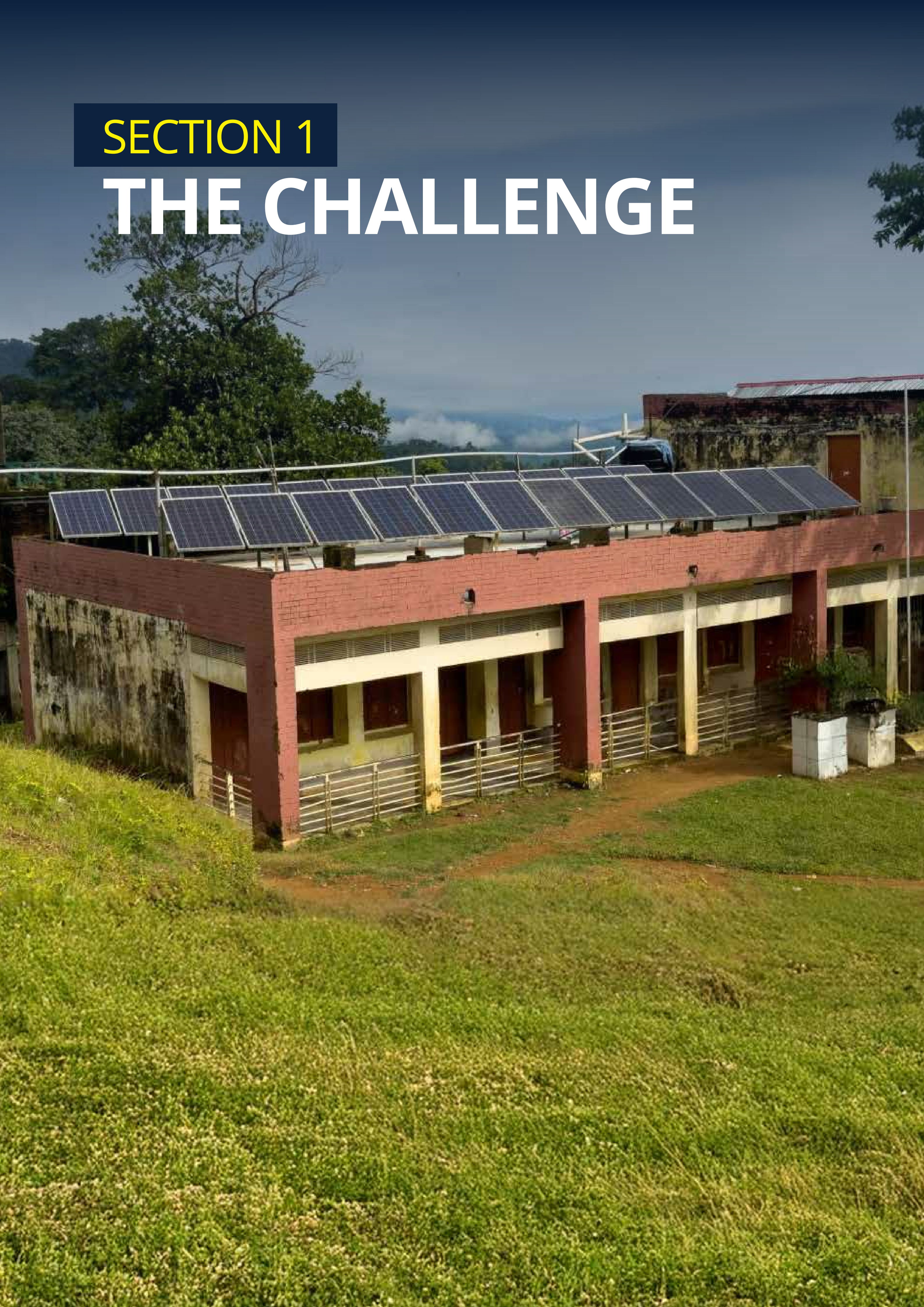
Development partners play a key role by cofinancing subsidies, providing concessional lending and guarantees, and strengthening contract management. Even where full 5P models are not yet feasible, countries can take transitional steps—such as long-term operations and maintenance (O&M) contracts and capacity building—that lay the foundation for sustainable electricity service delivery.

The 5P framework calls for a redefined role for governments and development partners. Instead of focusing on installing solar systems, governments and development partners need to strengthen public sector capacity to tender and manage long-term service contracts. They can also help standardize tools, quality assurance frameworks, and KPI monitoring platforms, reducing transaction costs and making contracts replicable at scale. In addition, they can derisk transactions by providing grants, concessional financing, and guarantees, which ultimately increase the fiscal space of governments and reduce their financial burden. The annex to this report provides a seven-step toolkit for governments and partners to use to design projects aligned with the 5P, drawing lessons from early pilots in Benin, Madagascar, Nigeria, and Uganda. By shifting incentives toward durability and performance, governments, donors, and private providers can move from delivering systems to delivering lasting, high-impact energy access for the least-served communities.

This report presents a framework and practical guidance for sustainably electrifying public institutions—especially schools and health centers—through service-based public-private partnership models that ensure reliable, long-term energy access and mobilize both public and private resources for human capital development. The approach has shown early results in Sub-Saharan Africa and is applicable to underserved and remote regions worldwide, including Small Island Developing States (SIDS) in East Asia and the Pacific and regions such as the Amazon basin in Latin America and the Caribbean.

SECTION 1

THE CHALLENGE



1 THE ROLE OF OFF-GRID SOLAR ENERGY IN ELECTRIFYING PUBLIC INSTITUTIONS

KEY TAKEAWAYS

- Nearly **1 billion people** rely on unelectrified health facilities, and one in four primary schools worldwide lacks electricity, especially in Sub-Saharan Africa and South Asia.
- Off-grid solar (OGS) is the **least-cost solution** for most unelectrified institutions, but sustainability—particularly long-term maintenance—remains a persistent challenge.
- Current financing is deeply inadequate, with only **about $120 million annually available** against an estimated **$2.4 billion needed by 2030**.
- **A new approach is required:** sustainable, performance-based models that ensure reliable, long-term electricity access for schools and health centers.

Governments and donors have collaborated for decades to improve the delivery of health care and education in developing countries. Access to energy has been at the forefront of these efforts.

> In this report, **public institutions** are defined as entities established or controlled by the central or local government that deliver public services like education, health care, or other community benefits.

Electricity is, in fact, a **key enabler** for public institutions to improve health and educational outcomes.

In **health centers,** electricity enables sometimes life-saving care. Electricity powers vital equipment, communication systems, refrigeration, and lighting, supporting everything from disease surveillance to disaster resilience. For example, in Zambia, electrified health centers halved the malaria detection time (World Health Organization, 2022). Rural clinics in Cuba with solar power saw reduced infant mortality; in contrast, women giving birth in unelectrified facilities in Uganda are 39 times more likely to die than those treated in health facilities with electricity (GVEP International, 2013) (WHO, World Bank, SEfor ALL, and Renewable Energy Agency 2023). Better health outcomes also strengthen economic growth—recent evidence suggests that in Uganda, each additional year of life expectancy corresponds to an average 2.4 percent increase in economic growth (Ridhwan et al. 2022).

In **schools,** electricity supports lighting, digital learning, and cooling, which becomes increasingly vital as climate impacts grow. In Ghana, electrified districts had student pass rates 30–40 percent higher than in districts without electricity (Adamba, 2018); in Nepal, electrification raised girls' enrollment by 23 percent (Gurung, 2011). Electrified schools often remain open past daylight, enabling evening programs such as adult literacy, vocational training, community meetings, and health outreach. In Rwanda, one-third of electrified schools offered formal evening classes after 6 p.m., while none of the unelectrified schools could (Lenz and Munyehirwe 2015). Electricity also powers Water, Sanitation, and Hygiene (WASH) services, improves safety, and helps attract and retain staff in underserved communities. For example, outdoor solar lighting in Ugandan refugee camps reduced violence and increased nighttime activity (WHO 2025d; UNHCR 2017).

Yet today, far too many schools and health centers still have no access to electricity, and when electricity is provided, it is often unreliable, insufficient, or both. While data on this topic are generally limited (see Chapter 2 for more details), it is estimated that **64 percent of health facilities** in low- and lower-middle-income countries require either a new electricity connection or a backup power system to address unreliable energy infrastructure (WHO, World Bank, SE4ALL, and IRENA 2023).[1] The same report finds that roughly **1 billion people** in these countries rely on health facilities that have no electricity at all or lack a dependable supply. Likewise, approximately **25 percent of all primary schools** globally have no access to electricity, with the largest access challenges present in Southeast Asia and Sub-Saharan Africa. Box 1.1 provides relevant granular data.

BOX 1.1

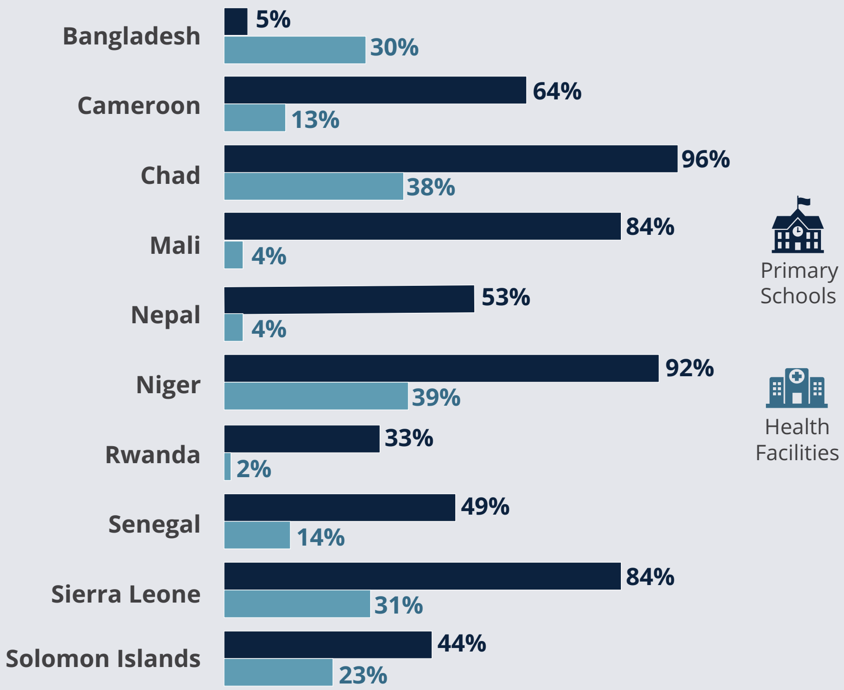
ACCESS TO ELECTRICITY FOR SCHOOLS AND HEALTH FACILITIES IN SELECTED COUNTRIES

Figure 1.1 compares access for both primary schools and health facilities in 10 countries in Sub-Saharan Africa and South Asia. In the sampled countries, a higher share of schools lacks electricity compared to health centers, suggesting a disparity in infrastructure development between the education and health sectors.

Countries like Chad, Mali, Sierra Leone, and Niger fare the worst, with over 80–95 percent of primary schools remaining unelectrified. Even in countries such as Senegal and the Solomon Islands, nearly half of all schools lack access to electricity.

The data presented in this box reflect the tendency for governments, donors, and charities to prioritize health facilities over schools in electrification efforts.

FIGURE 1.1 Percentage of Primary Schools and Health Facilities with no Access to Electricity in Selected Countries



Note: Data collection years are as follows: Primary schools (UNESCO). 2017: Mali; 2019: Solomon Islands; 2020: Sierra Leone; 2021: Rwanda; 2022: Bangladesh, Cameroon, Chad, Senegal; 2021: Nepal, Niger.

Sources: (United Nations Educational, Scientific and Cultural Organization 2025; WHO, World Bank, SEforALL, and IRENA 2023

This disparity is especially pronounced in remote areas. In these contexts, bringing electricity by extending the national grid to build new power lines is often too expensive and time-consuming. Alternative solutions like mini grids, which are small, standalone power systems that supply electricity to a local area, can also face high setup costs and logistical hurdles. These technologies require significant planning, infrastructure, and investment, which can delay electrification in hard-to-reach regions. As a result, public institutions in these areas may remain without reliable power for years, limiting access to essential services like health care and education.

For the reasons outlined above, public institutions in remote areas have traditionally relied on **diesel generators (gensets)** as their primary source of electricity. These generators can be deployed quickly and operate independently of the national grid. However, this solution comes with significant challenges: high and volatile fuel costs, frequent supply chain disruptions, demanding maintenance needs, disruptive noise and fumes, and poor reliability. These issues often result in costly, intermittent power that undermines the delivery of essential services.

Today, the declining costs of solar photovoltaic (PV) systems and battery storage have made **off-grid solar (OGS) systems** a transformative and increasingly cost-effective solution for delivering electricity to underserved populations, especially in remote and rural areas. OGS systems are decentralized energy solutions that harness solar power independently of the central electricity grid. For isolated public institutions such as rural schools and health centers, OGS provides a fast, affordable, and clean alternative to conventional approaches.

OGS has a critical role to play for the universal electrification of public institutions. Estimates show that OGS solutions represent the fastest, least-cost technology choice for electrifying around **700,000 schools and 60,000 health facilities** currently not served by grid or mini grid solutions (ESMAP, GOGLA, and Dalberg 2024).[2] Similarly, a World Health Organization (WHO) joint report estimates that OGS represents the least-cost solution for connecting 35 percent of the unelectrified health institutions globally—45 percent in Sub-Saharan Africa due to the limited grid coverage in the region (WHO, World Bank, SEforALL, and IRENA 2023). The same report shows that 223,000 health facilities were estimated to need a backup system due to unreliable electricity.

However, even OGS systems pose a critical, persistent challenge: ensuring the **long-term performance** of the systems installed. Many OGS projects for public institutions face difficulties in sustaining operations and maintenance (O&M) over the project cycle, often leaving beneficiaries in the dark shortly after OGS system installation.

This report calls for a **mindset shift**, recognizing that electricity access for public institutions must go together with assured, long-term, sustainable O&M. Based on lessons learned, it outlines targeted actions for all stakeholders involved to ensure resilient, lasting energy access.is depicted in Figure 2.3. Transmission planning involves identifying the most suitable network expansions and/or reinforcements based on predefined criteria. The costs of these expansions and reinforcements must be covered by those who require these assets ("causer") and/or benefit from them, linking network planning closely with cost allocation. Various business models may be available for investors to finance grid expansion projects, with cost recovery mechanisms being a key part of these models and directly related to regulation and cost allocation methods.

1.1 A CLOSER LOOK AT THE FUNDING GAP

As seen above, despite growing recognition of the critical role that electricity plays in improving education and health outcomes, the existing efforts to electrify schools and health centers are missing the mark, and the dedicated **funding remains deeply inadequate.**

Public budgets in many low- and lower-middle-income countries are constrained, with limited fiscal space to fund large-scale infrastructure investments or even to face recurring, low-ticket energy costs. Ministries of Health and Education often face competing demands for scarce resources, such as teacher and health worker salaries, medicines, learning materials, and building maintenance, leaving little room to invest in energy infrastructure.

Even when national commitments to public infrastructure electrification exist, **budget allocations rarely reflec**t the true scale of the need. Capital expenditures (CAPEX) for installing solar PV systems, battery storage, inverters, and the required equipment—particularly in remote or off-grid areas—can be significant. Operational expenditures (OPEX) are even more frequently overlooked, with few governments setting aside dedicated funds for system servicing, repairs, or equipment replacement.

Development partners and donors have played a critical role in filling this financing gap through grants, technical assistance, and concessional lending. For instance, efforts like **Mission 300**, jointly established and led by the World Bank Group and the African Development Bank (AfDB), are raising significant financing and are building momentum toward electrification in Sub-Saharan Africa (Box 1.2).

BOX 1.2

MISSION 300 AND THE ELECTRIFICATION OF SCHOOLS AND HEALTH FACILITIES

Contribution by Jem Porcaro, Senior Energy Partnership Specialist, the World Bank

Mission 300 is an ambitious effort to bring electricity to 300 million Africans by 2030. Launched in 2024 by the World Bank Group and the African Development Bank, Mission 300 aims to accelerate access to reliable and affordable electricity in Sub-Saharan Africa, with a particular focus on increasing grid and off-grid connections for people currently underserved by national power systems.

In addition to residential connections, the World Bank Group and the AfDB also aim to extend electricity access to businesses, schools, and health facilities, including productive uses of energy for agriculture and food processing, which are crucial for jobs and economic growth. The supply of electricity to these new connections relies on Mission 300's broader support for generation, transmission, regional interconnection, sector reform, and crowding in private sector investment to ensure the quality, reliability, and affordability of the power supply.

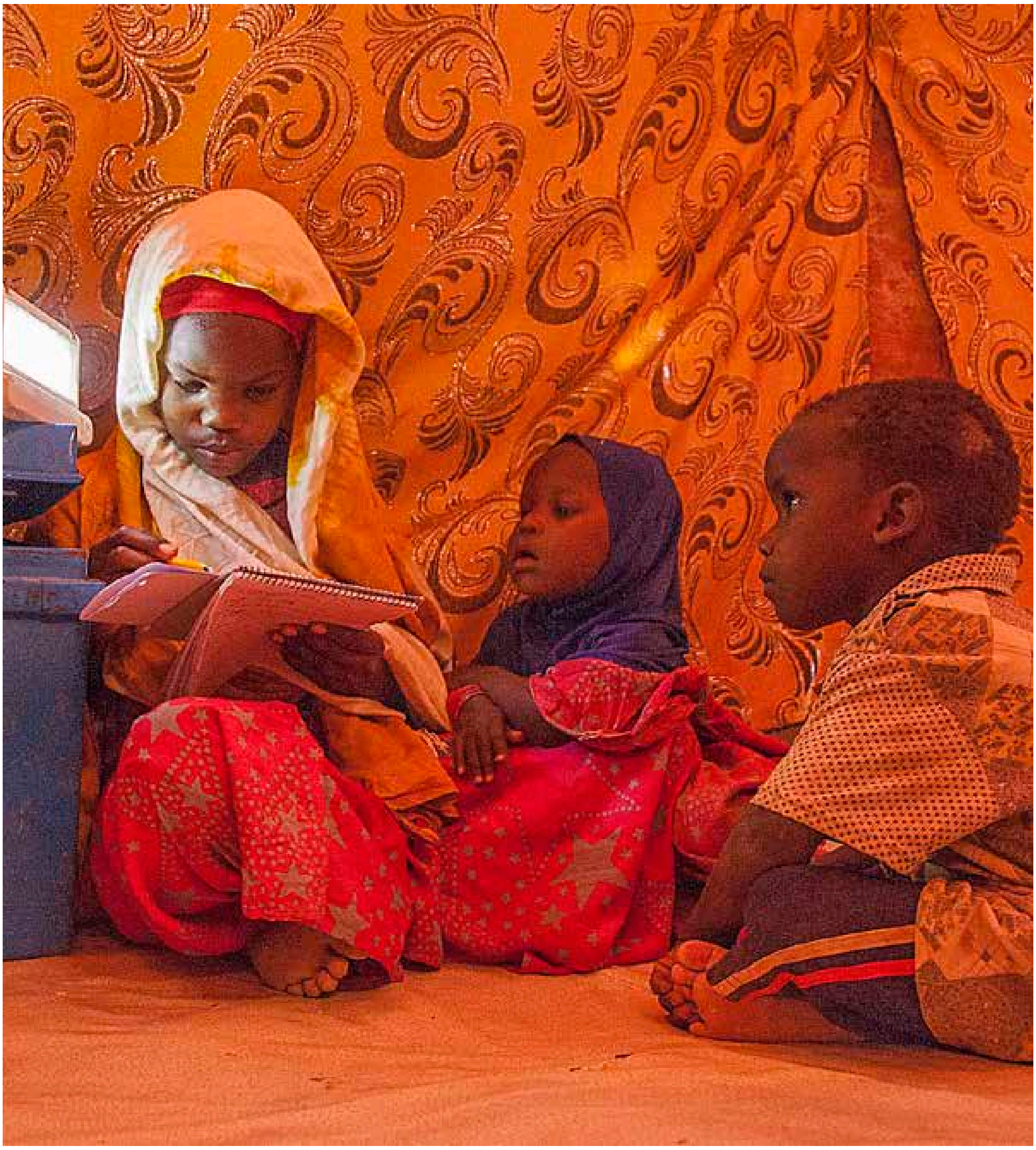
In this way, Mission 300 is helping shape a more integrated approach to electrification that goes beyond household access to also support critical public institutions, thereby contributing to improved educational and health outcomes in partner countries.

However, donor funding is often project-based and fragmented across geographies and sectors. Many electrification programs for public institutions are limited to pilot initiatives or short-term interventions, which lack the scale and sustainability required to achieve universal access. Donor coordination with national governments is also inconsistent, leading to parallel systems of implementation and limited opportunities for cost efficiencies or systemic reform. Moreover, donor funding is primarily focused on covering upfront capital costs, with little attention given to long-term O&M. As a result, many systems fall into disrepair, undermining the sustainability of the investments and the delivery of essential services they were meant to support.

Achieving universal access to electricity for schools and health facilities through OGS requires a **significant increase in both public and private investment.** Since 2018, at least **75,000 OGS systems** are estimated to have been sold for use in social infrastructure, reflecting steady but limited progress (ESMAP, GOGLA, and Dalberg 2024).

Current investment trends—estimated at **$120 million** annually and mostly provided by donors—will be sufficient to electrify r**oughly 250,000 institutions** between now and 2030 (ESMAP, GOGLA, Dalberg, 2024). However, this would only address a small fraction of the **estimated $2.4 billion** required to serve the **760,000 schools and health centers** currently lacking electricity that would best be connected via off-grid solar solutions (ESMAP, GOGLA, and Dalberg 2024).

New approaches that leverage additional resources cover not only CAPEX but also OPEX, and that focus on performance must be explored. Such approaches are presented in Part II of this report, while the next chapters further outline the challenges posed by current approaches.



2. THE DATA GAP

KEY TAKEAWAYS

- Planning electrification of schools and health facilities is hampered by **scarce, fragmented, and outdated data**, especially in Sub-Saharan Africa.
- **Critical gaps** include geospatial mapping, electricity access status, unreliable cost and financing data, and poor coordination across ministries and partners.
- **Closing these data gaps is essential** for efficient investment, and it requires stronger national systems and coordinated international support.

The evidence provided in Chapter 1 shows that a vast number of schools and health centers globally, and particularly in Sub-Saharan Africa, receive **no access to electricity**. It also shows that **significant funding is required** from both the public and private sectors to achieve universal electrification of public institutions.

Reliable data are critical to achieving these goals. Notwithstanding, there is a widespread **lack of granular, updated, and reliable country-level data** on the status of electrification and the electricity needs of public institutions, which hinders efforts at scale.

The data scarcity challenge is thus manifold. Four critical gaps stand out.

First, in many countries, **geospatial data on the location** of these institutions is incomplete, outdated, or totally absent. Even when facilities are mapped, their electricity access status is often missing or inconsistent. This includes critical information such as whether a facility is connected to the grid or an off-grid solution, the number of service hours per day, and the reliability and quality of the electricity supply.

Accurate data on which public institutions have already been electrified are necessary to target resources and prioritize interventions effectively. Quality data support better decision making, allow for more efficient allocation of funding and faster deployment, and avoid unnecessary duplication of efforts (Box 2.1).

BOX 2.1

COLLECTING DATA TO ELECTRIFY FACILITIES IN LIBERIA

Contribution by Joern Huenteler, Senior Energy Specialist, the World Bank

The implementation of the Liberia Electricity Sector Strengthening and Access Project (LESSAP) Phase 1 showcased **strong collaboration among key stakeholders to collect granular data on public institutions amid limited centralized, up-to-date data availability.**

Beginning in 2021, the Ministry of Health (MoH), the World Bank Health and Energy teams, and the Rural and Renewable Energy Agency (RREA) worked closely to identify priority health facilities for electrification. The MoH promptly nominated candidate facilities, and the World Bank's Health team provided a comprehensive list of health centers already under MoH support. Regular coordination meetings, joint site visits, and collective engagement throughout the tender preparation and contract implementation helped foster cooperation and shared ownership. Additional development partners such as USAID and GIZ also participated actively, contributing to a coordinated effort within the health sector.

Despite the strength of this collaboration, persistent data quality issues emerged as a serious challenge throughout the program. Multiple facility lists, often shared by different stakeholders, were rarely aligned, with inconsistencies in basic details such as facility names or GPS coordinates. Site visits by RREA and implementation contractors often revealed that some facilities already had access to electricity or were otherwise ineligible, despite prior vetting, revealing challenges in coordination and data exchange between local and central government actors.

These gaps reflect broader capacity constraints common in fragile and post-conflict settings, which prevent maintaining centralized and up-to-date registries, particularly for rural and remote areas. The gaps also reflect the decentralized and donor-driven nature of health sector support in many fragile countries, where government agencies themselves are sometimes unaware of projects supporting specific local facilities. Furthermore, information is often collected and shared through informal or project-based channels, which hinders consistency across databases. This fragmented environment means that facility needs shift rapidly, and no single dataset can be relied on as definitive, posing a significant challenge for planning and implementation. **It also raises questions about effective ways to collect and store information and how electrification programs can tap into donor coordination mechanisms to ensure synergy.**

Beyond access status, there is limited information on the **energy needs of the public institutions.** For instance, some institutions may appear to be electrified on paper but have **nonfunctional systems or an inadequate power supply** to meet basic operational needs. Even when facilities are not electrified, there is a lack of clarity about the type of services that each facility could deliver through electricity. Understanding these needs is critical for designing appropriate and sustainable energy solutions. By gathering comprehensive data, stakeholders can better determine the type and size of off-grid solar systems needed, ensuring that systems are not over- or undersized, and proceed at scale.

> Each type of facility has **power requirements** based on its size, purpose, and operational hours. For example, a health center may need a reliable supply of electricity for refrigeration of vaccines, medical equipment, and lighting for night shifts, while a school may prioritize lighting, internet access, and computer charging.

Electrifying at scale requires readily available data on the power needs of the facilities to electrify, in addition to their location and access state.

Another key data gap lies in understanding the cost of **electrifying public institutions.** CAPEX estimates vary widely by country and facility type, and OPEX needs are often underestimated or excluded altogether. This lack of standardized cost data hinders effective budget planning and investment mobilization. At the same time, there is little insight into existing financing flows—whether public, donor, or private sector—to understand how much funding is reaching these sectors and where additional resources are most needed.

Finally, **data fragmentation and poor coordination between sectors** further exacerbate these gaps. Ministries of energy, health, and education often collect data independently, using different formats and standards. As a result, datasets are not interoperable or shared systematically across institutions or with development partners. This siloed approach undermines integrated planning and slows progress toward universal, sustainable electrification of public institutions.

A few international organizations have developed **centralized databases** that aggregate publicly available data, including datasets collected by national authorities. These platforms are useful, as they provide a convenient one-stop source, reducing the need to search for data country by country. However, they are ultimately limited by the quality and availability of the original data they compile. As such, they serve as illustrative examples of the data scarcity and incompleteness presented above.

In the **health sector**, WHO's Global Health Observatory (GHO) is one of the key available sources. The database summarizes data from national health facility assessments, surveys, and reports on the electrification status of health facilities, capturing whether they report no access to any electricity, unreliable access, or reliable access to electricity (WHO 2025c). Figure 2.1, which shows GHO data in a joint WHO publication, indicates the percentage of countries reporting no access to electricity. As shown in the figure, **only 16, or 43 percent, of low-income and middle-income countries in Sub-Saharan Africa have available data** on access to electricity for health care facilities. Moreover, the data provided are not without issues: much of the available information is outdated or incomplete, and does not include information on system adequacy for facility needs (WHO, World Bank, SEfor ALL, and IRENA 2023).

Electricity access data for **schools** also present challenges. The most comprehensive data in this space dates to 2021 and is compiled by UNESCO's Institute for Statistics. In this extensive database, **only 21 countries in Sub-Saharan Africa** reported the rate of access to electricity for primary, middle secondary, and upper secondary schools since 2022 or later (United Nations Educational, Scientific and Cultural Organization, 2025). In this case as well, data are often incomplete and are not nuanced enough to cover the energy needs of the facilities.

These persistent data gaps underscore how difficult it is to plan, finance, and implement electrification efforts at scale without reliable, granular information. Incomplete or outdated data can lead to inefficient investments, misallocation of resources, and limited impact on service delivery. Closing the data gap is therefore a foundational step toward building effective, scalable, and sustainable electrification programs. Key strategies to help countries and development partners strengthen data collection and management systems, enabling more targeted, efficient, and results-driven action, as outlined in Part II.


COMPREHENSIVE PRIMARY HEALTH CARE CENTRE
GIDAN MANGORO
USAID
Albishirin Ku!

3. LIMITATIONS OF CURRENT ELECTRIFICATION PRACTICES

KEY TAKEAWAYS

- Most donor- and government-financed projects follow the Engineering, Procurement, and Construction (EPC) approach, where systems are procured and installed, with **limited or no allocation for recurrent costs** such as servicing, repairs, or component replacement, which are left to beneficiary governments and public institutions.
- Once systems are handed over, EPC contractors have no incentive to ensure continued functionality, and **governments often lack the budgetary flexibility to cover ongoing costs.**
- As a result, **many systems fail within only a few years**, forcing repeated reinvestments and leaving schools and health facilities without reliable electricity.
- This cycle leads to **inefficiencies, wasted resources, and limited development impact** despite significant upfront spending.
- While in some contexts, such as those affected by fragility, conflict, and violence (FCV), EPC and **public–sector-driven approaches may be necessary**, the tradeoffs are significant. Without private sector leverage, electrification will rely entirely on public funding, while its implementation challenges will be compounded.

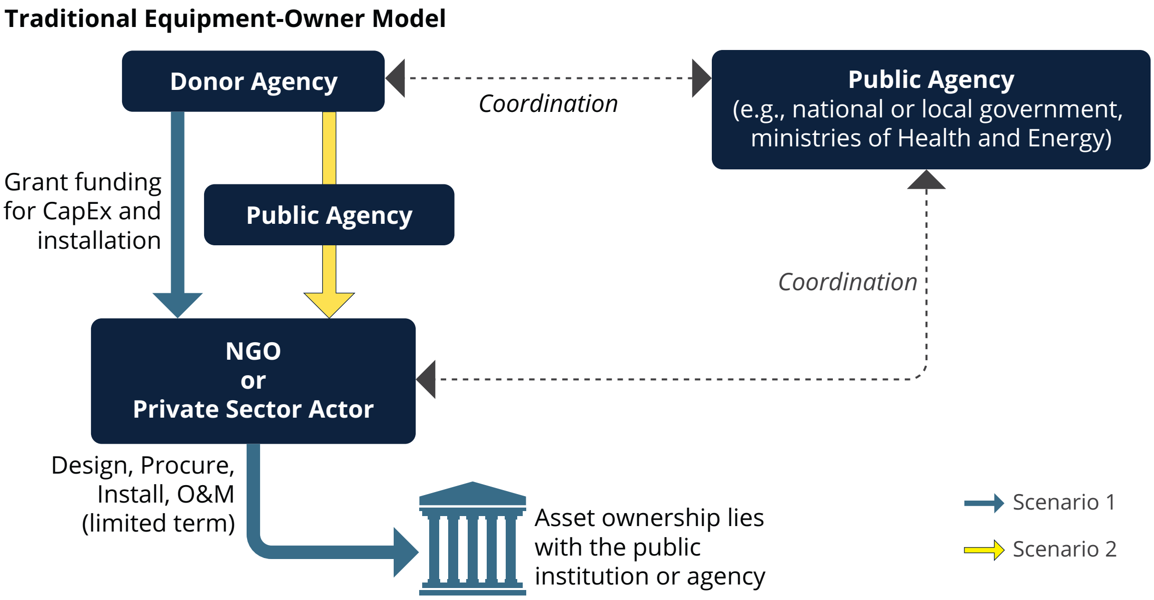
Despite the important and growing role of OGS systems in electrifying schools and health centers, there is mounting evidence that many of these systems are either **failing completely or severely underperforming** after a short amount of time.

The most common and critical reason for these shortcomings is the **absence of long-term maintenance** and the failure to replace key components such as batteries or inverters once they reach the end of their useful life. This often stems from a combination of financial, technical, and organizational shortcomings enabled by the incentives and current business models used in the sector. This chapter outlines the extent of these challenges and their implications.

3.1. THE INCENTIVE ALLOCATION IN THE ENGINEERING, PROCUREMENT, AND CONSTRUCTION (EPC) APPROACH

Most of the OGS systems deployed by donors and governments alike follow the traditional **procurement-based approach via EPC (Engineering, Procurement, and Construction)** providers (Figure 3.1). Under this approach, a contractor is hired to design, supply, and install the solar system. Once the system is commissioned, the contract ends, and the responsibility for system upkeep is typically handed over to local authorities or institutions, which often lack the technical capacity, funding, or mandate to manage ongoing O&M.

FIGURE 3.1 Structure of a Typical EPC Project for School and Health Facility Electrification



Sources: ESMAP and SEforAll (2021)..

The EPC approach, often informally referred to as “install and forget,” creates a serious gap. Even when systems are well designed and installed, they require regular maintenance and eventual replacement of parts to continue functioning. In remote or resource-constrained areas, such follow-up services are seldom provided, and local institutions are rarely equipped to handle them on their own. As a result, **many solar systems fail prematurely,** undermining the reliability of the electricity supply in critical public services like health care and education.

Table 3.1 presents core reasons for the current failures through the EPC model shown in Figure 3.1, arranged by the three core stakeholders: donors, governments, and the private sector.

TABLE 3.1 Summary Matrix: EPC Installation Failures, by Stakeholder

STAKEHOLDER/ FAILURE TYPE	FINANCIAL	ORGANIZATIONAL	TECHNICAL
Donors	• Funding heavily skewed toward CAPEX, as it needs to be disbursed over the project length (usually short). • No long-term service delivery financing models.	• Project results based on system installation, not performance. • Disconnected planning across donor programs.	• Procurement favors low-cost bids over lifecycle cost and performance. • Technology mismatches due to rigid tender specs.
Governments	• No recurrent budget for O&M or system upkeep. • Limited financial planning for replacements.	• Weak ownership and responsibility post-installation. • Fragmented roles between ministries and agencies. • Delays and inefficiencies in public procurement.	• Limited capacity to monitor system performance or enforce warranties. • Lack of data on energy needs, leading to over- or undersized systems.
Private Sector (EPC firms)	• Incentives to one-off installation payments. • Limited working capital to support warranties or maintenance.	• EPC firms exit once system is installed; no accountability mechanism. • Small firms can't scale or manage remote installations.	• Inadequate technician training or supervision. • Logistical challenges to serve remote areas.

Donors often prioritize short-term project outcomes over long-term service delivery. Most donor funding supports CAPEX for the initial installation for two main reasons. First, large donors are usually required to disburse their funds within the length of their projects; this prevents them from supporting long-term service delivery to the systems. Second, results indicators tend to measure systems installed, thereby incentivizing the installation at the expense of long-term maintenance provision. As a result, systems degrade quickly when no financial support is available for repairs or replacements (ESMAP and SEforALL 2021).

Moreover, **donor-led projects can be designed in silos**, with limited coordination between development partners. This can lead to fragmented approaches, varying technology standards, and duplicated or incomplete coverage of facilities. For instance, there is evidence of facilities served by multiple systems, installed by donors in a sequence once one system stopped working, or in parallel, servicing different parts of the health facility. Such practices reinforce unsustainable business models, leading to the misuse of already limited donor and public funding (ESMAP and SEforALL 2021).

Governments frequently struggle with limited institutional capacity to operate and maintain energy systems once installed. Ministries of health or education may receive solar systems for clinics or schools, but often lack the technical, administrative, or budgetary structures to keep these systems functioning over time (SEforALL 2024). National or local budgets rarely include dedicated lines for system O&M, or even electricity bills in some cases, resulting in broken systems and wasted infrastructure. Furthermore, as the interventions are project-specific and don't cover the entire country, it is difficult for governments to take a holistic approach to address these issues through budgetary or usual government processes. Additionally, electrification efforts are often not adequately planned for the facilities' needs, leading to systems that are either too small or oversized and underused. Finally, public procurement processes can also introduce delays or integrity risks, undermining quality and accountability, when follow-on monitoring is not required.

EPC firms generally operate under fixed-fee contracts that pay for installation, with little incentive to provide long-term service to the public institutions once the systems are installed due to lower financial returns on O&M compared with system installation. In addition, smaller firms may lack the capital or logistical capacity to support long-term maintenance, especially in remote or hard-to-reach areas. Competitive pressures and underpriced contracts can lead to poor-quality installations, and there are often significant skill gaps in local technician networks. Finally, limited supply chain infrastructure, especially in remote areas, can make simple repairs difficult and costly (ESMAP and SEforALL 2021).

3.2. EXPERIENCE FROM THE FIELD

These challenges to sustainably electrifying public institutions via EPC models with limited O&M provisions have been known for more than a decade.

Back in 2010, a **World Bank guidance note** pointed out that "[i]f maintenance and repair services are not provided, many [solar PV] systems become inoperative after 3–5 years" (World Bank 2010). This notwithstanding, these sustainability risks continue to materialize vividly.

In **Malawi**, a survey of 43 OGS installations for schools and health clinics revealed that 38 percent of systems had stopped working (Dauenhauer and Frame 2016). In Ethiopia, a field inspection of 22 public institutions with five- to10-year-old OGS installations found 10 (40%) to be completely or partially dysfunctional (Ethiopia Ministry of Energy and Water, 2024).

Data compiled by the UN Foundation and presented in a joint ESMAP and SEforAll report highlight duplicated efforts and inefficient, non-standardized system installations (ESMAP and SEforALL 2021). For instance, data from **Malawi** show that 396 individual off-grid solar PV systems were present in 73 Tier 1 health centers assessed. This means that **the facilities had an average of five systems each, but only 57 percent of these systems were functional.** Audits also uncovered operational issues with power-dependent medical equipment. Likewise, only **42 percent of the lighting systems provided was functional**, as much of the equipment had been centrally procured and distributed to facilities without adequate guidance on system maintenance or monitoring. Similar outcomes were registered in **Ghana, Tanzania, and Uganda** (ESMAP and SEforALL 2021).

These failure examples are from relatively well-documented cases, but far more OGS systems installed in the past are likely to be malfunctioning. Detailed documentation of OGS failure is limited due to the absence of project evaluation within a medium-term timeframe.

Table 3.2 presents a summary of the most frequent outcomes based on the type of O&M provision in EPC-based, donor-funded projects.

TABLE 3.2 Most Frequent Outcomes Based on Types of O&M Provision in EPC Projects

O&M PROVISION	MOST FREQUENT OUTCOMES
No budget provision for O&M	• Systems are installed but fall into disrepair due to lack of maintenance funding. • Ministries expect service providers to cover O&M without a clear payment mechanism. • Maintenance relies on ad hoc donor or project funds with no sustainability plan.
Short-term O&M	• Service is delivered initially but deteriorates after the contract period ends. • Temporary system availability followed by system failure due to lack of follow-up. • Short contracts disincentivize investment in quality spare parts or local capacity.
Long-term O&M contracts with no budget assured	• Service providers withdraw or stop performing due to nonpayment. • Accumulation of arrears undermines trust and contract enforceability. • Payment delays create financial stress for providers, affecting service quality. • Maintenance contract may be limited in scope, covering only basic activities such as tuneups and cleaning, but exclude major component replacement.

Unfortunately, this risky approach continues. Even projects with long-term planning for O&M have had to revise their approaches when in-house staff capacity was found to be insufficient for O&M and/or operational budgets were not earmarked for sustaining OGS operations. This, coupled with the little recognition that solar systems need ongoing maintenance, entails that payments for electricity remain uncertain and easily deprioritized, often depending on short-term priorities of health facilities.

Some projects have multiple reasons for their lack of sustainability. In **Uganda**, the **Energy for Rural Transformation (ERT)** program solarized public institutions with standalone OGS installations over more than two decades. Up to 40 percent of the systems had failed after just five years due to multiple factors that included technical shortcomings, lack of organizational arrangements, and inadequate funding for long-term sustained operations (Box 3.1).

BOX 3.1

EXPERIENCE FROM THE ENERGY FOR RURAL TRANSFORMATION PROJECT IN UGANDA

Contribution from Federico Qüerio, Senior Energy Specialist, the World Bank

The **Energy for Rural Transformation (ERT)** program, a World Bank-funded initiative in Uganda, ran from 2002 to 2022 in several phases. Both Phase 1 (2002−09) and Phase 2 (2009–16) of ERT supported the installation of small, standalone off-grid solar (OGS) systems across 624 and 1,112, respectively, schools, health centers, and water facilities. However, the program faced significant challenges stemming from technical and institutional factors. In 2022, the government assessed the functionality status of the systems installed in ERT-I and ERT-II, noting that approximately 50 percent and 30 percent of the systems installed in schools and health centers that were electrified under ERT-I and ERT-II, respectively, were not functioning.

These failures were largely due to **technical and institutional shortcomings.** On the technical side, 85 percent of the failures were attributed to issues with old/faulty batteries. System designs underestimated actual energy needs, leading to undersized and underperforming systems. Rigid battery performance standards were not enforced, and although contractors were required to meet basic technical specifications, substandard components were sometimes installed due to the government's limited capacity for quality control. Technical requirements were strengthened in Phase 3 to address these issues.

Institutional challenges further undermined system sustainability. School and health centers lacked the experience and resources for effective system management, and the perception of solar power as a "free" solution resulted in inadequate O&M budgeting. Funds for maintenance, including battery replacement, competed with other priorities, and the absence of early support planning led to neglect and system failures.

Sustainability ultimately depended on whether district governments could fund O&M after the first five years. While infrastructure maintenance budgets were provided, they did not specifically cover OGS systems or battery replacement—one of the primary causes of system failure. Moreover, O&M payments were not guaranteed and relied on the priorities of district officials for health facilities or school administrators.

Phase 3 of the program (ERT-III) (2016-2023) acknowledged these challenges. The World Bank worked to build consensus across ministries on the need to allocate funds for system maintenance, repairs, and part replacements beyond the five-year mark. Although agreements were reached to budget for these needs for the systems financed under the ERT-III project, sustainability remained an unresolved issue. Dialogue under ERT-III was instrumental in developing the innovative, service-based business model that is presented in this report, now being implemented through the Electricity Access Scale-up Project (EASP) (World Bank 2009, 2013, 2020).

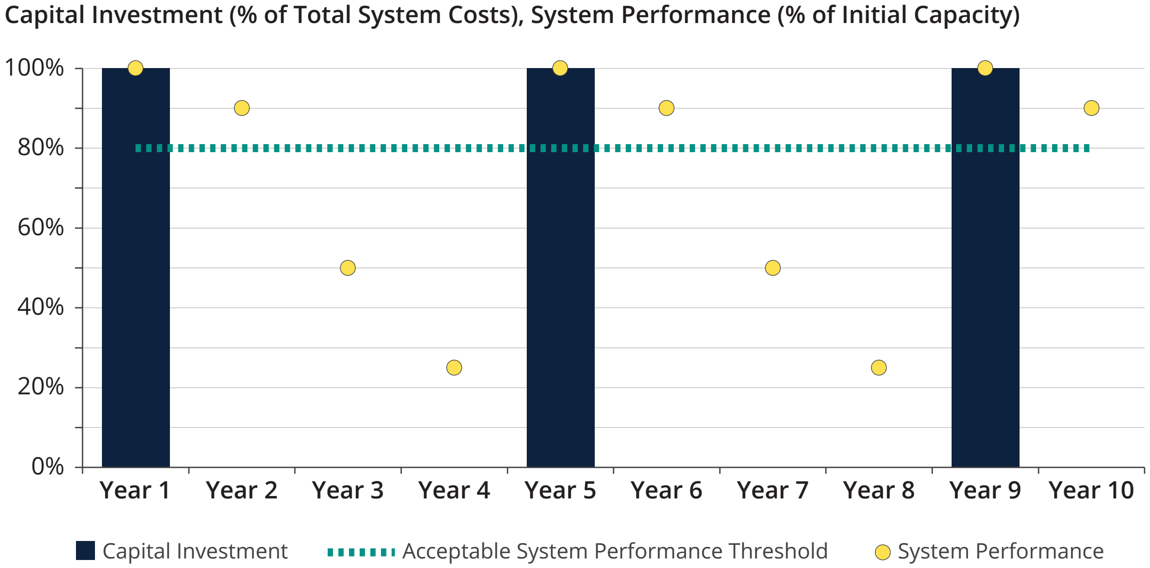
The evidence over past decades suggests that many well-intended efforts by the governments, development partners, and philanthropic institutions actively provided OGS-generated electricity to thousands of schools and health centers. However, they failed to deliver sustained electricity services when O&M funding was unavailable or inadequate to repair or replace components, especially high-value imported batteries.

3.3. THE FINANCIAL AND PERFORMANCE IMPLICATIONS OF EPC CONTRACTING WITH LIMITED O&M

Despite the scale of public investment in off-grid solar for public institutions, the current EPC-based model without proper O&M remains financially unsustainable. Projects operate as a series of isolated capital investments with little or no provision for maintenance or replacement of core components. Without mechanisms to ensure system upkeep, the full system cost is often incurred multiple times in relatively short periods, as systems are left to fail and are then replaced wholesale. In parallel, system performance declines steeply due to component failures, limiting the quality of the services provided by schools and health centers.

Figure 3.3 illustrates the financial and performance consequences of neglecting O&M for solar systems in public institutions. This example assumes that a solar system is installed and operational in year 1 but with no maintenance budget in place. As expected, system performance steadily declines over time—battery storage degrades, components wear out, and small issues compound. By year 5, the system has effectively failed, often due to predictable failures like battery or inverter breakdowns.

FIGURE 3.2 Reinvestment and Declining System Performance Over 10 Years



Note: The model is based on field data, which estimate that many PV systems become inoperative after three to five years if proper maintenance and repair services are not provided, and registers multiple donor investments in a similar time frame (UN Foundation and SEforALL 2019.

Source: World Bank staff.

Instead of repairing the system, another donor reinvests in a completely new system, starting the cycle over again. But without O&M, the same decline happens. By year 9, the system will fail once more and is replaced again. In a 10-year cycle, the institution has thus received three full system installations, spending **300 percent of the original capital cost,** but has not received reliable electricity service.

> Under the EPC model, **public funds are used to cover only a few years** of progressively declining electricity service.

The graph shows system performance—represented by blue dots—falling in steps after installation following progressive system failure due to a lack of system maintenance. The red line marks a **threshold of acceptable performance.** The area between this threshold and the system performance levels represents **missed energy output,** periods when the system failed to meet the institution's needs due to avoidable maintenance lapses

The repeated full-cost reinvestments every four years demonstrate a costly and unsustainable model for government and donors. Without budgeting for proper maintenance, donors and governments risk continually funding system replacements in previously electrified institutions instead of expanding access to new schools or clinics.

This example shows how poor maintenance planning leads to both **inefficient spending and unreliable service.** Worse, it limits how many schools or clinics can benefit, since the same ones receive repeated investments while others remain unelectrified. The long periods of underperformance or outright failure represent students learning without lights, health centers storing vaccines without refrigeration, and essential services operating without power.

There are contexts where EPC-based, public−sector-driven interventions may still be necessary. In settings characterized by FCV, delivering services through private actors is often not feasible. Security risks, limited institutional capacity, and unstable governance structures reduce the ability of the private sector to engage in long-term contracts or risk-sharing arrangements. In such contexts, public−sector-led EPC models may remain the only viable option.

However, the EPC approach relies entirely on public funding, and the pace of electrification is limited by government budget cycles and donor disbursements. The tradeoffs are significant: the private sector cannot contribute funding for the EPC approach, progress is inherently slower, and the financial and performance challenges described earlier are magnified. In FCV contexts, EPC can provide a baseline level of access, but system reliability and coverage expand only as quickly as public resources allow, leaving many institutions underserved due to lack of public resources.

The examples presented in Part I of this report underscore the need for a different approach: one that protects public funds, ensures consistent power supply, and enables scale by leveraging private sector participation.

By focusing on system performance, governments and partners can break the cycle of repeated investment, increase reliability, and accelerate progress toward universal electrification. Part II presents this approach in detail.

Endnotes

1 Data from 63 low- and middle-income countries. Facility electrification rates for Sub-Saharan Africa are likely significantly lower, as only 43 percent of the countries had data to report.

2 Additionally, a 2017 World Bank-funded study reported that OGS systems are the least-cost electrification option for around 800,000 educational and health facilities in Western and Central Africa (Lighting Global, 2017).

SECTION 2
MOVING TOWARD SUSTAINABILITY

4. A NEW APPROACH

KEY TAKEAWAYS

- **Service delivery models are widely used to deliver essential services** such as water, electricity, and digital connectivity, where providers are compensated based on performance.
- **In rural areas, however, off-grid electrification typically depends on the sale of standalone solar systems** rather than service delivery models, given the dispersed nature of communities and the relatively low levels of household energy demand.
- **Public institutions in these areas also tend to rely on direct procurement of standalone solar systems.** Yet, these systems often fail prematurely due to limited budgetary resources for O&M.
- While service-based models can provide a more sustainable solution for powering public institutions, many facilities cannot afford the full cost of such services. At the same time, scarce public resources remain insufficient to reach all institutions that still lack electricity.
- To bridge these gaps, **Public-Private Partnerships for People's Prosperity (5Ps)** combine lessons from service-based models, traditional public-private partnerships (PPPs), and results-based financing (RBF). This integrated approach helps attract private sector investment in public infrastructure, while performance-based incentives ensure that services are delivered, scaled, and sustained over time.
- To address these gaps, **Public-Private Partnerships for People's Prosperity (5Ps)** integrate lessons from service-based model, Public Private Partnership (PPP) approaches to attract private sector to finance public infrastructure and Results Based Financing (RBF) to provide incentives after delivery of services to scale up and sustainably electrify public institutions.

As Part I of this report shows, despite growing recognition of the importance of electrifying public institutions, prevailing approaches still fall short of delivering sustainable and reliable energy access. Scarce public money is used to provide a short-term, progressively declining level of electrification, thereby harming the system recipient and hindering its human capital development.

This chapter shows how governments and development partners, to change this trajectory, can adjust the mainstream approach of delivering electricity—a service delivery model—with lessons learned from proven models such as RBF and PPPs. This results in a new framework for enabling long-term service delivery for low-income people through the private sector.

4.1 SERVICE DELIVERY MODELS IN THE INFRASTRUCTURE SECTOR

In most infrastructure sectors, essential services such as electricity, water, and internet access are provided through service delivery models. Instead of purchasing the underlying infrastructure, users—including households, businesses, and public institutions—pay predictable recurring fees for access to a service. Payments are tied to agreed performance indicators such as availability, reliability, or quality of supply. This ensures accountability for providers and continuity of service beyond the initial installation.

Service delivery models are also the most widely used for electricity delivery. In these models, also known as "energy-as-a-service," consumers typically pay monthly or quarterly bills rather than investing directly in costly assets like generators. Consolidating demand across many customers enables providers to achieve economies of scale, thereby reducing unit costs, stabilizing revenues, and improving efficiency and quality of service. These benefits explain why service-based models dominate electricity delivery in both grid-connected and mini grid contexts.[1]

However, dispersed rural customers with low electricity demand have historically been excluded from this model. For such populations, providers have preferred selling standalone off-grid solar systems rather than offering long-term service contracts, since low consumption levels and the high costs of continuous service provision prevent economies of scale. The same has been true for public institutions in off-grid areas. Electrification has typically relied on one-off direct procurement of solar systems rather than service contracts. As Part I of this report shows, this has frequently resulted in unreliable and unsustainable service, with no provisions for long-term maintenance or accountability.

Transitioning from asset procurement to service delivery contracts can significantly improve electricity affordability and reliability for public institutions. Aggregating multiple facilities into bundled service contracts allows providers to spread fixed costs, lower per-unit prices, and improve operational efficiency. Larger contracts also generate more predictable revenue streams. When tied to performance indicators, these contracts ensure accountability and long-term sustainability.

Nonetheless, economies of scale and service-based models alone are not enough to close the electrification gap and ensure full long-term coverage of all the institutions currently in the dark. Section 4.2 explores the additional mechanisms needed to overcome the affordability and financing challenges that prevent this.

4.2 THE 5P FRAMEWORK FOR ELECTRIFYING PUBLIC INSTITUTIONS

Service models work well when customers can pay tariffs, contracts are enforceable, economies of scale are present, and risks are manageable. Yet they often fall short in low-income and underserved contexts, such as for the electrification of dispersed schools and health clinics in developing countries. This report has already introduced the possibility of aggregating facilities in large lots to create economies of scale; however, further challenges need to be addressed.

The most critical barrier is a structural affordability gap. Many facilities operate on minimal budgets that barely cover salaries, leaving little room to pay commercial energy tariffs. Donor funds, when available, are often fragmented or unpredictable, making it difficult to commit to long-term energy contracts. This affordability challenge compounds the broader financing gap noted in Chapter 1—public and donor funding remains far below what is required to achieve universal electrification of public institutions. Closing this affordability gap is therefore essential for attracting private investment.

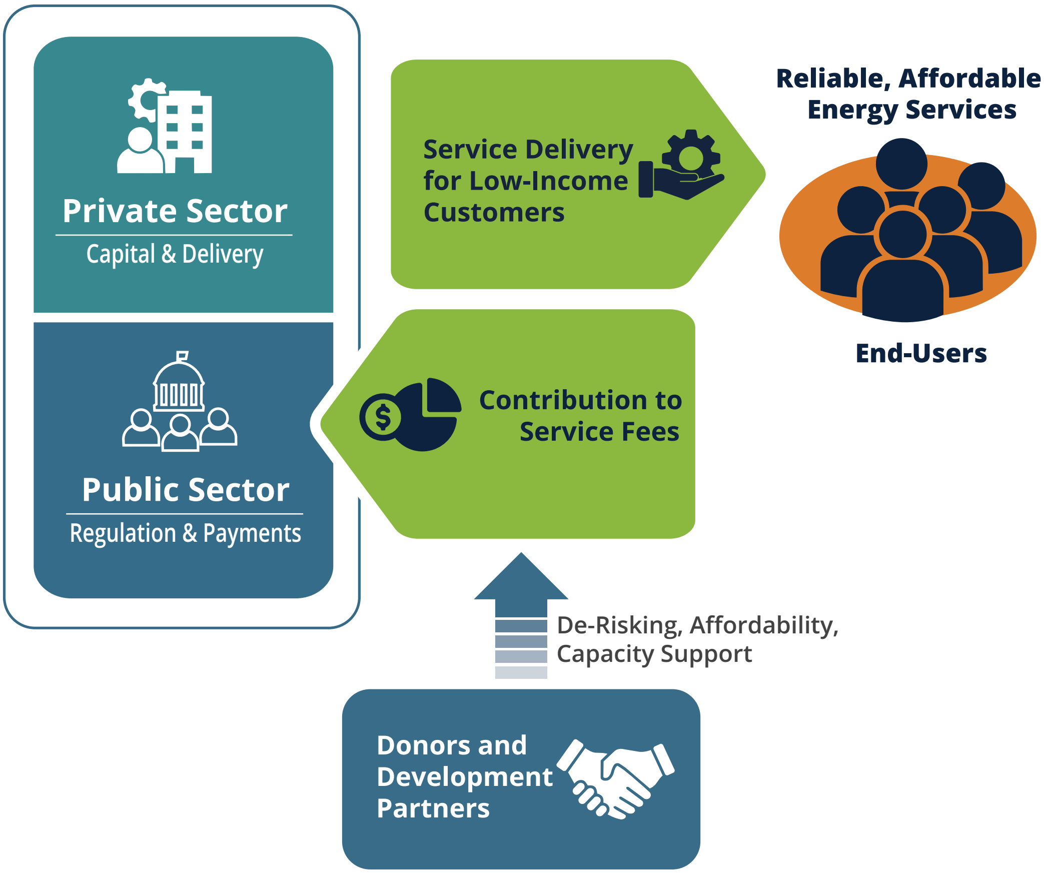
To address these gaps, service delivery models can be strengthened by applying lessons from other proven approaches. Two mechanisms stand out:

First, the **public-private partnership (PPP)**, where governments enter long-term contracts with private providers that assume substantial risks and management responsibilities, with compensation tied to performance. Second, **results-based financing (RBF),** where payments or incentives are disbursed only upon the independent verification of pre-agreed results, encompassing outputs like service delivery, intermediate outcomes, or final results such as improvements in learning or health indicators.

The integration of these approaches to a service-based model yields the Public-Private Partnership for People's Prosperity (5P) model. Under this model, extended service contracts tie remuneration directly to performance while incorporating results-based incentives to lower costs and mitigate payment risks. This enables resource-limited public institutions to access scalable, long-term energy services through private expertise and capital while keeping fees affordable. In the electrification context, the model shifts service delivery from public agencies to specialized service providers such as energy service companies (ESCOs). Governments contract these providers to deliver reliable energy services under agreements that include measurable key performance indicators (KPIs) for availability, reliability, or quality of supply. Payments are conditional on verified performance, closing the accountability gap left by one-off procurement models that focused on construction without long-term O&M.

The proposed 5P approach also mobilizes private capital through predictable, performance-based service payments. The 5P model enables providers to raise financing against future, performance-based revenue streams from users or governments. Because revenue depends on long-term service performance, providers have a vested interest in building systems that last and maintaining them effectively (Figure 4.1).

FIGURE 4.1 Public-Private Partnership for People's Prosperity (5Ps)



Source: World Bank staff.

Extending PPPs to benefit the underserved is not a new concept. The World Bank and other development partners have long recognized the limitations of traditional PPPs in addressing infrastructure affordability and access, particularly in low-income settings. In response, "PPPs for the Poor" were tested to blend public sector funding, concessional finance, and private investment in order to bridge both viability and affordability gaps. In Karachi, Pakistan, a public–private initiative restored water access to informal settlements via "Awami tanks," where municipal systems had collapsed. In West Africa, "social connections" for low-income households were provided at no cost, removing a major barrier to electricity access (World Bank 2025b)[2]. The proposed idea also builds on the World Bank Group's Hybrid PPPs, which refers to traditional, performance-based PPPs, that include viability gap funding.[3]

Development partners play a critical role in the 5P framework. They can help governments strengthen public sector capacity to design, procure, and manage service-based contracts by (1) supporting the readiness of local firms through technical assistance, training, and business development services; and (2) easing fiscal constraints through concessional finance, guarantees, and results-based funding that create space for governments to sustainably contract private providers.

The 5P model rests on the two complementary building blocks in Figure 4.2.

FIGURE 4.2 Building Blocks of the 5P Model

First, the 5P model reframes success not by the number of assets deployed, but by the quality and continuity of the service provided, whether electricity in a health center, clean water in a rural school, or internet access in a government office. Like traditional PPPs, the 5P relies on specialized private operators to deliver services under long-term contracts, with payments linked to performance. This principle extends beyond grid-based utilities to underserved and vulnerable sectors such as off-grid schools and health clinics, where infrastructure is often standalone and fragmented, and beneficiaries have severe affordability constraints. In this way, the accountability and efficiency of PPPs are transposed to benefit the most vulnerable.

Second, it mobilizes public budgets to unlock private capital, even in low-income, remote, and rural settings. Private investment in electrifying public institutions has long been constrained by high perceived risks, especially affordability gaps that make projects commercially unviable. The 5P model addresses this by blending public and donor resources into predictable, performance-linked payment flows that give investors confidence and make projects bankable. Building on lessons learned from RBFs, performance incentives close the viability gap for providers, while concessional finance, guarantees, and other risk-mitigation tools help crowd in private equity and debt.

The next chapters delve into both building blocks of the 5P models in the context of off-grid public institutions electrification and outline how development partners can enable this framework.

4.3 THE 5P FRAMEWORK IN ACTION

5P models remain relatively new in the electrification of off-grid public institutions, though several pioneering initiatives are already demonstrating their potential to sustainably scale the delivery of energy services. These models are not one-size-fits-all: they must be tailored to each country's institutional capacity, legal structure and contracting ability of public institutions, public financial management systems, and private sector maturity. Factors such as government contracting procedures, the strength of regulatory frameworks, and the ability to monitor service quality all influence how a 5P approach can be implemented effectively.

A few foundational institutional elements are essential to making such partnerships work.

First, roles and responsibilities must be clearly defined. On the government side, the customer is typically the ministry or agency that holds budgets, owns and operates the schools or health centers to be electrified, and engages an ESCO to design, install, operate, and maintain the solar electricity systems. The government entity bundles an adequate number of unelectrified institutions within a suitable geographic area to ensure economies of scale to make the scheme bankable and attract private sector investment. The ESCO supplies electricity on a long-term basis under a performance-based contract for all the institutions within that area and receives payment per service delivered.

Second, there must be a clear legal framework that defines the government authority responsible for the contract. Such authority is usually a designated government entity with the jurisdiction to oversee, regulate, and enforce energy service agreements (ESAs), ensuring alignment with national policies and procurement rules.

Third, the ESA must cover designing and building, and operations and maintenance. The ESCO is responsible for delivering systems that meet agreed performance standards and ensuring reliable service over time. To assess compliance, the ESCO will deliver data to independent, remote monitoring platforms in established time increments, and needs to ensure that the necessary hardware and software to collect, transmit, and store such data are in place, including as a backup in case transmission is limited by outages or interruptions. The data will be assessed against KPIs specified in the service agreement.

Finally, blended public-private funding must be used, to address the affordability challenges of electrifying public institutions with private equity and debt. As public institutions gain access to reliable electricity, their operating costs will increase due to the use of electricity. While electricity will enhance their service delivery, public institutions usually do not charge service fees. To keep this enhanced service level affordable, the 5P will use the blended finance approach. This approach maintains the cost of electricity at an acceptable level but will also ensure that the ESCO considers this a business opportunity to invest and remain involved, guaranteeing reliable electricity service and earning a reasonable return on its investment.

To illustrate how these foundational elements come together in practice, it is helpful to examine one of the most advanced implementations—not as a template to replicate, but as a reference point to be refined based on lessons learned. **The Uganda Electricity Access Scale-Up Project (EASP)** provides such an example. EASP targets the electrification of 750 schools and health centers through a service-based delivery model that leverages private sector expertise for system design, installation, and long-term maintenance.

Under EASP, 10-year energy service contracts are established between ESCOs and the health ministry and education ministry, respectively. These contracts define KPIs that guide service delivery. The ministries act as contracting authorities, responsible for tendering ESCOs, monitoring compliance with KPIs, and authorizing payments once performance targets are met. Each ministry signs a separate service agreement with the ESCOs, retaining full ownership of the selection process and contractual arrangements.

The Uganda Energy Credit Capitalization Company (UECCC)—EASP's implementing agency—provides grants and concessional financing to ESCOs to ensure the financial viability of the project. Service fee payments from the beneficiary ministries are centralized to avoid dispersion and delays, and protected budget lines are coordinated with the Ministry of Finance, creating predictability for private actors and reducing the administrative burden on individual institutions. Performance-based conditions further link disbursement from UECCC to timely payment by ministries upon KPI achievement, reinforcing accountability and performance throughout the duration of EASP.

Following Uganda's example, a growing number of governments are adapting service delivery models to their own institutional and fiscal contexts, signaling increasing global momentum. Notable initiatives include Madagascar's Decentralized Electricity for Communities and Institutional Modernization (DECIM), Nigeria's Distributed Access through Renewable Energy Scale-up (DARES), and the Regional Off-Grid Electrification Access Project (ROGEAP) in Benin and Nigeria. The private sector is simultaneously gaining experience with 5P models, learning to adjust business models, financing structures, and incentive mechanisms to prioritize long-term service delivery.

These early examples demonstrate that service-based electrification is both feasible and preferable, particularly in contexts where long-term reliability has historically been elusive. They provide a blueprint for scalable impact, showing how carefully structured public and donor financing can crowd in private investment while aligning incentives around performance. Furthermore, they highlight the critical importance of coordination across sectors, ministries, and development partners.

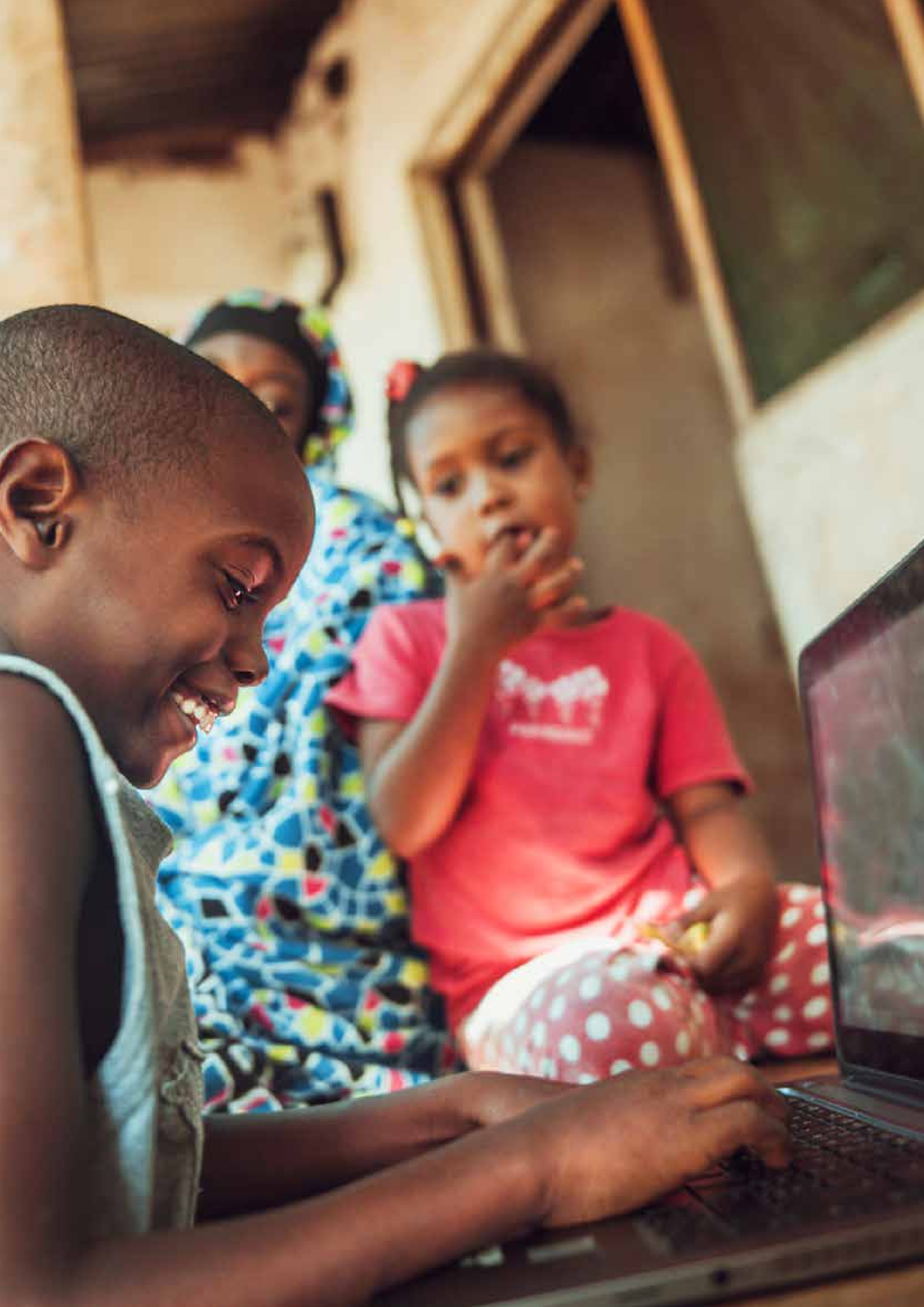
The next chapter examines the building blocks of the 5P model, setting out the principles and mechanisms that make service-based electrification sustainable at scale, as well as various strategies for its implementation.

Endnotes

1 The term energy-as-a-service is widely used to describe service delivery models in off-grid and decentralized energy contexts. In mini grids and grid-connected systems, this term is less common, although electricity is delivered through the same service model.

2 Further readings and case studies on the World Bank's PPPs for the Poor are available at: https://ppp.worldbank.org/ppps-poor.

3 For further readings on Hybrid PPPs, see https://ppp.worldbank.org/library/hybrid-ppps-turning-risk-viability. In addition to the above, the Pro-Poor Public Private Partnerships model was developed by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) in the context of widening access to energy service in rural areas (Ratajczak, 2017).



5. BUILDING BLOCK 1: SHIFTING FROM PROCUREMENT OF ASSETS TO SERVICE DELIVERY

KEY TAKEAWAYS

- The first building block of the 5P model is to **ensure that schools and health centers receive reliable energy services over time** through the private sector.
- **A structured KPI framework** links service fees directly to performance outcomes—such as energy availability and system uptime—thereby creating accountability, incentivizing continuous service quality, and protecting public sector investments.
- **Remote monitoring systems** provide real-time performance data, enabling governments, donors, and ESCOs to verify compliance, reduce downtime, and maintain transparency in contract management while lowering operational costs.
- **Quality assurance guidelines, standardized contracts, and financial modeling tools** help governments and development partners structure enforceable, replicable, and scalable 5P models that balance technical robustness with financial sustainability.
- **Effective institutional coordination** is essential: energy ministries typically lead on technical design and procurement, while health and education ministries define service needs, participate in monitoring, and ensure that energy provision is aligned with broader development outcomes.
- **Development partners play a catalytic role where gaps exist**, providing technical assistance, policy support, and capacity building to bridge weak institutional capacity, and creating market opportunities for the private sector.

The first building block of the 5P framework rests on the fact that tracking project success simply in terms of system deployment can cause a misalignment of incentives between project outcomes and impacts.

From a technical standpoint, 5P models adjust standard service delivery models to meet performance targets through the support of the private sector, bringing in development partner support to fill capacity gaps when needed.

This chapter focuses on the core **technical elements** of 5P models aimed at electrifying off-grid public institutions.

5.1 KEY PERFORMANCE INDICATOR FRAMEWORK FOR SERVICE DELIVERY

The foundational technical backbone of 5P models for off-grid solar public institution electrification is a structured framework of **key performance indicators (KPIs)** that defines, tracks, and enforces the quality and reliability of energy service provision. The KPIs link service expectations to payment, accountability, and trust in the system.

The KPI framework for off-grid solar systems for public institutions via service-based models presented in this chapter was developed by the World Bank Group in collaboration with the Schatz Energy Research Center and ECREEE (World Bank, Schatz Energy Research Center, and ECREEE 2023). This framework offers a practical and scalable model for structuring performance, presenting a standardized approach to measuring whether systems perform as expected and whether users are receiving the level of service for which governments have paid.

The core KPIs elaborated in this document and further refined with lessons learned from project implementation are outlined in Table 5.1.

TABLE 5.1 Key Performance Indicators (KPIs) for Electricity Service Delivery

KEY PERFORMANCE INDICATOR	KPI GUIDELINES	COMPLIANCE RESPONSIBILITY
Available energy	Available energy (Ea) per day ≥ target performance per day specified in the service agreement	ESCO
System uptime	System uptime ≥ target amount of time specified in the service agreement	ESCO
Depth of discharge	Depth of discharge (DOD) ≤ maximum DOD recommended for the battery and specified in the service agreement	ESCO
Days fully charged (for lead-acid batteries)[a]	Days batteries are fully charged ≥ target days of full charge specified in the service agreement. Only applicable to lead-acid batteries	ESCO
Manually detected issues	Noncompliance of the ESCO with other elements specified in the service agreement (e.g., lighting, wiring)	ESCO
Energy consumed	Energy consumed ≤ maximum pre-agreed value specified in the service agreement	Public institution
Peak load	Peak load ≤ a maximum power value specified in the service agreement	Public institution

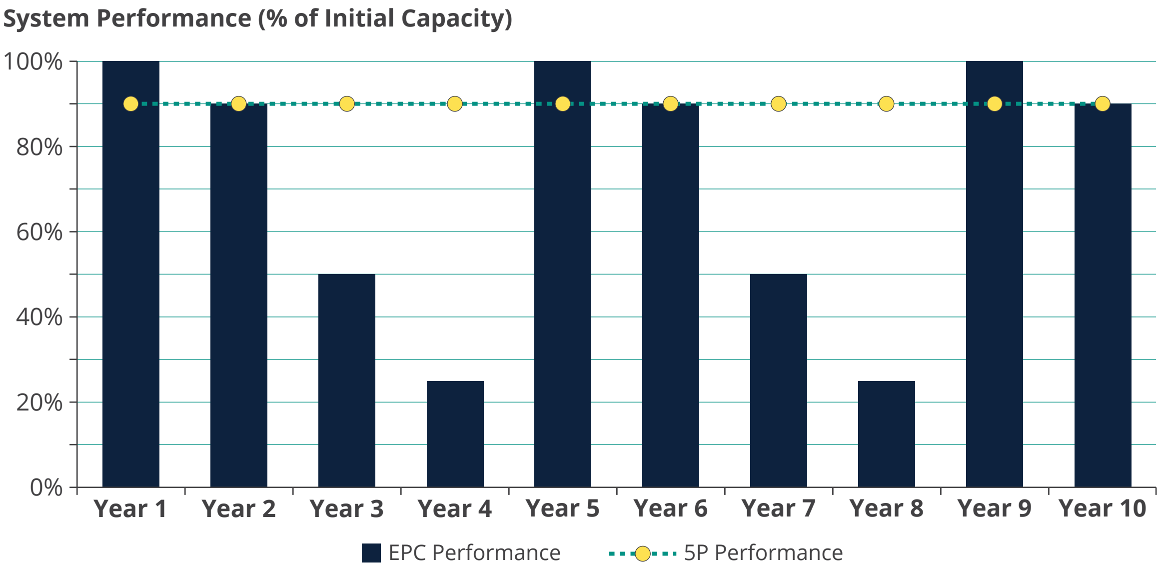
Note: [a]Lead-acid batteries are increasingly less common in standalone off-grid solar systems due to li-ion batteries' progressively reducing costs, superior performance in cycle life, high temperature operation, longevity, and reduced maintenance. However, as the 5P model is technology agnostic, this indicator is currently being proposed to capture compliant use of lead-acid batteries, should they be deployed.

Each KPI includes a clearly defined target value outlined in the energy service contract between the government and ESCO. When all targets are fully met for a given period, the ESCO becomes eligible for 100 percent of the agreed service fee. To avoid a rigid "all-or-nothing" outcome, the contractual framework can include an additional, **lower threshold value** for each KPI result below the target value. If performance meets this lower benchmark but lies below the target value, the ESCO receives a prorated portion of the service fee. However, if performance falls below this minimum threshold, no payment is made for that period. This structure introduces accountability while recognizing operational realities and encouraging continuous service improvement.

Importantly, some KPIs are not the responsibility of the ESCO but of the public institution. These indicators are designed to ensure that institutions use the systems as intended and do not compromise system longevity. For example, if a public institution consistently uses the system at levels beyond what was originally designed and agreed in the energy service contract, the ESCO may be granted a grace period during which penalties for noncompliance are waived, recognizing that the system was not designed to meet excessive or out-of-scope demand. These protections ensure fairness and maintain the integrity of performance-based contracts.

KPIs ensure that systems achieve constant performance over time. Figure 5.1 demonstrates the contrast in solar PV system performance over time between EPC and 5P models, measured as a percentage of initial system capacity. EPC performance shows considerable variability across different years, reflecting how systems functioning without maintenance promptly fall below optimal levels, as already shown in Figure 4. In contrast, KPIs help ensure system performance always meets prescribed standards in the 5P model.

FIGURE 5.1 EPC vs. 5P Model Solar PV System Yearly Performance Comparisons



Note: The graph is designed to illustrate the difference in approach between the models analyzed. 5P performance has been set at 90 percent, thereby indicating the minimum threshold that systems must maintain to fully meet KPIs. Effective system performance may be higher.

Source: World Bank staff.

KPI targets determine the level of electrification delivered to health and education facilities. While full electrification of a facility would be the ideal outcome, governments facing budget constraints, competing priorities, or infrastructure limitations may opt for smaller, targeted service levels. In such cases, KPI targets can be calibrated to reflect partial electrification strategies, such as powering only essential loads. For instance, 5P models could focus on ensuring uninterrupted electricity supply sufficient only for critical functions like lighting or communication equipment while leaving nonessential loads unelectrified to reduce costs. This approach allows governments to align service delivery with available resources and policy priorities while still improving the reliability of essential services. Full electrification can be achieved at later stages by expanding systems and the current 5P model contractual framework (Box 5.1).

BOX 5.1

APPLIANCE-SPECIFIC ELECTRIFICATION

Contribution by Cedric Ndizeye, Senior Health Economist, and Eliane Ramiandrison, Senior Health Specialist, the World Bank

In some situations, governments may also adopt technology-specific solutions to electrify critical loads. One example is the deployment of solar direct drive (SDD) systems for vaccine refrigerators, which operate independently of the main electrical installation. Isolating critical medical equipment from the broader power system, as in the case of SDD, can reduce strain on the main system, lower maintenance requirements, and safeguard the continuity of essential services (United Nations Children's Fund 2020).[1] Similarly, education facilities might prioritize powering information and communications technology (ICT) labs or lighting for evening classes while deferring full campus electrification until resources allow.

In Madagascar, the Ministry of Health has procured autoclaves—medical devices that use high-pressure steam to sterilize surgical instruments—together with solar systems to electrify health facilities in the most remote areas. Procured through the UN Office for Project Services, these systems will be deployed in locations that are currently too isolated to be commercially viable for models such as the 5P. To maximize impact, the initiative is being coordinated with other programs in the country, including the Digital and Energy Connectivity for Inclusion in Madagascar (DECIM), which will focus on electrifying commercially viable areas through the 5P model. This complementary approach allows the government to address urgent energy needs in rural health facilities through direct procurement of autoclaves and small solar systems while progressively expanding market-driven, commercially sustainable electrification across the country.

KPIs are typically tracked in real time through remote monitoring systems, which are treated in detail below.

5.2. REMOTE MONITORING SYSTEMS

Remote monitoring systems collect real-time data on system operation, enabling independent and transparent verification of performance. These systems serve as the backbone of performance-based contracts, allowing service delivery to be monitored remotely, payments to be triggered based on verified outcomes, and underperformance to be identified and addressed swiftly.

Performance dashboards, powered by remote monitoring data, can be used to assess compliance with service contracts. These dashboards help automate payment triggers, flag anomalies, and provide a transparent audit trail of energy service delivery. In many large-scale service delivery programs, access to real-time monitoring platforms is a prerequisite for participation by both public and private stakeholders.

Remote monitoring supports a wide range of stakeholders, donors and funders who need to ensure that their investments are delivering results; public agencies overseeing contracts and service delivery; private operators seeking to optimize performance and reduce costs; and third-party verification agencies tasked with independent oversight. Technicians benefit from early fault detection, while technology providers can use performance data to refine equipment and troubleshoot issues more effectively.

ESCOs report significant operational benefits from remote monitoring, including reduced system downtime, faster detection and resolution of faults, and lower maintenance costs. These improvements lead to more reliable service, greater customer trust, and stronger financial performance. Remote monitoring also plays a vital role in securing systems: it can deter theft, vandalism, and inappropriate use by detecting abnormal patterns and enabling rapid intervention. It can also be used to detect excessive or unexpected loads, helping plan for timely system upgrades before batteries or other components are overstressed.

In certain cases, manufacturers link their warranties to remote monitoring compliance. For example, at least one supplier of SDD vaccine refrigerator systems offers a 10-year warranty—aligned with WHO performance expectations—on the condition that the system is equipped with and continuously operating a remote monitoring device.

Despite its advantages, remote monitoring faces technical limitations, particularly in rural and remote areas where mobile connectivity is unreliable or unavailable. To address this, monitoring devices should include local data storage capabilities, allowing compressed data to be retained for several weeks and uploaded to the cloud once connectivity is restored. Additionally, systems should be equipped with a local interface, enabling technicians to access system performance data directly without relying on internet access—especially important for maintenance personnel in the field. Finally, donor projects should consider jointly providing the two complementary services of energy and connectivity, including via performance-based contracts. An example of such projects of the World Bank is provided in Box 5.2.

BOX 5.2

DELIVERING ENERGY AND CONNECTIVITY AS-A-SERVICE IN MADAGASCAR

Contribution from Anne-Elisabeth Costafrolaz, Digital Specialist, the World Bank

In addition to reliable energy, the DECIM project is designed to also provide connectivity services to schools and health facilities. This joint service delivery model ensures that the facilities' essential infrastructure needs are met through a unified service provider. By integrating both energy and digital connectivity, the project aims to streamline service delivery, reduce operational complexity, and enhance the reliability of these critical resources. This approach not only simplifies management for facility administrators but also enables more efficient maintenance and support, ultimately improving the overall quality of services available to students and patients.

Reliable energy supply is a prerequisite for digital connectivity, powering devices, networks, and essential equipment. In turn, robust connectivity enables access to digital learning resources, telemedicine, and data-driven management systems, amplifying the impact of electrification. By delivering both services together, DECIM ensures that schools and health facilities can fully leverage modern technologies to improve educational outcomes and health care delivery, fostering greater inclusion and resilience in underserved communities.

Technology developments and lowering costs are increasingly enabling remote monitoring for energy service delivery. As 5P models scale up to electrify public institutions, remote monitoring systems will become indispensable for tracking performance and ensuring accountability. While the private sector typically develops and maintains these systems, it is critical that governments develop their own capacity to access, interpret, and act on remote monitoring data. This way, governments become empowered partners capable of overseeing service delivery, validating performance claims, and making informed decisions about contract compliance, expansion, or corrective action.

5.3 ENSURING QUALITY AND STANDARDIZATION

The performance-based incentive structure adopted in the 5P model, in principle, reduces the need for governments to set overly prescriptive technical specifications. However, quality assurance (QA) guidelines are indispensable for assessing some level of technical adequacy of the systems proposed by private providers before committing to support, especially if a portion of the funding is disbursed upfront. Additionally, quality standards are helpful to optimize the upfront and recurring costs of the electricity services.

Recognizing this need, the World Bank Group—together with the Schatz Energy Research Center, and ECREEE—developed a comprehensive set of Requirements and Guidelines for Installation of Off-Grid Solar Systems for Public Facilities. These guidelines are designed to support the delivery of technically robust solar systems deployed through 5P models, ensuring quality across design, installation, and long-term operations and maintenance (World Bank, Schatz Energy Research Center, and ECREEE 2023).

The QA approach centers on two complementary elements. First, it establishes minimum technical standards for the quality and safety of key system components, as well as guidelines for system sizing and installation. Second, it leverages KPIs and digital remote monitoring systems—presented in section 5.1—to verify that the energy service is being delivered as contracted and to trigger payments based on performance.

Concerning technical standards, the QA framework for 5P models does not impose a prescriptive or one-size-fits-all system design. Instead, it allows the private sector to optimize system design both to meet targets efficiently and to minimize lifecycle costs. Service providers are thus motivated to choose configurations that reduce the likelihood of system failures and lower the need for expensive field interventions; furthermore, by leveraging remote monitoring technology, operators can detect and respond to issues without dispatching technicians unnecessarily, resulting in lower operating costs and more reliable service.

In addition, flexible technical standards incentivize energy efficiency, which in turn lowers the energy demand of target facilities. Switching to efficient LED lighting and brushless DC fans can reduce the energy requirement of the institution, allowing lower capital investment and recurrent cost. Governments can adopt existing standards such as the US Energy Star label or equivalent for the European Union or China (World Bank, Schatz Energy Research Center, and ECREEE 2023). System design can also prioritize critical power load for the core functions of public institutions; for instance, vaccine refrigerators can have an independent power supply from the rest of the system to avoid the loss of active vaccine due to the loss of power. Limiting power load to staff residential facilities (for example, residences of teachers and health care workers) by using load limiter is also encouraged, to avoid the surge in the residential demand compromising the power availability to the public institutions.

Box 5.3 further outlines the role of a QA framework for electrifying public institutions.

BOX 5.3

THE CRITICAL ROLE OF A HARMONIZED QUALITY ASSURANCE FRAMEWORK

Contribution by Chris Carlsen, VeraSol Policy Lead; Arne Jacobson, VeraSol Technical Lead; and Meg Harper, VeraSol Principal Engineer

A built-for-purpose QA framework is the foundation of a functional and sustainable 5P model. By requiring high-quality components, combined with a system design and installation that are backed by robust O&M and remote monitoring, governments and facility staff members can have confidence that the energy needs of public facilities will be met over the long term.

The holistic approach to ensuring system quality, safety, and durability is backed by harmonized international standards, best practices, extensive field research, and inputs from key stakeholders. This strategy facilitates replication of critical elements of the QA framework across projects and geographies while also allowing governments to adapt the approach according to their specific needs and objectives.

"Flexible harmonization" of QA for off-grid electrification of public facilities gives confidence to governments and their partners in the viability of the 5P model. Beneficiary ministries (for example, education, health, and water) may lack the specialized technical expertise to develop a one-off QA framework for solar PV electrification of their facilities. Adaptation of the harmonized QA framework—paired with technical assistance from the Ministry of Energy and off-grid solar experts—enables a multidisciplinary approach while leveraging existing resources.

ESCOs also benefit from the harmonized approach, which reduces their effort and the potential for misunderstanding when submitting bids. Furthermore, once an ESCO gains experience with the 5P model, it is well equipped to successfully deliver energy services for other projects that use similar QA frameworks.

Technical guidelines like the one mentioned above can provide good practice to reduce the risk of underbidding with low-quality components.

The QA framework is complemented by standardized bid specification templates. These templates help ensure consistency and comparability across bids, reduce transaction costs for governments, and give private sector bidders a clear understanding of project expectations. An Excel-based system design tool is also available to assist implementers and developers in estimating appropriate PV system sizes based on expected loads and usage profiles.

Beyond technical standards, the QA framework is complemented by a suite of tools that allow replication of the model at scale.

> The resources mentioned in this section are accessible through the following links:
>
> - Quality Assurance Framework
> - Bid Specification Template
> - System Design Tool
> - The remaining resources are currently under development and will be made publicly accessible to allow for replication and scale.

First, the energy service agreement is a cornerstone of the 5P model. It outlines the roles and responsibilities of the ESCO and the government, defines KPIs and payment terms, and establishes the conditions under which performance will be evaluated. This document provides legal clarity and enables long-term partnerships to be structured around measurable outcomes, not just asset delivery. Box 5.4 provides more details.

BOX 5.4

THE ENERGY SERVICE AGREEMENT

The **energy service agreement (ESA)** serves as the foundational legal instrument that governs the delivery of electricity services under the 5P model. It defines the full scope of the relationship between governments and ESCOs from project development and installation to operations, performance verification, and payment. The ESA is designed to ensure long-term service delivery by clearly allocating responsibilities, risks, and incentives while also remaining flexible enough to accommodate a variety of local, legal, and operational contexts.

The agreement lays out key elements needed to operationalize service delivery. It includes provisions for site access, construction timelines, and commissioning requirements. Crucially, it links service fees to the delivery of measurable outcomes, using remote monitoring systems and third-party verification (when needed) to assess whether energy services meet agreed performance standards. This approach ensures that payments are based not on asset ownership, but on results—reinforcing the core logic of the 5P model.

Beyond service delivery, the ESA includes detailed financial, legal, and risk management provisions that make it suitable for attracting commercial capital. It defines predictable payment mechanisms, allows for deductions when services fall short of KPIs, and includes tools to manage insurance, force majeure, and eventual asset transfer. The agreement is supported by a suite of standardized annexes—including performance monitoring protocols and lender agreements—which make it ready for immediate deployment. Together, these elements create a robust and replicable framework that governments, ESCOs, and financiers can use to scale up sustainable electrification of public institutions.

Second, bidding documents ensure a competitive and transparent procurement process that maximizes the performance incentives of 5P models. They allow governments to clearly communicate technical requirements, performance expectations, and evaluation criteria to potential bidders. These documents help attract qualified private partners and reduce delays and inconsistencies in project preparation.

Third, the financial modeling for 5P models helps governments and project developers estimate the cost of delivering electricity services over the full life of a contract. This tool enables users to model system sizing, capital expenditures, O&M costs, replacement schedules, payment structures, and donor support. It also calculates the service fee required to ensure financial viability for ESCOs while flagging potential affordability gaps that may need to be covered through public or donor funding. The model can be adapted for different country contexts and technology configurations, and it helps ensure that bids and negotiations are grounded in realistic financial expectations.

Finally, complementing the resources above are a **terms of reference (ToR)** designed to guide the preparation and execution of key components of 5P models. For instance, a ToR for **technical and market analytics** supports governments or development partners in assessing system design options, demand estimates, and cost benchmarks before launching tenders. A dedicated ToR for establishing or enhancing a **remote monitoring platfor**m helps define system architecture, data protocols, access rights for stakeholders, and cybersecurity safeguards to ensure continuous, reliable performance tracking.

Together, these resources form a comprehensive toolkit that enables governments and their partners to design, finance, and manage 5P programs effectively.

5.4 CREATING MARKET OPPORTUNITIES FOR THE PRIVATE SECTOR

Effective tendering can generate economies of scale, strengthen financial viability, and attract a broader range of qualified bidders. Three principles are particularly important.

First, aggregation of facilities into sizable lots reduces transaction costs and balances risks by combining both easily accessible and harder-to-reach sites. This not only attracts larger players with access to finance but also enables partnerships with local providers that can manage O&M. Aggregation improves the investment profile of projects by spreading fixed costs across multiple facilities and offering unified revenue streams under long-term service contracts.

Second, regional proximity should guide the structuring of lots. Clustering facilities within manageable geographic areas reduces transport and logistics costs, facilitates the establishment of local warehouses and maintenance hubs, and improves response times for servicing. This lowers the lifetime cost of O&M while ensuring reliability.

Third, standardization and streamlining of requirements lowers barriers to entry. Facilities should be categorized by type or size, with uniform performance indicators for each category, rather than treated as bespoke projects. This simplifies design and allows ESCOs to replicate solutions across multiple sites, reducing bid preparation and engineering costs while retaining flexibility to optimize system design. Governments can develop a standard energy need for a specific facility type for the purpose of engaging ESCOs while allowing the space for adjustment before final contracting. Table 5.2 provides an example of standardized type classification and the different facility categories' energy demand. A successful example from the field is presented in Box 5.5.

TABLE 5.2 Energy Demand Per Facility Category

FACILITY TYPE	ENERGY DEMAND
Basic Primary Health Clinic (Basic PHC)	1-2 buildings, 1-5 rooms per building, with loads including general lighting, security lighting, fans, a procedural lamp, mobile phone charging, a fetal heart monitor, and a portable ultrasound
Improved Primary Health Clinic (Improved PHC)	Similar to Basic PHC plus additional rooms, loads, and use times; an oxygen concentrator; general-purpose refrigerator/freezer; laptop computer; and USB modem
Basic School	1-2 classrooms and an office with minimal services for school staff and students with loads including general lighting, fans, mobile phone charging, and security lighting
Improved School	Similar to Basic School plus additional rooms and loads: a laptop computer, USB modem, and printer

Source: The World Bank, Schatz Energy Research Center, ECREEE, 2023

BOX 5.5

ECONOMIES OF SCALE IN UGANDA'S ENERGY ACCESS SCALE-UP PROGRAM

Contribution from Joseph Kapika, Senior Energy Specialist, and Yabei Zhang, Senior Energy Specialist, the World Bank

Uganda's Energy Access Scale-Up Program (EASP) represents the country's first large-scale effort to electrify public institutions using the 5P model. To encourage private sector participation, EASP bundled facilities into sizable lots for tenders (either in terms of number of facilities or costs), combining both easily accessible and harder-to-reach sites. This strategy aims to improve financial viability by attracting larger players with access to capital while enabling smaller, local service providers to manage O&M in partnership with the former. Aggregation has also strengthened the investment profile of projects by spreading fixed costs across multiple facilities and providing longer, unified revenue streams under standardized service contracts, and by ensuring economies of scale.

Target KPI levels for facilities within each lot have also been standardized, simplifying the bidding process and allowing ESCOs to replicate designs efficiently while retaining flexibility to optimize systems. Lessons learned from the initial tenders for the Ministry of Education and Sports and the Ministry of Health are expected to inform future tender designs in Uganda and beyond.

Well-structured 5P contracts also create a new market segment for ESCOs, offering predictable service-based revenues and opportunities for long-term growth. Over successive tenders, firms can build institutional knowledge, standardize processes, and capture efficiencies that lower costs and improve system performance.

However, in many fragile or low-income contexts, the domestic private sector ecosystem remains limited. Local ESCOs may lack the capacity to bid on multisite contracts, supply chains may be unreliable, technicians undertrained, and financiers reluctant due to currency, political, or payment risks. In such settings, regional or international providers can bridge capacity gaps, bringing finance and technical expertise while partnering with local firms for operations and maintenance. Far from displacing domestic players, these partnerships can strengthen local capacity and gradually build sustainable markets.

Development partners play a complementary role in strengthening private sector readiness, as summarized in Table 5.3.

TABLE 5.3 Development Partner Support to Strengthen Private Sector Readiness for the 5P Model

TYPE OF DEVELOPMENT PARTNER SUPPORT	DESCRIPTION	PRIMARY RECIPIENT(S)
Market Scoping and Matchmaking	Support for market assessments, investor roadshows, and matchmaking events to identify and connect ESCOs, financiers, and suppliers with 5P models opportunities.	Local and regional ESCOs, investors, government agencies
De-risking Instruments	Use of guarantees, first-loss capital, and credit enhancements to reduce risk exposure for ESCOs and financiers operating in high-risk or low-capacity environments.	Private financiers, ESCOs, DFIs
Concessional Finance for CAPEX	Provision of grants or low-interest loans to help offset high upfront capital costs for private providers in underserved markets.	ESCOs, private project developers
Business Development Services	Technical assistance for local firms to strengthen internal systems, improve bidding capacity, meet eligibility criteria, and scale operations.	Local ESCOs, energy SMEs
Regional Market Entry Support	Facilitation of entry by experienced regional or international ESCOs into new or fragile markets, potentially through partnerships with local firms.	Regional ESCOs, local partner firms
Workforce Training and Certification	Funding for technician training programs, certification schemes, and workforce development to ensure quality installation and long-term maintenance capacity.	Technicians, training institutions, local firms
Supply Chain Strengthening	Support to improve access to spare parts, tools, and logistics networks that underpin reliable service delivery.	Local distributors, maintenance firms, ESCOs

Private sector interest is a function of the enabling environment. Where the right policies, coordination, and payment systems are in place, the private sector will see the 5P model as a viable investment opportunity. Without the 5P, tenders will attract few bidders, limiting competition and undermining service quality.

5.5 ELECTRIFICATION PLANNING

The effectiveness of the 5P model is enhanced by effective, coordinated electrification planning. Equipped with reliable data, countries can shift from fragmented project implementation toward **coordinated electrification strategies**. This includes integrating public institutions into broader sector electrification and donor coordination plans, as in Malawi (Box 5.6).

BOX 5.6

CASE STUDY: MALAWI'S HEALTH FACILITY ELECTRIFICATION PLAN

Contribution from Zhengjia Meng, Lead Energy Specialist, the World Bank

In Malawi, the Ministry of Health (MoH), with support from the World Bank and development partners, has taken a leadership role in developing a national health facility electrification plan.

Recognizing the need for coordinated action, the MoH established a dedicated task force comprising senior health officials, biomedical engineers, the Ministry of Energy, and key donors and partners. The Clinton Health Access Initiative was asked to serve as the task force secretariat. From the outset, the government directed the process, ensuring alignment with national health priorities and focusing on the central question: which health facilities are electrified, and how reliable is their power supply? To address this, least-cost electrification planning was combined with facility mapping, though early efforts revealed significant gaps and inaccuracies in existing geospatial data.

To resolve these challenges, the MoH launched a nationwide facility verification campaign. Instead of conducting a standalone survey, the electrification assessment was integrated into an ongoing capital planning exercise, allowing field teams to collect data on both infrastructure and energy access. This comprehensive effort has gathered detailed information on the presence and functionality of solar systems, wiring conditions, device usage, system maintenance, and frequency of power outages. By grounding planning in reliable, government-led data, Malawi is setting the stage for more effective coordination between the health and energy sectors, ensuring that future investments in electrification are better targeted, sustainable, and directly responsive to the needs of health facilities. The World Bank is working to support health facility electrification according to this national plan through the ASCENT Malawi Project.

Unfortunately, many national plans still fall short of articulating how different ministries should collaborate or how investment planning should align with long-term service delivery. Ministries of energy, health, and education often develop overlapping or disconnected initiatives, using different planning tools, technical standards, and financing channels. Without clear mechanisms for coordination, facilities may be left unelectrified or receive solutions that do not match their operational needs.

Platforms like the Distributed Renewable Energy (DRE) Atlas, developed by ESMAP, provide powerful tools for this purpose. By combining comprehensive geospatial data and advanced filtering capabilities, the DRE Atlas helps governments make informed investment decisions about facilities that may be suitable for electrification through DRE solutions like mini grids (Box 5.7).

BOX 5.7

THE ROLE OF GEOSPATIAL PLANNING: ESMAP'S DISTRIBUTED RENEWABLE ENERGY ATLAS

Contribution from Ashish Shrestha, Energy Specialist, the World Bank

Geospatial planning tools are critical to supporting efficient, least-cost electrification planning for public institutions. ESMAP's **Distributed Renewable Energy (DRE) Atlas** is a cutting-edge, open-access geospatial planning tool designed to support governments and development partners in accelerating progress toward universal electricity access. By integrating high-resolution data on population distribution, existing infrastructure, electricity networks, and social services, the DRE Atlas enables users to conduct multicriteria analyses to better match public institutions with suitable electrification solutions.

For public institutions such as schools and health centers, where data gaps are often a major barrier, the DRE Atlas allows planners to visualize social infrastructure locations and assess their proximity to existing electricity networks. This helps identify unelectrified facilities, estimate energy demand based on facility type, and prioritize investment decisions. By bringing together geospatial analytics and sector-specific data, the DRE Atlas enhances coordination among stakeholders and supports more informed, transparent, and cost-effective planning for public institutions electrification.

For more information, visit: https://www.esmap.org/global-electrification-platform-gep and https://dre.energydata.info/.

5.6 BUILDING PUBLIC SECTOR CAPACITY AND COORDINATION

As governments transition to service-based electrification models for schools, health centers, and other public facilities, the role of stakeholders will evolve accordingly.

A new division of labor can emerge in which energy teams are best positioned to lead on business model design, procurement, and infrastructure oversight, while health and education counterparts bring the institutional knowledge and sector-specific data necessary to plan electrification, prioritize facilities, and support service continuity. Table 5.4 outlines these technical roles. Chapter 6 explores the financial responsibilities further.

TABLE 5.4 Roles and Responsibilities of Stakeholders

ACTOR	PLANNING AND DESIGN	PROCUREMENT	IMPLEMENTATION
Ministry of Energy	• Lead design of 5P model • Ensure alignment with national electrification plans • Coordinate market assessments	• Support procurement of ESCOs • Provide technical guidance and oversight • Manage remote monitoring platforms	• Coordinate performance oversight • Liaise with ESCOs and third-party verifiers
Beneficiary Ministries	• Define energy needs by facility • Validate technical and service-level requirements	• Participate in bid evaluation and solution design • Confirm alignment with service goals	• Monitor service delivery • Verify performance indicators • Ensure timely payments

More specifically, beneficiary ministries, typically health and education, must play a central role in the energy service relationship. As the owners or custodians of public facilities, these ministries are directly responsible for stipulating energy delivery contracts with the private sector. They must lead the tendering processes and participate in the monitoring and verification of performance indicators. Chapter 6 addresses how these ministries should also budget and secure funding for energy services, engaging with the Ministry of Finance to secure such budget lines.

The Ministry of Energy holds technical and strategic leadership for the 5P model. It is typically responsible for providing technical assistance to the beneficiary ministries for the procurement of the ESCOs, including market assessment and private sector mobilization, quality assurance, and alignment with broader electrification plans. The ministry should also lead the coordination of technical assistance and capacity building programs, positioning itself as a bridge between technical service providers and beneficiary ministries.

Additional ministries can play supportive roles. The **Ministry of ICT or Digital Affairs**, for instance, can assist with network connectivity, data security, and integration of monitoring platforms within national government systems. **Planning ministries** may help ensure that the 5P model is embedded in national development strategies and coordinates donor support for infrastructure investments.

In practice, many governments lack the institutional capacity or legal frameworks to manage such arrangements. Gaps may include weak procurement capacity, limited ability to monitor performance, poor interministerial coordination, and absence of enabling regulations for long-term contracting with private providers.

Development partners can play a catalytic role in filling these capacity gaps. They can support ministries in designing and implementing standardized procurement and contracting frameworks, establish digital monitoring platforms, and develop protocols for performance verification. Beyond tools and systems, targeted training programs are essential to ensuring that national and subnational officials have the skills to manage contracts, interpret data from monitoring systems, and engage in long-term planning for service delivery.

Support can also extend to helping governments establish the necessary legal and policy frameworks to enable private sector participation. In several countries, there is no enabling legislation or institutional mandate for ministries to enter into long-term service agreements with private operators. Development partners can help fill this gap by advising on policy reforms, updating public procurement regulations, and embedding 5P principles into national electrification strategies. Table 5.5 summarizes the areas of support that can strengthen government readiness to implement and manage 5P programs at scale.

TABLE 5.5 Development Partner Support to Strengthen Public Sector Capacity for 5P Implementation

TYPE OF DEVELOPMENT PARTNER SUPPORT	DESCRIPTION	PRIMARY RECIPIENT(S)
Procurement and Contracting	Development of standardized bidding documents, service agreement templates, and evaluation criteria for procurement.	Ministries of energy, health/education
Performance Monitoring Systems	Financing and deploying digital platforms; training ministries to use real-time dashboards and escalation protocols.	Ministry of Energy, beneficiary ministries
Digital Infrastructure	Investment in connectivity, data integration, and secure digital systems to enable monitoring, enforcement, and reporting.	Ministries of ICT, energy, health/ education
Policy and Regulatory Reform	Assistance in developing or adapting national policies and legal frameworks to enable long-term private sector participation and service contracting.	Ministries of energy, finance; legal bodies
Interministerial Coordination	Support to establish national task forces or steering committees to ensure alignment across sectors.	Ministries of energy, finance, planning; line sectors
Training and Capacity Building	Technical training on procurement, contract management, budget planning, performance verification, and use of monitoring platforms.	National and subnational government officials

As governments strengthen capacity, they may also consider establishing one-stop coordination hubs to centralize responsibilities across relevant ministries and stakeholders. These hubs can serve as focal points for planning, procurement, contract management, monitoring, and capacity-building activities, streamlining communication and reducing administrative friction. The most appropriate hosting unit—whether within the Ministry of Energy, a cross-sectoral task force, or a dedicated agency—will depend on each country's institutional structures, legal frameworks, and administrative capacities. Importantly, the design and scope of these coordination mechanisms should be tailored to local contexts: there is no one-size-fits-all solution. When implemented thoughtfully, such hubs can enhance interministerial collaboration, consolidate technical expertise, and provide a platform for ongoing engagement with private sector partners, ultimately supporting more effective and sustainable 5P implementation.

Building public capacity must go together with private sector readiness. Where governments provide clear rules, reliable payments, and well-structured contracts, private firms view the 5P model as a viable long-term business. Without this foundation, tenders risk attracting few bidders and undermining service quality.

Endnotes

1 Instead of storing energy in batteries, SDD refrigerators store it in thermal form, typically through high-efficiency insulation and an "ice bank" or phase-change material that maintains stable temperatures overnight or during cloudy periods. This avoids the need for batteries, which are the weakest and most expensive link in most solar electric systems.

6. BUILDING BLOCK 2: MOBILIZING PRIVATE CAPITAL AT SCALE THROUGH PUBLIC LEVERAGE

KEY TAKEAWAYS

- **Public and development partner funding cannot achieve universal electrification of public facilities.** Yet, private capital has scarcely entered this space, due to an affordability gap and high offtaker risks.
- **The 5P model suggests new roles for public and private financing** to maximize leverage and sustainable service provision.
- **Governments can provide predictable, performance-based payment**s through streamlined processes, creating cashflow certainty for private investors and enabling long-term energy service contracts. Development partners can support capacity gaps, cofinance payments, or backstop risks.
- **ESCOs and private investors finance, build, and operate off-grid systems at their own risk,** recouping investment only when agreed KPIs are met. Private financing can include equity, concessional debt, commercial debt, and guarantees, helping smaller or early-stage firms participate and derisking investments in low-income or fragile contexts.
- **To meet universal electrification, public funding must increase from $120 million to $500 million annually,** while private contributions should rise from $20 million to $200 million by 2030.
- **Effective tenders** can bundle facilities, group them regionally, and standardize KPIs to attract private providers, reduce costs, and simplify operations. Coupled with long-term contracting, this approach creates a predictable market for private sector growth and economies of scale.

As highlighted in Chapter 1, electrifying public institutions faces a substantial financing gap. Roughly 760,000 schools, health centers, and other public facilities across low- and middle-income countries could be most cost-effectively served through off-grid solar (OGS) solutions. Reaching this target by 2030 will require an estimated $2.4 billion in capital investment (ESMAP, GOGLA, Dalberg, 2024). As Chapter 3 further shows, this challenge is worsened as schools and health centers are repeatedly re-electrified when systems fail due to a lack of maintenance. Finally, as noted in Chapter 4, traditional service delivery models are unable to electrify off-grid public institutions in developing countries, as end-users cannot afford fully commercial service fees.

The 5P model addresses these challenges through a strategic blend of public and private capital, supported by long-term operational commitments and development partner assistance.

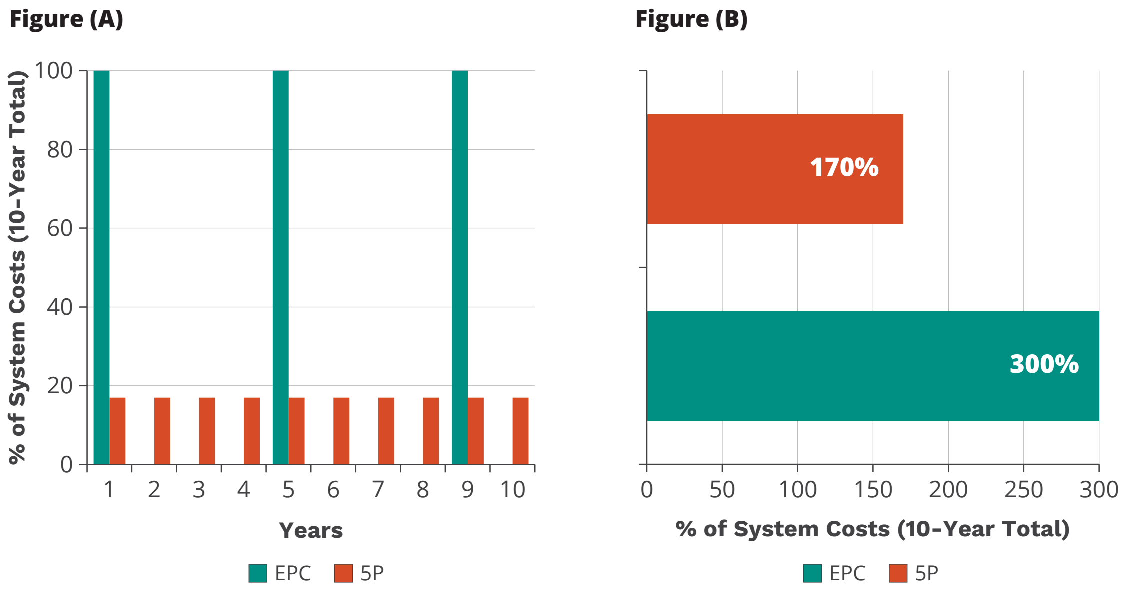
This chapter examines how predictable, performance-based payments from the public sector—with assistance from development partners—can mobilize private investment, the forms this investment can take, and how effective tendering can help energy service providers achieve economies of scale.

6.1 THE ROLE OF PUBLIC SECTOR FUNDING

5P models rely on public sector funding to mobilize private sector capital. In the context of an energy service contract, this means that governments must commit to paying for the energy services over time—just as they do for salaries, supplies, and essential infrastructure maintenance. This ongoing stream of public payments creates the cashflow certainty that enables private firms and financiers to invest confidently in long-term service contracts and relieves governments from the need to raise capital investment funding.

A simple but powerful way to demonstrate the impact of 5P models on public funding is through a comparative investment flow diagram that contrasts it with the traditional EPC approach presented in Figure 3.1. Figure 6.1 (a) illustrates this comparison clearly: while the EPC model shows **repeated public funding spikes** to replace failed systems every few years, the 5P model features **stable, performance-linked service payments.** Likewise, Figure 6.1 (b) shows a side-by-side comparison of the **10-year total costs** of both approaches. EPC procurement results in three system replacements over the period. In contrast, 5P results in 170 percent of system costs on a discounted basis, including both installation and O&M.

FIGURE 6.1 (A) EPC vs. 5P Model Annualized Cost Comparison of a Solar PV System[a]
(B) EPC vs. 5P Model 10-Year Cost Comparison of a Solar PV System[b]



Note: a) The graphs are designed to illustrate the difference in approach between the models analyzed. EPC annualized cost assumes three full system replacements over a 10-year horizon, with no O&M. For simplicity, no discount value was added, as it is assumed to be offset by system price increases. As in Figure 4.1, these assumptions are based on field data, which estimate that many PV systems become inoperative after three to five years due to a lack of proper maintenance and repair services, and register multiple donor investments in a similar time frame (UN Foundation, SEforALL, 2019). The 5P annualized cost includes installation + O&M (7% of system cost per year), levelized over 10 years. All costs are expressed as the percent of the initial system cost to enable relative comparison. For both EPC and 5P, profits, financing, and discounting have not been included, to allow for direct cost comparison. b) Assumptions are the same as for Figure 6.1 (a).

Source: World Bank staff.

Regular government payments are anchored in the principles below.

The first and most fundamental requirement is a clear, sustained commitment from the government to finance energy services over the medium to long term. This includes line ministries—such as health and education—formally recognizing energy access as vital to service delivery and embedding it into operational budgets. Equally important is the role of the Ministry of Finance, which must reflect energy service payments in annual budget ceilings and multiyear expenditure frameworks. Without this foundational signal, ESCOs perceive significant counterparty risk, which in turn leads to limited market participation and higher risk premiums.

Centralized payments reduce payment fragmentation, improve predictability and cash flow management, and strengthen contract enforcement by reducing the number of actors involved.

Second, payment responsibility should be centralized. In 5P models that reach scale, payments are generally made not by individual schools or health centers, but by a central government entity, typically the beneficiary ministry or Ministry of Finance. To reinforce this structure, governments may adopt mechanisms like protected budget lines, escrow accounts, or social infrastructure electricity accounts that ringfence payments for energy services and limit budget diversion risk. The requirements for these accounts tend to vary on a country basis and should therefore be explored within individual projects.

Third, even with centralized budgets, the credibility of government payments hinges on execution. This means clear, fast, and streamlined protocols for invoice submission, verification, approval, and disbursement. Delays and lack of transparency in any part of this process increase the financial burden on ESCOs, which must otherwise rely on expensive working capital or risk payment default. Governments can build on the **technical elements and resources** presented in Chapter 5 to establish clear service-level agreements with simple KPIs and payment triggers, where remote monitoring systems are used to automate performance verification and trigger payments in a transparent, reliable manner. These signals **reduce the perceived risk** of doing business with the government, improving participation and lowering bid prices.

Even with these principles in place, some governments may struggle to meet the institutional or financial capacity to pursue such contracts. In these cases, **development partners** can play a catalytic role by cofinancing service payments, backstopping payment risk, or providing technical assistance to improve financial management systems.

6.2 EXPANDING PUBLIC FISCAL SPACE THROUGH DEVELOPMENT PARTNERS

Despite the principles above, many governments in low-income or fragile settings have limited fiscal space to support long-term service payments. Public budgets are often overstretched by competing social priorities, rising debt service obligations, and currency volatility. These pressures constrain governments' ability to reliably fund recurring energy service payments, the public sector's cornerstone for the deployment of the 5P model.

In these contexts, development partners can step in not simply as financers of capital expenditures, but as long-term partners in ensuring service continuity. As seen in Chapter 3, traditionally, donor financing in the off-grid and public infrastructure space has focused on upfront capital grants, resulting in infrastructure failing prematurely.

Development partner support must therefore evolve to target the affordability gap over time. This means directing funds toward **performance-linked subsidies and financing mechanisms** that make recurring service payments viable for governments. These subsidies can take various forms: partial capital buydowns to reduce total system cost, output-based disbursements tied to verifiable service levels, or cofinancing mechanisms that top up public contributions over multiple years. This ensures continued engagement from both governments and service providers and reduces the risk of short-termism.

Following the above, development partner support should also be leveraged from relevant health and education programs, whose funds can be deployed to support ongoing payments for energy services (Box 6.1).

BOX 6.1

FINANCIAL SUPPORT FOR ONGOING EXPENDITURES FROM HEALTH AND EDUCATION PROGRAMS

Contribution from Samer Al-Samarrai (Lead Education Specialist), Sergio Venegas Marin (Education Specialist), Tamer Samah Rabie (Lead Health Specialist) and Stephen Geoffrey Dorey (Senior Health Specialist), the World Bank

Development partners and World Bank operations in the health and education sectors have a long history of supporting the improvement of public service delivery, which in some cases has involved covering certain recurring costs. Through investment operations with results-based components, projects have financed expenditures such as the procurement of school supplies, distribution of medicines, and the installation and maintenance of water and sanitation (WASH) facilities in schools. These mechanisms demonstrate that donor financing is not confined to capital investments; it can also be structured to sustain selected ongoing costs that underpin the effective operation of schools and health facilities. This precedent is highly relevant for the 5P model, where recurring payments are essential to ensuring reliable energy access over time, particularly in areas with low public fiscal space.

Experience further shows that integrating operational support into sector programs enhances sustainability. For example, in education projects, funding for textbooks, learning materials, and maintenance of WASH facilities is often combined with infrastructure upgrades to maximize impact and ensure facilities can function effectively. The WASH example is particularly instructive: performance-based indicators can be used to ensure the continued maintenance and availability of water in school facilities, demonstrating how results-based financing can sustain essential services over time. Similarly, health operations have covered essential medicines, diagnostic supplies, and maintenance of cold-chain systems alongside the construction or rehabilitation of facilities. These practices provide a strong basis for extending support to energy-related service payments, recognizing that reliable electricity is now just as fundamental to teaching and health care delivery as staff or supplies.

Equally important is the coordinated work to ensure that such expenditure contributes to lasting improvements in service quality. Health and education programs routinely apply quality assurance standards to equipment procurement, whether for school furniture, ICT devices, or medical technologies. Partnerships with technical agencies and initiatives such as WHO prequalification schemes or national standards bodies help ensure that goods and services financed under donor programs are safe, effective, and durable. Applying the same approach to energy systems—ensuring that service providers adhere to quality and performance standards—would safeguard service reliability and value for money.

In this way, existing sector financing frameworks already provide the tools and precedents to sustain ongoing operational costs. Extending them to cover electricity service fees under the 5P model would align with established practices in health and education, while ensuring that facilities are consistently powered to deliver quality services.

Box 6.2 presents additional instruments that could support ongoing budgetary requirements for governments to implement 5P models.

BOX 6.2

THE POTENTIAL ROLE OF SOVEREIGN WEALTH FUNDS AND DEBT-FOR-DEVELOPMENT SWAPS

Contribution from Jessica Erikson Stiefler, Lead Infrastructure Finance Specialist, MIGA

Sovereign wealth funds (SWFs) offer a promising source of predictable, long-term financing for social infrastructure electrification in Africa. Funded largely by commodity revenues, these state-owned investment vehicles are increasingly pursuing opportunities that align financial returns with sustainable development goals. While many SWFs have traditionally focused on preserving capital and safeguarding intergenerational wealth, a growing number—particularly those with strategic or development mandates—are investing in renewable energy, health care, and digital infrastructure that deliver broader social and economic benefits.

As of 2025, over 20 African countries operate SWFs, many of which prioritize national development objectives over purely commercial returns. These funds often blend public and private capital, support economic diversification, and align with human capital goals. Well-designed social infrastructure electrification programs therefore present a compelling opportunity for SWFs to invest in national priorities that promote human development while generating long-term economic value. With their broad reach and measurable social impact, such programs are particularly well suited to SWFs with strategic or impact-oriented mandates.

Within a 5P framework, SWFs can partner with the private sector to improve resource allocation and provide stable, long-term contributions toward energy service or lease payments. This helps make private investments in school and health center electrification more bankable while reducing reliance on annual public budgets. The approach supports SWFs' strategic objectives—economic diversification, intergenerational equity, and sustainable development—while positioning them as long-term partners in building resilient and inclusive infrastructure systems.

Complementary financing mechanisms such as **sustainability bonds and debt-for-development swaps** can also help secure predictable funding for energy services in underserved areas. Sustainability bonds raise capital for projects with social and environmental benefits, generating steady cashflow through interest payments and project-linked revenues, while sustainability-linked bonds can tie returns to performance indicators such as emission reductions or education outcomes. Debt-for-development swaps, in contrast, convert part of a country's debt into investments for agreed development priorities, creating a steady funding flow through structured disbursements and fiscal reallocation.

Both instruments face challenges in identifying suitable projects due to limited pipelines of well-prepared, high-impact initiatives. Social infrastructure electrification programs can help bridge this gap by providing investment-ready projects that are additional, strategically aligned, and designed for long-term sustainability and measurable development outcomes.

In this light, fiscal constraints should not be viewed as a barrier to electrification, but rather as a signal for where smart, sustained donor and development partner engagement is most needed. With the right combination of performance-linked financing, coordinated support, and adaptive contracting, the 5P model can thrive even in low-resource settings, delivering durable, high-impact electrification to the institutions that need it most.

6.3 THE ROLE OF PRIVATE SECTOR CAPITAL

As shown, the 5P model unlocks private investment through predictable, performance-based cashflow over time from the public sector. ESCOs are incentivized to finance, build, and operate off-grid systems at their own risk—recouping their investment only when they deliver energy services that meet agreed KPIs. This dynamic fundamentally shifts the risk-reward balance: the public sector commits to outcomes, not assets, while the private sector designs and finances the systems to deliver those outcomes as efficiently as possible.

Private capital can enter 5P transactions in several forms. For smaller ESCOs or early-stage markets, equity and concessional debt may dominate, often backed by impact investors and development finance institutions. In more mature or aggregated deals, commercial debt becomes viable—especially when paired with public guarantees or first-loss instruments.

Development partners have a critical role in providing concessional capital, guarantees, and other derisking instruments that lower financing costs and attract private investors. Namely, they can ensure that smaller and local ESCOs have access to financing, structure instruments to reflect the long-term nature of service contracts, and provide risk coverage in fragile or underserved markets where private capital is reluctant to engage. Table 6.1 summarizes their role in deploying financial instruments to catalyze markets, and Box 6.3 presents examples of debt and equity facilities.

TABLE 6.1 Financial Instruments for Private Sector Mobilization and their Role

INSTRUMENT	PURPOSE IN THE 5P MODEL	ROLE OF DEVELOPMENT PARTNERS
Credit Lines	Provide access to debt for ESCOs to finance CAPEX and manage cashflow gaps.	Establish concessional, long-tenor credit lines tailored to service contracts, extend access to smaller/local ESCOs, and reduce cost of capital.
Commercial Debt	Provide debt to more mature ESCOs at the commercial rate to scale up the 5P model in already established settings familiar with the model and off-grid solar electrification.	Provide partial guarantees, first-loss facilities, or blended finance to attract commercial lenders and expand reach to underserved populations.
Equity Facilities	Support early-stage and smaller ESCOs with growth capital to enter service-based markets.	Capitalize dedicated equity funds or co-investment platforms, with a focus on local and undercapitalized firms to broaden market inclusivity.
Guarantees	Mitigate risks such as nonpayment, currency inconvertibility, transfer risks, or termination due to government default.	Design instruments covering government payment default or political risks, improving project bankability and investor confidence, particularly in fragile markets.

BOX 6.3

LENDING AND EQUITY PROVISION THROUGH INTERNATIONAL FINANCE CORPORATION

Contribution from Yann Tanvez, Senior Investment Officer, IFC

Donors and development finance institutions can play a catalytic role by establishing low-interest, long-tenor debt facilities tailored to service delivery operators of the 5P model. Such credit lines enable ESCOs to bridge the gap between large upfront capital expenditures and staggered inflows from grant disbursements or performance-based payments. By reducing the cost of capital, concessional lending improves project margins, enhances commercial viability, and opens the market to smaller or younger firms—particularly in higher-risk, last-mile contexts. Longer loan tenors also lower repayment burdens, ultimately supporting affordability for end-beneficiaries.

Beyond debt, equity support is equally essential, especially for early-stage or locally owned companies. In many markets, promising ESCOs lack sufficient, affordable, and fit-for-purpose equity to finance the initial investments required for multiyear service contracts. Equity facilities can address this gap either through direct investments in companies or by capitalizing funds that prioritize local and emerging ESCOs. Affordable patient equity allows firms to stabilize, refine business models, and eventually leverage debt more effectively. The World Bank and partners are developing such mechanisms, recognizing that without early equity, many local players will remain excluded from the transition to sustainable service-based electrification.

Guarantees also play a critical role in derisking the 5P model for public institutions by helping the private sector address government payment default risk, political or regulatory uncertainties, and even currency inconvertibility or expropriation in fragile and low-income markets. These instruments are particularly important where government budget execution or creditworthiness may be a concern for investors. By improving the credit profile of service contracts and enhancing project bankability, guarantees help crowd in private debt and equity and ensure that investors remain engaged over the long term, even in challenging markets. Box 6.4 presents an example of such guarantee mechanisms.

BOX 6.4

THE WORLD BANK GUARANTEES PLATFORM'S PROPOSED REVOLVING LIQUIDITY SUPPORT FACILITY

Contribution from Jessica Erickson Stiefler, Lead Infrastructure Finance Specialist, MIGA

The World Banks Guarantees Platform (housed at the **Multilateral Investment Guarantee Agency (MIGA)**, a member of the World Bank Group), is developing a fit-for-purpose guarantee mechanism to unlock private investment in off-grid electrification for public facilities such as schools and health centers. Unlike utility offtakers for large grid-connected independent power producers (IPPs), these public institutions rely on budgetary allocations to sustain timely payments under the energy service agreement. This increases the risk perception for payment delays, nonpayment, and early termination, adversely impacting the project's bankability. MIGA's response is a revolving direct payment guarantee, specifically tailored to this use case.

This mechanism does not rely on a letter of credit. Instead, it offers a flexible, revolving guarantee payment that disburses compensation directly to the private service provider when payments are overdue and that replenishes once government payment arrears are cleared and the guarantee disbursements are repaid to MIGA. The structure includes:

- A contractual link to the sovereign, either as the direct counterparty or guarantor of the payment obligations (a counter-indemnity is not required).
- A third-party monitoring and verification agent who confirms ESCO performance, supporting the government in the timely payment of invoices linked to performance verified outcomes.
- No requirement for an arbitral award to trigger a claim, expediting response and payout.[1]

This payment guarantee, which is available for projects with a foreign investor, is designed to work in parallel with MIGA's breach of contract insurance (which requires an arbitral award), offering layered protection for both ongoing availability payments and termination events. For private investors, this provides the clarity and comfort needed to operate in low-income settings. For governments, these guarantees lower investors' risk perception, reducing risk premiums embedded in the service cost and increasing tender competition by crowding in more ESCOs. Furthermore, by crowding in private sector capital, governments can optimize the use of donor resources for further facility electrification or investment in downstream health and education equipment and services. By derisking public service delivery, MIGA's new tool is expected to be a gamechanger for scaling the 5P model in underserved areas.

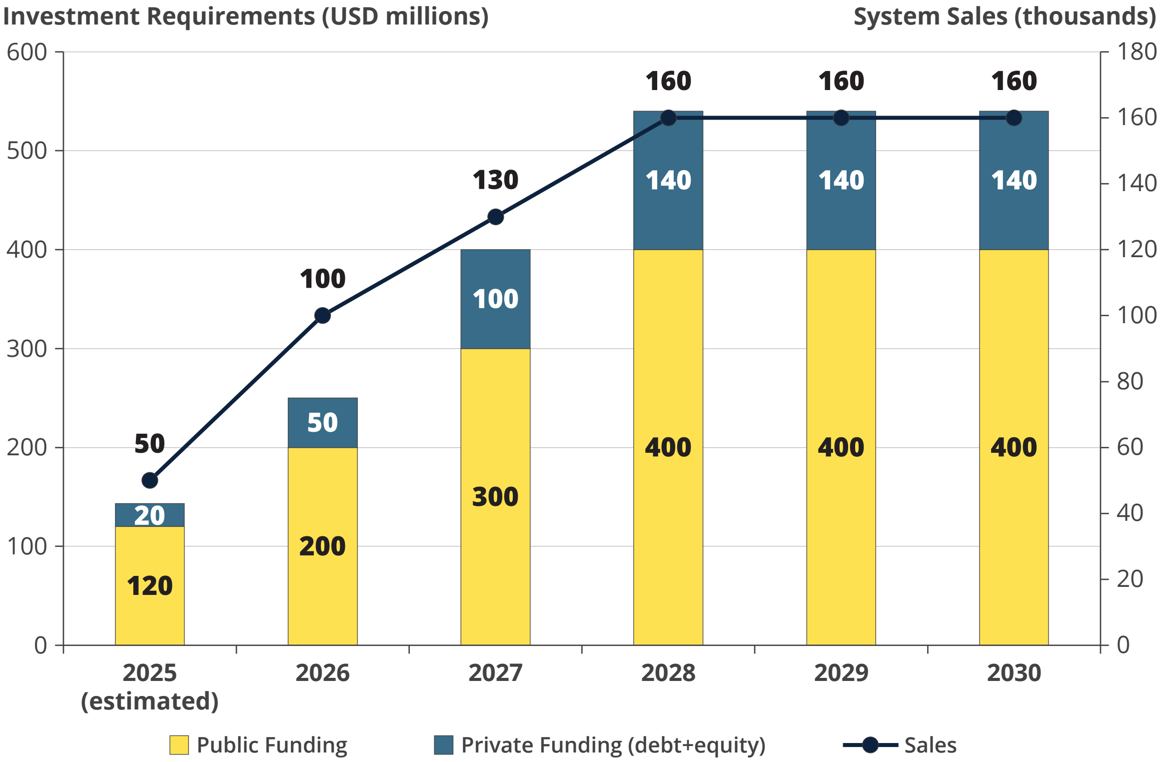
Figure 6.2 provides an estimate of the **annual investment** between 2025 (estimated data based on current trends) and 2030 that is required to achieve the electrification of the facilities that are cost-effectively electrified via OGS estimated to amount to 760,000 (ESMAP 2024). It also shows the funding requirements of the public and private sectors and an estimate of the sales trends required to meet these targets.

The model presented in Figure 6.2 assumes a gradual scale-up in deployments over the 2025–30 period, with increased efficiency and cost reductions achieved through procurement at scale. Annual electrification targets were developed based on projected implementation capacity and the current readiness of government and market systems.

Based on these estimates, public funding must rise from the current **$120 million** to **$400 million annually by 2028–30**.[2] Private capital contributions should increase from **$20 million in 2025** to **$200 million annually by 2030**, driven by scalable business models, concessional finance, and risk mitigation instruments.

> **The purpose of private sector mobilization for the 5P model is twofold.** First, it **multiplies the value of public capital** by leveraging several dollars of private capital for every dollar of public contribution. Second, it **aligns incentives:** ESCOs must deliver quality service to be paid, and financiers are incentivized to ensure that service continues reliably over time.

FIGURE 6.2 Estimated Annual Investment Required to Achieve Universal Access to Electricity for Facilities Best Served Via OGS by 2030 (USD millions), and Estimated Annual OGS System Sales by 2030 (thousands)



Source: ESMAP 2024.

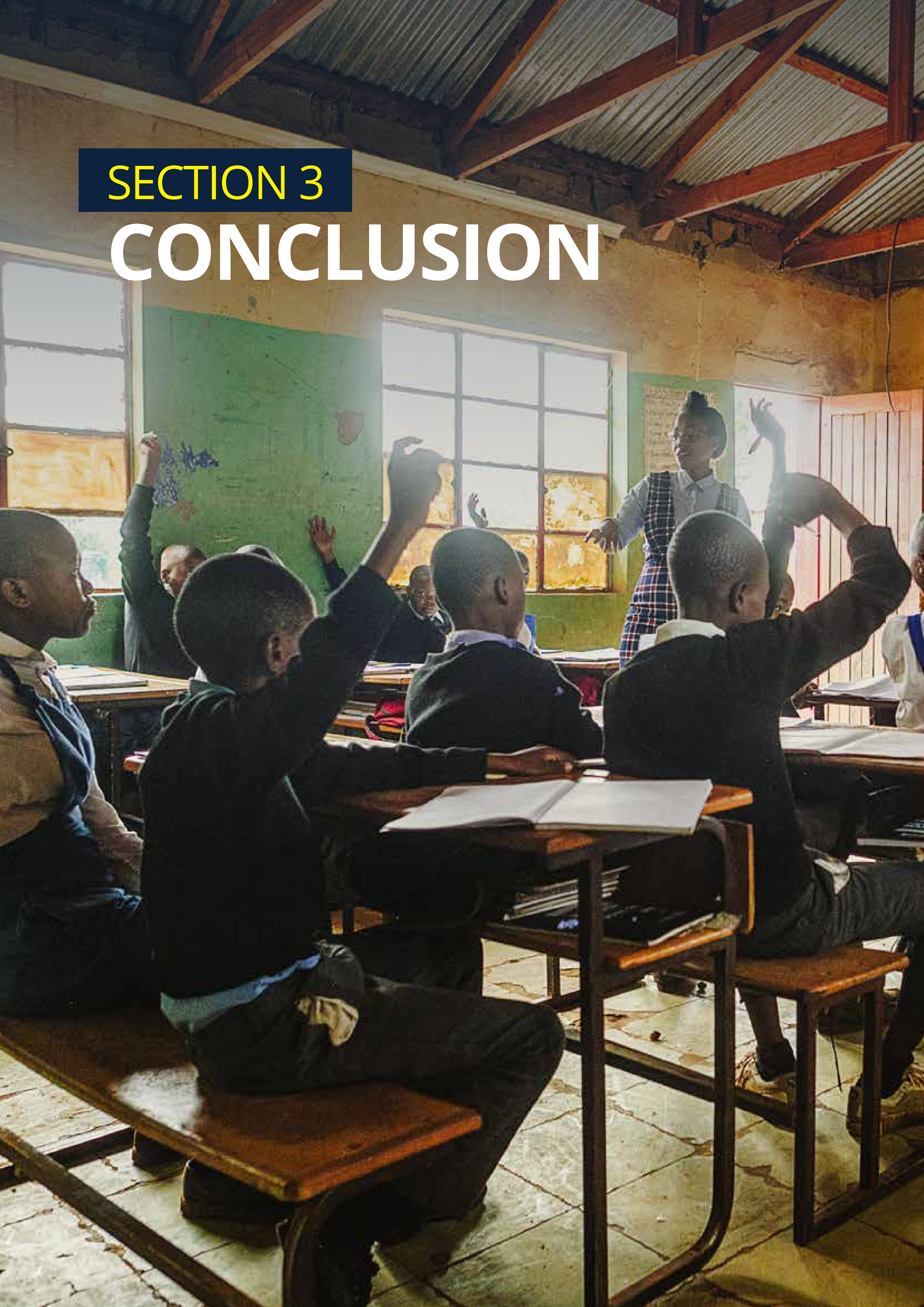
Endnotes

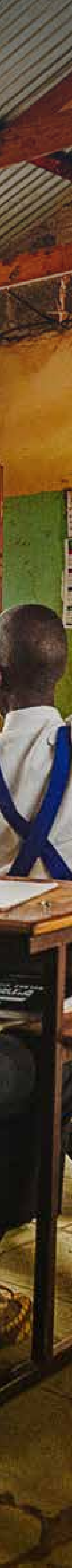
1 Disbursement of the payment guarantee does not settle the government's payment obligation under the project agreement. The project agreement payment will remain outstanding until the arrears are cleared by the government. At that time, the project company will repay disbursements under the guarantee and the available capacity of the guarantee can be reinstated.

2 2025 funding is based on current World Bank public institutions electrification funding trends. It is estimated that the World Bank has allocated an annual $80 million dedicated to OGS electrification of schools and health centers between fiscal years 2018 and 2025. Funding from other donors has been estimated as 50 percent of the current World Bank funding, for 2025. The funding needs are number of institutions best server by OGS technologies are resulting from the OGS Market Trends Report 2024.

SECTION 3

CONCLUSION





The 5P framework represents a critical evolution in the electrification of off-grid public institutions. The 5P model addresses two of the most persistent challenges in this sector: ensuring reliable electricity over time and bridging the financing gap that public budgets alone cannot fill. Part I of this report demonstrates that traditional EPC approaches are inherently limited. Without mechanisms for operations, maintenance, and performance accountability, investments are at risk of repeated failure and escalating costs, and public funding alone constrains the pace and scale of electrification.

Early initiatives implementing 5P principles show that service-based electrification is not only feasible but preferable, particularly in environments where system reliability has historically been elusive. Lessons from these pioneering projects—such as Uganda's EASP—demonstrate that structured public financing, when strategically deployed to leverage private sector participation, can generate sustainable, high-quality energy access. By aligning incentives through performance-based contracts, these models encourage private actors to invest, innovate, and deliver reliable services, while governments and donors can focus scarce resources strategically rather than repeatedly funding system replacements.

Even in contexts where full 5P implementation is not immediately feasible, the principles of the framework remain highly valuable—even for EPC approaches. Governments and development partners can embed long-term service obligations, coordinate across ministries, and establish pooled O&M or multidonor funds to protect investments and maintain continuity. These measures lay the groundwork for future private sector engagement and service-oriented contracts, ensuring that electrification efforts are not temporary stopgaps but sustainable investments in human development. However, without private sector participation, such approaches will remain limited in funding and will achieve electrification only at the pace allowed by public and donor budgets.

The 5P model provides a pathway for transformative, sustainable electrification: it protects public funds, ensures reliable power to schools and health centers, and unlocks private sector capital that multiplies the reach and effectiveness of public investment. By adopting and adapting these principles, countries can accelerate progress toward universal access, ensuring that every student can study with light, every patient receives care with functioning equipment, and every community benefits from the reliable public services that electricity makes possible.

Moreover, the 5P framework can extend well beyond energy services. Its principles—strategic public-private collaboration, performance-linked incentives, capacity building, and long-term planning—are applicable to a broad range of essential public services, from water and sanitation to digital connectivity. By embedding these practices, governments and partners can build systems that are resilient, accountable, and scalable, amplifying the impact of limited public and donor resources and laying the foundation for long-term development outcomes across sectors.

Bibliography

Adamba, C. 2018. "Effect of School Electrification on Learning Outcomes: A Subnational Level Analysis of Students' Pass Rate in English and Mathematics in Ghana." *Educational Research for Policy and Practice:* 15−31.

Al-Akori, A. 2014. *PV Systems in Rural Health Facilities in Developing Areas: A Completion of Lessons Learned.* International Energy Agency. https://iea-pvps.org/wp-content/uploads/2020/01/IEA-PVPS_T9-15_2014_PV_for_rural_health_facilities.pdf.

Ali, S., and R. Tongia. 2018. *Energy sector data: Suggestions for improving data quality and usability.* Washington, DC: Brookings Institution. https://www.brookings.edu/research/energy-sector-data-suggestions-for-improving-data-quality-and-usability/.

Bluesun Solar. 2024. *Solar Service Centers.* https://www.youtube.com/watch?v=VA4GqBSr2ao.

CLASP. 2021. *Medical Equipment & Clinic Electrification.* Efficiency for Access.

Dauenhauer, P., and D. Frame. 2016. *Sustainability analysis of off-grid community solar PV projects in Malawi.* https://www.researchgate.net/publication/313805683_Sustainability_analysis_off-grid_community_solar_PV_projects_in_Malawi.

Devi, A., and P. Deka. October 24, 2019. "Powering Remote Hospitals with Solar: Overcoming the Remaining Challenges." Insights Commentary. World Resources Institute, Washington, DC. https://www.wri.org/insights/powering-remote-hospitals-solar-overcoming-remaining-challenges.

ESMAP, GOGLA, and Dalberg. 2024. *Off-Grid Solar Market Trend Report*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/099090225151516968.

ESMAP, World Bank, and Sustainable Energy for All (SEforALL). 2021. *From Procurement to Performance: Towards a private-sector led, service-based model to scale up sustainable electrification of public institutions*. Washington, DC: World Bank. https://www.seforall.org/system/files/2021-12/Procurement-to-Performance-SEforALL.pdf.

ESMAP. 2024. Off-Grid Solar Market Trends Report 2024: Outlook (English). Washington, D.C. : World Bank Group.

Ethiopia Ministry of Energy and Water. 2024. Ethiopian Public Institutions Electrification portal. https://epepi.gov.et/en-GB/.

Ginoya, N., H. Meenawat, A. Devi, P. Deka, and B. Jairaj. 2021. *Powering Development in Climate Vulnerable Areas: The Role of Decentralized Solar Solutions in India*. Washington DC: World Resources Institute. https://files.wri.org/d8/s3fs-public/2021-04/powering-development-climate-vulnerable-areas.pdf?VersionId=zM6jasv2v_9a4ajKLnfv4ybs40uRxF4y.

Ginoya, N., U. Narayan, L. Concessao, P. Deka, and T. Mandal. 2021. *Integrating Electricity Priorities into Healthcare and Education in India: A Review of National and Subnational Policies.* Washington DC: World Resources Institute. https://www.wri.org/research/integrating-electricity-priorities.

Gurung, A.G. 2011. "The potential of a renewable energy technology for rural electrification in Nepal: A case study from Tangting." *Renewable Energy*: 3203−10.

GVEP International. 2013. *Powering the Health Sector. Annex A: Literature Review*. UK Aid. Sterling, VA: GVEP International. https://assets.publishing.service.gov.uk/media/57a08a09e5274a31e00003ba/61311-LiteratureReview.pdf.

Lenz, L., and A. Munyehirwe. 2015. *Does Large Scale Infrastructure Investment Alleviate Poverty? Impacts of Rwanda's Electricity Access Roll-Out Program*. http://nbn-resolving.de/urn:nbn:de:101:1-201505192414.

Lighting Global. 2017. *Lighting Africa to Support New Regional Program Targeting 19 West African Countries.* Washington, DC: Lighting Global. https://www.lightingglobal.org/lighting-africa-support-new-regional-program-targeting-19-west-african-countries/.

NITI Aayog. 2021. *Study on the Not-for-Profit Hospital Model in India*. New Delhi: NITI Aayog. https://www.niti.gov.in/sites/default/files/2023-03/Study-on-Not-for-Profit-Hospital-model-in-India.pdf.

Odarno, L. 2020. *Linking Electricity Access and Development Outcomes in Africa: A Framework for Action*. Washington DC: World Resources Institute. https://files.wri.org/s3fs-public/linking-electricity-access-developement-outcomes-africa.pdf.

Ratajczak, E. 2017. *Pro-Poor Public-Private Partnerships (5P): Access to Affordable, Reliable, Sustainable and Modern Energy for Enhanced Rural Livelihoods*. https://repository.unescap.org/server/api/core/bitstreams/77a85427-c8a3-45a9-b9cc-66fc31a59750/content.

Ridhwan, M.M., P. Nijkamp, A. Ismail, and L.M. Irsyad. 2022. "The effect of health on economic growth: a meta-regression analysis." *Empirical Economics*: 3211–51.

Sustainable Energy for All (SEforALL). 2021. *From Procurement to Performance: Towards a private sector-led, service-based model to scale up sustainable electrification of public institutions*. Vienna: Sustainable Energy for All. https://www.seforall.org/publications/from-procurement-to-performance.

Sustainable Energy for All (SEforALL). 2024. *State of the Market Report for Health Facility Electrification*. Vienna: Sustainable Energy for All. https://www.seforall.org/system/files/2024-02/Report_SOTM_2024.pdf.

United Nations Children's Fund (UNICEF). 2020. *Cold Chain Support Package - Solar Direct Drive*. New York: United Nations Children's Fund. https://www.unicef.org/supply/media/6276/file/e003-solar-direct-drive-refrigerators-freezers.pdf.

United Nations Children's Fund (UNICEF). 2025. MGMERL homepage. https://mgmerl.mwater.co/#/.

United Nations Foundation and Sustainable Energy for All (SEforALL). 2019. *Lasting Impact: Sustainable Off-Grid Solar Delivery Models to Power Health and Education*. New York: United Nations Foundation; Vienna: Sustainable Energy for All.

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2023. *Global Education Monitoring Report 2023: Technology in education - A tool on whose terms*. New York: United Nations Educational, Scientific and Cultural Organization.

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2025. UNESCO Institute for Statistics (UIS) Data Browser. https://databrowser.uis.unesco.org/.

United Nations High Commissioner for Refugees (UNHCR). 2017. *How Night-time Street Lighting Affects Refugee Communities*. New York: United Nations High Commissioner for Refugees. https://www.unhcr.org/sites/default/files/legacy-pdf/5b3cb5bb7.pdf.

Welland, A. 2017. *Electrification of Health Clinics in Rural Areas: Challenges and Opportunities*. https://www.e4sv.org/wp-content/uploads/2017/05/TR12-Electrification-of-health-clinics-in-rural-areas-Challenges-and-opportunities_web.pdf.

World Bank. 2009. Project Appraisal Document: A Proposed Credit in the Amount of SDR 49.5 Million and a Proposed Grant from the Global Environmental Facility Trust Fund in the Amount of $9 Million to the Republic of Uganda from an Energy for Rural Transformation Program. World Bank, Washington, DC. https://documents1.worldbank.org/curated/en/134391468309342418/pdf./471830PAD0UG0P101Official0Use0Only1.pdf.

World Bank. 2010. *Photovoltaics for Community Service: Guidance for Sustainability*. Washington, DC: World Bank Group.

World Bank. 2013. Project Appraisal Document: Uganda Energy for Rural Transformation III (P133312). World Bank, Washington, DC. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/182131468000919884.

World Bank. 2020. *Increasing Human Capital by Electrifying Health Centers*. Washington, DC: World Bank. https://openknowledge.worldbank.org/server/api/core/bitstreams/0b60fc4c-2cf0-598e-ac35-a25fd72e8507/content.

World Bank. 2025a. *Let There be Light: In Tanzania, More Electricity Brings Better Education and Health*. Washington, DC: World Bank. https://www.worldbank.org/en/news/feature/2025/04/29/let-there-be-light-in-afe-tanzania-more-electricity-brings-better-education-and-health#:~:text=Things%20began%20to%20change%20in,the%20area%20to%20gain%20access.

World Bank. 2025b. *PPPs for the Poor*. Washington, DC: World Bank. https://ppp.worldbank.org/ppps-poor.

World Bank. 2025c. *Bringing Light and Life to Rural Health Centers in Madagascar.* Washington, DC: World Bank. https://www.worldbank.org/en/news/feature/2025/01/21/bringing-light-and-life-to-rural-health-centers-in-afe-madagascar#:~:text=Imagine%20giving%20birth%20in%20the,way%20for%20nearly%20seven%20years.

World Bank, Schatz Energy Research Center, and ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE). 2023. *Requirements and Guidelines for Installation of Off-Grid Solar Systems for Public Facilities*. https://www.lightingglobal.org/wp-content/uploads/2021/05/QA-InstSystFramework_2023.pdf.

World Health Organization (WHO). 2022. *Immunization Agenda 2030: A Global Strategy to Leave No One Behind*. World Health Organization: Geneva. https://www.who.int/docs/default-source/immunization/strategy/ia2030/ia2030-document-en.pdf.

World Health Organization (WHO). 2025a. *Cold Chain Equipment Inventory and Gap Analysis Tool*. World Health Organization: Geneva. https://www.who.int/publications/m/item/cold-chain-equipment-inventory-and-gap-analysis-tool.

World Health Organization (WHO). 2025b. *Service Availability and Readiness Assessment (SARA). World Health Organization: Geneva*. https://www.who.int/data/data-collection-tools/service-availability-and-readiness-assessment-(sara).

World Health Organization (WHO). 2025c. *The Global Health Observatory*. https://www.who.int/data/gho/data/themes/database-on-electrification-of-health-care-facilities.

World Health Organization (WHO). 2025d. *Water, sanitation and hygiene (WASH). World Health Organization: Geneva*. https://www.who.int/health-topics/water-sanitation-and-hygiene-wash#tab=tab_1.

World Health Organization (WHO) and World Bank. 2014. *Access to Modern Energy Services for Health Facilities in Resource-Constrained Settings*. World Health Organization: Geneva; Washington, DC: World Bank. https://iris.who.int/bitstream/handle/10665/156847/9789241507646_eng. pdf;jsessionid=92D2CC47709D632F3EBD50E1B307E9AF?sequence=1.
World Health Organization (WHO), World Bank, Sustainable Energy for All (SEforALL), and International Renewable Energy Agency (IRENA). 2023. *Energizing health: accelerating electricity access in health-care facilities*. Geneva: World Health Organization; Washington, DC: World Bank; Vienna: Sustainable Energy for All; Charleston, SC: International Renewable Energy Agency.

APPENDIX

The 5P Implementation Toolkit

The 5P model--Public-Private Partnership for People's Prosperity--is a powerful tool for delivering sustainable, long-term electrification of public institutions in developing countries. But translating this model into action requires a sequenced, practical approach grounded in data, institutional readiness, and coordinated planning. This appendix provides a high-level implementation toolkit to support governments and development partners in designing and executing the 5P model, with an emphasis on contexts where capacity or resources may be limited.

FIGURE A.1 Diagram of a Sample 5P Project with World Bank Group Support

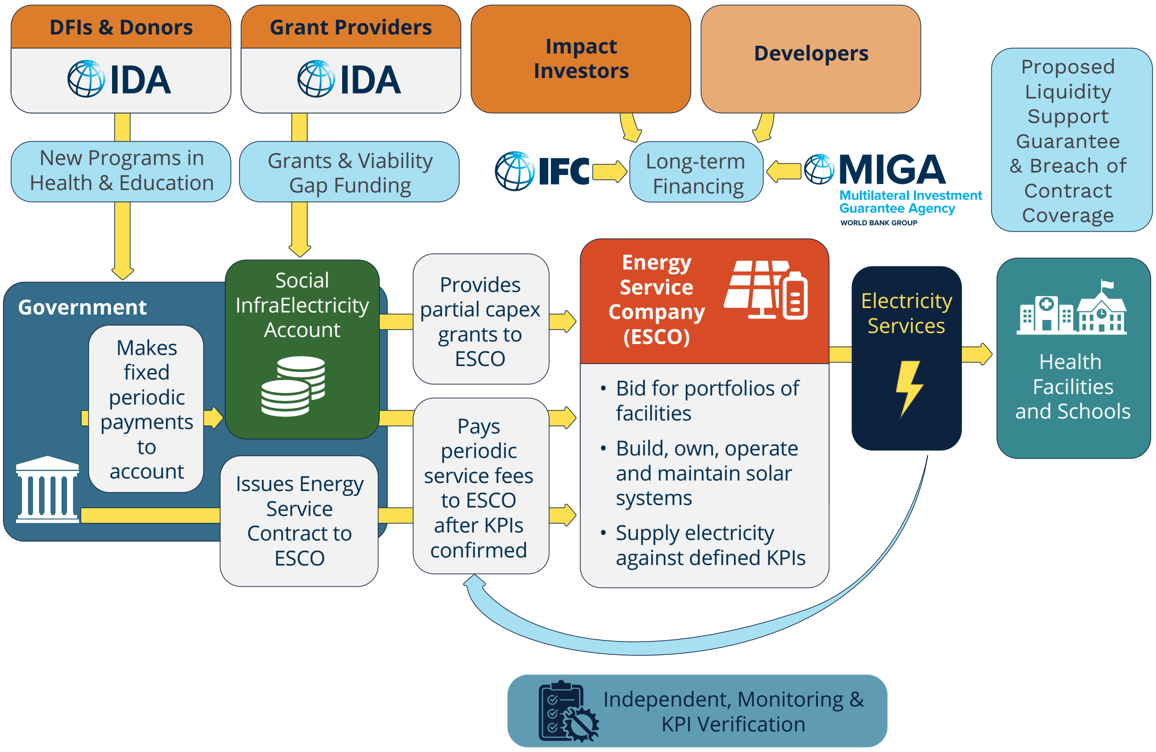
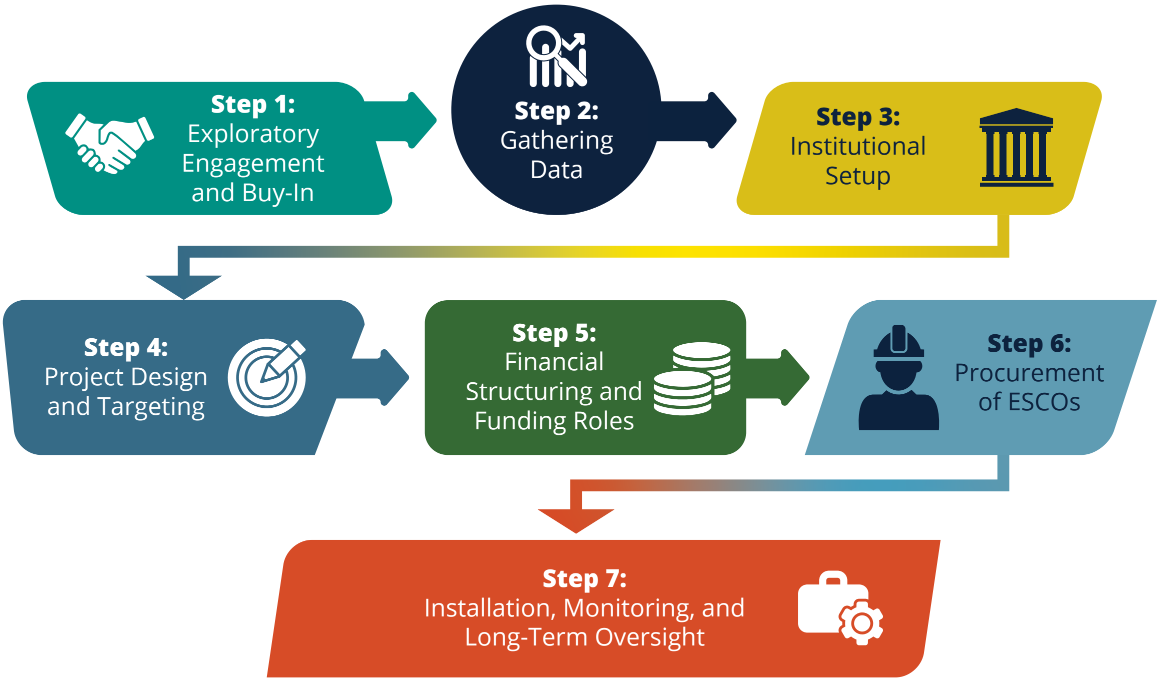


Figure A.1 illustrates how the 5P model works in practice in World Bank-led operations. ESCOs bid for facility portfolios, deliver energy services, and receive payment only when KPIs are met. Government ministries lead facility identification and oversight. Donors and development partners provide support through capacity building and grants and by derisking private sector capital via concessional financing, while remote monitoring platforms ensure transparency and protect the integrity of the results-based model. Payment risks are mitigated through guarantees mechanisms that build confidence among private investors. Other actors from the World Bank Group are also involved, including MIGA, which derisks investment through a liquidity support facility and breach of contract coverage, and IFC, with long-term financing and equity.

To operationalize the 5P model, a seven-step toolkit, showcased in Figure A.2, was developed. These steps are fully explained following the figure.

FIGURE A.2 Step-By-Step Process for the Implementation of the 5P Model



STEP 1: EXPLORATORY ENGAGEMENT AND BUY-IN

The first step in implementing a 5P model is to initiate exploratory conversations with government stakeholders to secure their understanding, buy-in, and commitment.

This involves engaging relevant units across the ministries of energy, health, and education to introduce the 5P framework, explain its objectives, and discuss its potential benefits for schools and health facilities. These initial dialogues help identify key champions, clarify roles and responsibilities, and assess the government's readiness to support service-based electrification. Early engagement also provides an opportunity to surface capacity gaps, legal or regulatory constraints, and any concerns, allowing development partners and governments to co-design strategies that ensure alignment, ownership, and long-term commitment to service agreements.

Relevant Sections of This Report

- Building Public Sector Capacity and Coordination (5.6)

STEP 2: GATHERING DATA

Once the institutional framework has been outlined and capacity building measures have been put in place, the project can move to the following foundational element: reliable and up-to-date data.

To deploy a 5P model, countries need to know where public institutions are located, which ones are unelectrified, and what their energy needs are. They also need to understand the quality of service currently being delivered and whether systems installed in the past are still functioning. A stock take of ongoing initiatives, responsible agencies, integrated planning strategies, and available data should form part of this early diagnostic phase. This step also includes an assessment of **data ownership and interoperability** across ministries and platforms. Where possible, governments should consolidate fragmented databases into shared, regularly updated systems.

Beneficiary ministries should take the lead in assessing the state of their databases with support from the **Ministry of Energy**. When gaps are identified, **development partners** can intervene by supporting data collection and planning efforts.

Relevant Sections of This Report

- Building Public Sector Capacity and Coordination (5.6)

STEP 3: INSTITUTIONAL SETUP

Before selecting target areas or defining technical parameters, governments and development partners must agree on how the 5P model will be implemented and by whom. This phase lays the institutional and operational foundation for project scoping, procurement, and implementation. It also ensures that technical, financial, and policy decisions are made together rather than in silos.

This begins with understanding the public sector. Relevant units in the government—including the ministries of energy, health and education—must be able to design, procure, and manage long-term service contracts. **Governments** should therefore be able to identify—independently or jointly with development partners—the key stakeholders that can drive implementation, as well as any capacity gaps and the measures to fill them.

As part of this step, governments and **development partners** should also coordinate with other donors and parallel public or private activities, to avoid duplications of efforts or conflicting objectives.

Relevant Sections

- Building Public Sector Capacity and Coordination (5.6)

Key Resources

- Template Operations Manual (under development)

STEP 4: PROJECT DESIGN AND TARGETING

With a clear understanding of the context, the next step is to define the scope and ambition of the project. This means identifying which facilities to electrify, based on service delivery needs and strategic priorities. **Governments and development partners** can work together to determine the type of energy services required for each facility type and translate these into clear key performance indicators (KPIs) that will guide procurement and monitoring. The KPIs' targets should be standardized as much as possible, thereby facilitating bid application, evaluation, and contract implementation monitoring.

Relevant Sections of This Report

- Key Performance Indicator Framework for Service Delivery (5.1)
- Creating Market Opportunities for the Private Sector (5.4)

Key Resources

- Requirements and Guidelines for Installation of Off-Grid Solar Systems for Public Facilities

STEP 5: FINANCIAL STRUCTURING AND FUNDING ROLES

Once the project is defined, attention turns to financing. **Governments** must assess whether the necessary budgetary space exists to pay for ongoing energy services and how this cost will be reflected in ministry budgets. If full fiscal coverage is not possible in the near term, **development partners** may be called on to subsidize part of the service fee, especially in low-income or underserved areas.

The role of private capital must also be considered. Some energy service companies (ESCOs) will need access to concessional or commercial credit to finance upfront installation costs. Others may require **guarantees or blended finance** to derisk their investments. The financing structure should balance sustainability with feasibility and reflect the real capacity of all actors involved.

Relevant Sections of This Report

- The Role of Public Sector Funding (6.1)
- The Role of Private Sector Capital (6.3)
- Expanding Public Fiscal Space (6.2)

Key Resources

- Template Financial Model (under development)

STEP 6: PROCUREMENT OF ENERGY SERVICE COMPANIES

With financing in place, **governments** can prepare for procurement using standardized tools tailored to 5P models. These include energy service agreement templates, bidding documents, and monitoring protocols. A clear Terms of Reference (ToR) should also be developed for third-party verification and digital monitoring systems to track performance over time.

Procurement must be backed by targeted capacity building enabled by **development partners**. Government staff—particularly in health and education—need training in contract management, payment flows, proposal evaluation, and use of monitoring tools with technical support from energy ministries. Cross-ministerial coordination platforms are also essential to align procurement and oversight across sectors. In this endeavor, governments can also be supported by dedicated consultants.

Finally, governments should initiate the procurement of a centralized remote monitoring platform that can monitor KPI achievement.

Relevant Sections of This Report

- Ensuring Quality and Standardization (5.3)
- Creating Market Opportunities for the Private Sector (5.4)

Key Resources

- Template Bidding Documents (under development)
- Template Energy Service Agreement and Grant Agreement (under development)
- ToR for Supervision Consultant (under development)
- ToR for Remote Monitoring Platform (under development)

STEP 7: INSTALLATION, MONITORING, AND LONG-TERM OVERSIGHT

Once contracts are awarded, installation can begin, following the technical standards required in the contracting. From the outset, remote monitoring systems should be installed to provide real-time data on performance and enable early detection of issues.

As systems are deployed, the focus must shift to ensuring long-term service delivery. This means enforcing contract terms, managing service payments, and maintaining strong oversight structures. Ministries of health and education must be actively involved in verifying that services are being delivered as agreed and that energy is powering the services it was intended to support. Implementation models should be flexible enough to secure adjustments whenever these are needed.

Relevant Sections of This Report

- Quality Assurance Framework for Installation and Maintenance (5.3)
- Creating Market Opportunities for the Private Sector (5.4)

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