State of the Market Report for Healthcare Facility Electrification

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Abbreviations

AC	alternating current
capex	capital expenditure
CDM	Clean Development Mechanism
CHAI	Clinton Health Access Initiative
DARES	Distributed Access through Renewable Energy Scale-Up
DC	direct current
D-REC	distributed renewable energy certificates
EASP	Energy Access Scale-up Project
EPC	engineering, procurement and construction
EPI	Expanded Programme on Immunization
ERT	Energy for Rural Transformation
ESCO	energy service company
ESMAP	Energy Sector Management Assistance Programme
FCDO	UK Foreign, Commonwealth and Development Office
GIS	geographic information system
HEPA	Health and Energy Platform of Action
HETA	Health Electrification and Telecommunications Alliance
HFE	health facility electrification
HHFA	Harmonized Health Facility Assessment
HVAC	heating, ventilation and air condition
IFC	International Finance Corporation
IRENA	International Renewable Energy Agency
KPI	key performance indicator
kW	kilowatt
kWp	kilowatt peak
LED	light-emitting diode
MIGA	Multilateral Investment Guarantee Agency
MW	megawatt
O&M	operation and maintenance
opex	operational expenditure
PAHO	Pan American Health Organization
PPA	power purchase agreement
PV	photovoltaic
REC	renewable energy certificates
RBF	results-based financing
ROGEAP	Regional Off-Grid Electricity Access Project
RREP	Rural Renewable Electrification Project
SARA	Service Availability and Readiness Assessment
SDG	Sustainable Development Goal
SEforALL	Sustainable Energy for All
SPV	special purpose vehicle
UN	United Nations
UNDP	United Nations Development Programme
UNF	United Nations Foundation
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services
W	watt
WHO	World Health Organization
WRI	World Resources Institute

Executive Report

Background and Objectives

This State of the Market report provides a comprehensive analysis of global healthcare electrification, grounded in the extensive Sustainable Energy for All (SEforALL) Powering Healthcare Intervention Database. It charts a strategic path forward, making it an essential guide for stakeholders aiming to align their activities with the UN Sustainable Development Goals and improve global health.

Healthcare electrification contributes to the improvement of health outcomes, promotes access to sustainable energy for all, fosters sustainable industrialization and innovation, and contributes to global efforts to combat climate change.

While substantial progress has been made, challenges persist, particularly in regions with weak infrastructure and limited financial resources. According to the World Health Organization (WHO), an estimated 1 billion individuals across the globe currently have local healthcare facilities with an unreliable power supply. Moreover, in Sub-Saharan Africa alone, a staggering 25,000 healthcare facilities lack access to electricity entirely, while around 70,000 health centres have an unreliable electrical supply. In South Asia, 12% of healthcare facilities lack any access to electricity.

This State of the Market report on healthcare electrification stands as a valuable contribution within the landscape of recent publications due to its unique bottom-up approach, which leverages the most up-to-date data from 387 initiatives from 78 stakeholders in 89 countries. What sets this report apart is its foundation in SEforALL's Powering Healthcare Intervention Heatmap and Database, which is currently the most comprehensive and up-to-date source of information regarding health facility electrification initiatives. This ensures the accuracy and granularity of the analysis, offering a real-world perspective on the challenges, opportunities and best practices in healthcare electrification.

The report not only presents the current state of the healthcare electrification market, but also charts a strategic roadmap towards the market's sustainable growth. Drawing on insights gathered from in-depth interviews with approximately 20 key stakeholders and a thorough examination of over 100 reports and evaluations, the report offers a comprehensive and informed perspective on the healthcare electrification landscape, while also serving as a signpost for the strategic evolution and sustainable advancement of this critical sector.

Healthcare electrification trends

Since the onset of the COVID-19 pandemic, healthcare electrification initiatives have seen robust growth, with a notable focus on smaller and rural health centres and a shift towards larger, more comprehensive power solutions.

Healthcare electrification gained momentum during the COVID-19 pandemic and activity levels have remained high compared to pre-2020 levels. The annual growth rate in electrification initiatives between 2018 and 2021 averaged 47%, gaining unprecedented prominence on the international stage, as governments and development partners rallied to ensure adequate and reliable power supply to medical facilities grappling with the demands of treating COVID-19 patients. While the number of newly electrified healthcare facilities declined in 2022, it remained high when compared to pre-2020 levels.

The provision of power solutions has consistently been the most common type of initiative related to healthcare electrification, commanding an average share of 38% between 2018 and 2023. Needs assessments accounted for almost one fifth of all initiatives, followed by technical assistance and feasibility studies at 17% and 16%, respectively. Furthermore, 82% of electrification initiatives have opted for stand-alone solar technology, reflecting its popularity as a reliable and sustainable energy source. Among mini-grid options, hybrid mini-grids have emerged as a more frequent choice by implementers, compared to solar mini-grids. An increasing trend of making grid connections to power healthcare facilities has been observed over the years, with a notable acceleration observed from 2022 onwards.

More organizations are opting for restricted procurement. This approach involves relying on specialists while following a fair and open tender process. It allows for the acceleration of project progression, enabling faster execution of healthcare electrification initiatives while enhancing the understanding of costs for better budgeting.

The duration of healthcare electrification initiatives is decreasing. The healthcare electrification landscape has seen a decline in the average duration of initiatives across different facility types. This reduction can be attributed to streamlined processes and increased data availability, allowing for the deployment of more standardized solutions. However, the shorter duration of these initiatives indicates that provision for operations and maintenance (O&M) may lack a long-term perspective. Looking ahead, the emerging emphasis on the energy service company (ESCO) model suggests that we can anticipate a marked increase in the duration of health facility initiatives, reflecting the inherently long-term orientation of these projects.

Collaboration between energy and health stakeholders is improving, but further progress is required. Collaborative global efforts, such as the Health and Energy Platform of Action and the Multilateral Energy Compact for Health Facility Electrification, have been instrumental in bridging the health and energy sectors to advance healthcare electrification. While these global initiatives have made significant progress, there remains a pressing need for enhanced coordination at the country level to ensure optimal resource utilization.

Recognizing the diverse energy needs of healthcare facilities, 53% of electrification initiatives now prioritize conducting needs assessments before project implementation. Different healthcare tiers, from health posts to regional hospitals, have varied energy requirements influenced by factors like medical services provided, equipment, staffing, local health challenges and even seasonal climate conditions. Such assessments ensure that energy provisions align with the specific needs of each facility, considering services, staff and equipment.

Data-driven decision-making is becoming paramount in healthcare electrification. Historically, the absence of comprehensive geographic information system (GIS) health facility data has posed challenges. However, advancements in spatial tools and big data processing are transforming the landscape. Decision-makers are leveraging geospatial technology to bridge data gaps and prioritize electrification initiatives. Remote monitoring technologies are also being integrated into healthcare electrification initiatives, providing real-time data on service quality.

Stakeholders are beginning to realize the importance of capacity building. Effective healthcare electrification requires strong in-house capabilities within government departments. However, many governments lack the capacity for tasks such as site evaluation and oversight of bidding processes. A notable challenge is the misconception that solar power is free, often due to the prevalence of donor-funded installations. This can lead to reluctance in allocating budgets for ongoing maintenance, jeopardizing project sustainability.

Climate finance emerges as a promising avenue for funding health facility electrification, aligning with broader sustainable development goals and climate change mitigation. As sectors increasingly tap into climate finance mechanisms, healthcare electrification can benefit from dedicated funds, renewable energy certificates (RECs), grants and concessional loans. This not only ensures sustainable electricity supply for healthcare, but also resilience and reduced greenhouse gas emissions.

Photo: PMI Impact Malaria

Technological advancements and strategic approaches are reshaping healthcare electrification, emphasizing efficiency, sustainability and adaptability.

Technological trends in solar photovoltaic (PV) systems, batteries and remote monitoring are making healthcare electrification more cost-effective and sustainable. The PV industry's growth has led to innovations in materials and manufacturing, with monocrystalline wafers and passivated emitter and rear cell (PERC) designs gaining traction. Battery technology, particularly lithium-ion, is rapidly evolving, offering longer lifespans and declining costs, although challenges with sourcing rare metals persist. Modular PV system designs are emerging, allowing for scalable solutions tailored to healthcare facilities' needs. Remote monitoring tools are becoming central, providing real-time insights, optimizing system performance and aiding demand estimation. Quality standards are being established for healthcare facilities, focusing on equipment efficiency and resilience. E-waste management is also gaining attention, with development partners developing toolkits to address the challenges of off-grid solar projects. On the demand side, however, there has been little advancement, particularly in the adoption of energy-efficient medical appliances.

There is a growing trend for exploring innovative business model approaches to ensure sustainability, in particular moving from engineering, procurement and construction (EPC) to ESCO or service-based models.

Efforts to electrify healthcare facilities have largely depended on grants and donor support, focusing on EPC models. While they offer quick implementation, they often overlook long-term O&M, leading to sustainability concerns. Tight donor deadlines and limited budgeting for long-term maintenance exacerbate these challenges. A shift towards service-based models, such as the ESCO model, is emerging where private sector providers offer electricity services over extended periods, ensuring consistent power quality. However, these models come with their own challenges, including non-payment risks and the potential for service disruption if providers face financial difficulties. While private sector involvement is crucial, it is essential to balance their expertise with the continuity of vital services. No single model addresses all healthcare electrification challenges, so a combination of approaches, tailored to specific contexts, is necessary.

An increasing number of governments are also including health facility electrification in their national electrification strategies or developing healthcare-specific policies that prioritize the electrification of healthcare institutions. For instance, tariff regulation has been playing a critical role in scaling up mini-grid implementation for healthcare electrification. Also, streamlining procedures and reducing bureaucracy for obtaining the necessary permits and approvals can significantly accelerate the implementation of healthcare electrification projects.

Key challenges and lessons learnt

Financial, technical and institutional challenges need to be taken into account when designing future interventions in order to ensure their long-term sustainability.

Developing sustainable and scalable health facility electrification projects continues to have its challenges, including:

- A lack of sustainable O&M frameworks
- Inappropriate health facility electrification design and needs assessments
- Limited capacity at government level
- A lack of institutional coordination
- A lack of understanding of the health sector's energy-related needs, often stemming from limited data availability
- A lack of flexible financing options tailored to healthcare electrification

Financing and investment needs

Approximately 64% of global health facilities lack adequate power supply, requiring an estimated total investment of USD 4.9 billion, with current financing falling significantly short. This underscores the urgent need for innovative funding solutions and partnerships to ensure reliable healthcare delivery.

The largest investment gap is in Sub-Saharan Africa at USD 2.5 billion, followed by South Asia at USD 2 billion. Current capital flows into health facility electrification programmes are significantly below the required amounts, indicating a substantial investment gap. The financing models need to be enhanced, with a focus on innovative structures and partnerships.

Measuring impact

In the realm of healthcare electrification, measuring impact is pivotal to evaluate the success of initiatives that provide consistent electricity to health facilities.

Healthcare electrification's success hinges on accurately measuring impact. Assessing the effects of healthcare electrification initiatives, by observing factors such as patient care, equipment functionality and overall healthcare quality, enables a comprehensive examination of the cost-effectiveness of electrification projects and the social and health outcomes for vulnerable communities. Through this process, stakeholders can identify areas for improvement and make informed choices for future projects. This process ultimately contributes to the enhancement of healthcare services and an improved quality of life in their surrounding communities.

Current methodologies focus on quantifiable metrics in energy, health, and broader social and environmental aspects. While data collection on energy metrics, such as system uptime, is straightforward, tracking progress in health-related metrics requires consistent collection of health outcomes over the years, which can be challenging, especially in remote and resource-constrained areas. A broader category of indicators encompasses economic benefits for the facility and the wider community, spillover effects on education and overall quality of life, and reduced gender inequality, as well as environmental benefits related to the reduction in the use of fossil fuels. However, the lack of a standardized list of key indicators that should be followed for impact assessments remains a challenge. Short-term initiatives yield immediate benefits like extended operating hours. Long-term initiatives enable a holistic view, showcasing improved patient outcomes and service efficiency. A consistent evaluation framework is crucial for these efforts.

Outlook

Current and planned initiatives for which funds have been secured account for roughly 4% of hospitals and 7% of non-hospitals that require a new connection. Despite the significant progress made over recent years, the electrification access gap among health facilities remains significant. Recent commitments highlight that the pace of health facility electrification may be substantially higher. Collectively the World Bank, USAID/Power Africa and the IKEA Foundation aim to electrify over 50,000 health facilities by 2026. This ongoing momentum is likely to increase the funding for such initiatives in the coming years, reducing the connections gap.

However, there are several potential risk factors that may affect the trajectory of the health facility electrification sector. Political and site selection issues, lengthy implementation timelines, logistical hurdles and the lack of a holistic framework are significant risks that could impede progress. Additionally, broader challenges such as population growth and the increased likelihood of more pandemics due to climate change further complicate these scenarios. Also, neglecting the maintenance and replacement needs of recently solarized systems can widen the energy access gap over time, undermining the long-term sustainability of solar initiatives. Financial challenges and the need for effective public-private collaboration also present hurdles that must be overcome.

The private sector plays a vital role in bridging the health facility electrification gap, with emerging market players leveraging innovative technologies, business models and partnerships to drive

change. These include energy storage providers, local installers, GIS/geospatial companies, technology giants, monitoring solution providers, local entrepreneurs, telecommunications companies, system integrators, financial institutions, de-risking facilities, and academic and research institutions. The engagement of these diverse players is crucial for a comprehensive and accelerated advancement towards equitable and sustainable electrification of healthcare facilities.

The health facility electrification (HFE) sector stands at the brink of significant transformative developments. In the next five years the integration of energy-efficient appliances, including advanced diagnostic tools, efficient lighting and reliable refrigeration systems, is expected to surge. Concurrently, the "energy-as-a-service" model is gaining traction, allowing healthcare facilities, particularly those with limited budgets, to pay for their energy use without having to cover large initial investment, while encouraging long-term sustainability. Data analytics, remote monitoring and artificial intelligence (AI) are set to enhance the efficiency and sustainability of health facility electrification initiatives by improving system management, automating data collection and proactively addressing system inefficiencies. Furthermore, the role of distributed renewable energy certificates (D-RECs) and broader climate finance in funding health facility electrification initiatives is becoming increasingly crucial. As traditional funding proves insufficient, especially in remote areas, D-RECs enable healthcare facilities to monetize the environmental benefits of their renewable installations.

Recommendations

For sustainable healthcare electrification, a collaborative approach involving policymakers, the private sector and donors/investors is crucial, emphasizing the importance of long-term O&M strategies, tailored country taxonomies, enhanced inter-sectoral coordination, capacity building, champion engagement and consistent impact measurement.

→ Policy and regulatory change is essential for sustainable health facility electrification. Governments in low-income countries often underestimate the maintenance needs, and associated costs, of solar energy systems, posing challenges to sustainable electrification, especially in healthcare facilities. A shift in perspective through capacity building is needed to recognize the importance of long-term O&M strategies.

→ In the pursuit of effective healthcare electrification, it is crucial to develop a tailored method of categorizing countries, considering their unique electrification landscapes and capacity. Recognizing the diverse starting points and varying private sector and government capacity across nations, a bespoke approach is essential. This categorization should guide custom-designed strategies, ensuring that electrification initiatives are context-specific and address both immediate needs and long-term growth in the healthcare sector.

→ Enhanced coordination between health, energy and climate stakeholders is vital for advancing healthcare electrification. Moving beyond traditional silos, there is a pressing need for integrated approaches and dynamic partnerships that pool expertise from both the health and the energy sectors. Establishing enduring institutional frameworks, such as multisectoral coordination committees, can streamline planning and investment. This would ensure that supply-side interventions are matched with demand-side investments, with both contributing to a stronger and more climate-resilient health sector. By prioritizing synchronized efforts at the country level, stakeholders can optimize resources and accelerate progress in healthcare electrification.

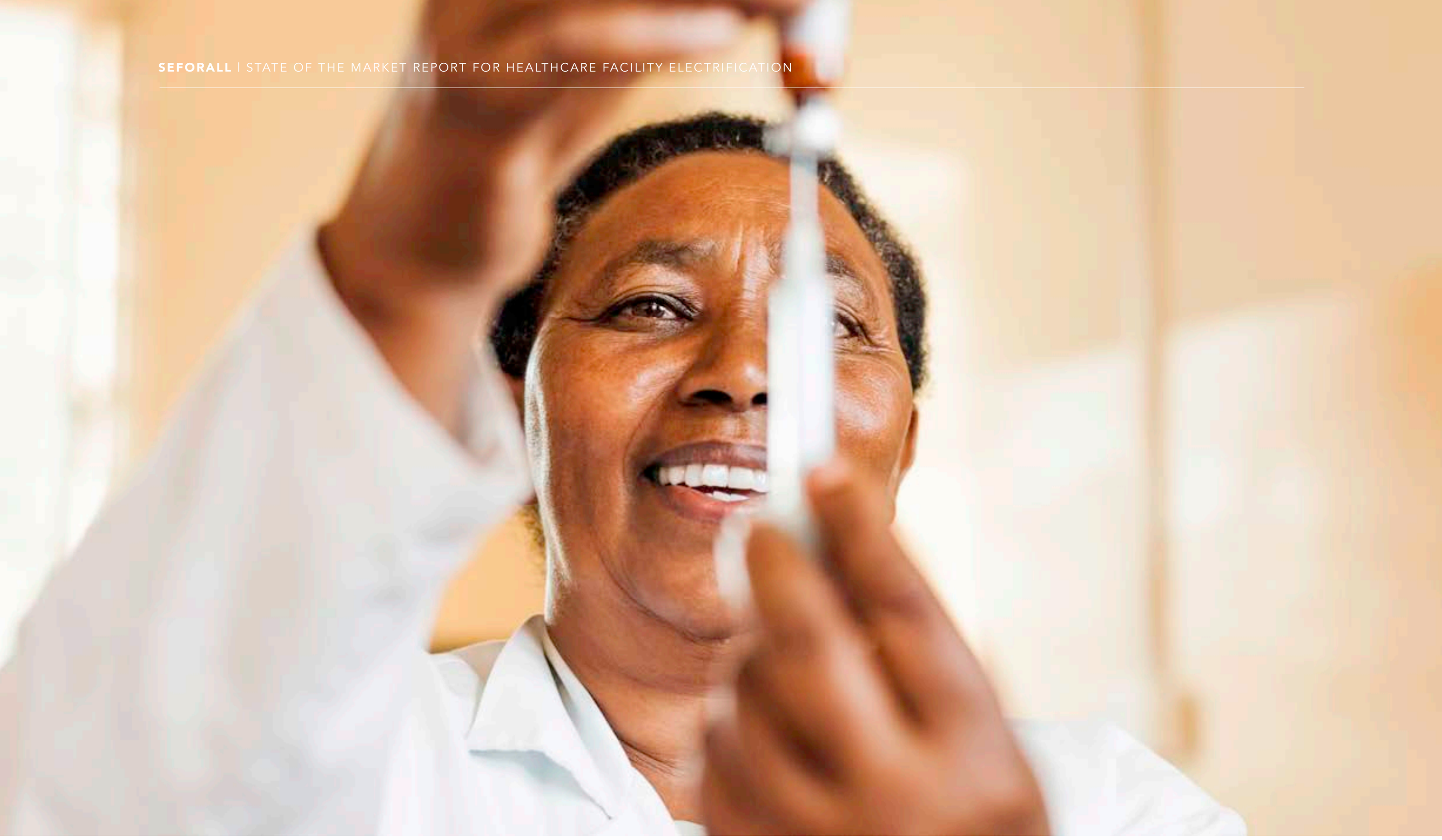
➜ **For long-term sustainability in healthcare electrification, it is crucial to build capacity across the policy, institutional and technical levels.** Clear, adaptable policies drive investment and foster innovation, while institutional strengthening ensures effective on-the-ground implementation and promotes community ownership. Technical advancements and capacity building are essential for modernizing healthcare delivery. Donor-funded initiatives should emphasize national capacity development through O&M training and capacity building, fostering collaboration that enhances local expertise and ensures project longevity. Embedding local knowledge in electrification efforts not only amplifies immediate benefits, but also promotes community ownership and care for the systems.

➜ **Engaging with champions, including government officials and healthcare workers, is vital for driving healthcare electrification initiatives.** Achieving sustainable healthcare electrification requires strong government buy-in, with government actively participating in all aspects of the electrification process, from site selection to capacity building.

➜ **Project design needs to be more structured and streamlined.** Every healthcare electrification initiative should commence with a detailed country roadmap, like those recently developed by SEforALL and IRENA, to understand the current energy landscape and devise tailored strategies. Electrification efforts should adopt a holistic approach, ensuring entire health facilities are powered, while also recognizing the value of specific solutions, such as vaccine storage during emergencies. A comprehensive needs assessment is essential to determine precise energy demands, ensuring a balance between functionality and affordability. Reducing administrative burdens on grantees allows them to focus on project execution, while leveraging economies of scale can optimize costs and attract funding. Starting with a pilot project helps identify challenges and refine strategies before broader implementation. Lastly, consistent measurement and monitoring of impact, possibly through remote technologies, are crucial to ensure long-term functionality and understand the health benefits of electrification.

➜ **There is a pressing need to substantially increase financial flows towards healthcare electrification initiatives, elevating them to a top development priority.** The current health facility electrification financing model based on grants is unlikely to cover the projected USD 2.5 billion investment gap. Enhancing financing models is essential so that they include provision for O&M costs and component replacement right from the outset, as well as to allow any new activity to continue where a previous one left off, effectively extending the overall programme duration.

➜ **To effectively bridge the healthcare facility electrification gap, a multi-pronged strategy involving policymakers, the private sector and donors/investors is essential.** Policymakers must shift their perspective on solar energy, promote energy-efficient designs and ensure government buy-in. The private sector should enhance coordination, especially in underserved regions, and adopt long-term funding mechanisms. Donors/investors need to adjust funding cycles to the long-term nature of electrification projects and ensure robust financial support. Shared responsibilities include developing a healthcare electrification taxonomy, fostering inter-sectoral coordination, building capacity, engaging champions and consistently measuring impact. This collaborative approach promises transformative change in healthcare electrification, enhancing healthcare access and community well-being.



CHAPTER ONE

Background and Objectives

1.1 OBJECTIVE OF THIS REPORT AND VALUE ADDED

The electrification of healthcare facilities plays a pivotal role in contributing to the achievement of several UN Sustainable Development Goals (SDGs). First, it directly supports SDG3, which aims to ensure healthy lives and promote well-being for all ages. Access to reliable electricity in healthcare facilities enables the proper functioning of medical equipment, refrigeration of vaccines and medicines, and the provision of adequate lighting, thereby enhancing the quality and efficiency of healthcare services. This, in turn, leads to improved healthcare outcomes, reduced mortality rates and better overall health for communities.

Healthcare electrification also supports SDG7, which focuses on ensuring access to affordable, reliable, sustainable and modern energy for all. Providing electricity to health facilities creates a foundation for sustainable and inclusive development. Renewable energy solutions, such as solar-powered systems, contribute to reducing carbon emissions, mitigating the impact of climate change and promoting environmentally friendly practices in the health sector.

Furthermore, electrification of healthcare facilities aligns with SDG9, which seeks to build resilient infrastructure, and promote inclusive and sustainable industrialization while fostering innovation.

Integrating modern and reliable energy solutions into the health sector bolsters the resilience of healthcare infrastructure, making it better equipped to handle emergencies and disasters, such as the COVID-19 pandemic. Additionally, innovations in healthcare electrification have the potential to drive technological advancements, making healthcare more accessible, efficient and cost-effective.

The electrification of health facilities is also integral to SDG13 on climate action. By adopting clean and sustainable energy sources, healthcare facilities can reduce their carbon footprint, enhance resilience to climate-related disruptions, improve healthcare access and quality, and promote sustainable practices. This alignment with SDG13 not only reduces greenhouse gas emissions, but also contributes to the broader global effort to combat climate change and foster a sustainable future.

While substantial progress has been made, challenges persist, particularly in regions with weak infrastructure and limited financial resources. Continued efforts and investment are required to expand electricity access to all health facilities, leaving no one behind and ensuring that quality healthcare services are accessible to communities regardless of their location.

International organizations have been at the forefront of driving change, fostering collaboration between stakeholders and advocating innovative solutions to bridge the electricity gap in healthcare facilities. One of the primary functions of international organizations like Sustainable Energy for All (SEforALL), the World Bank, the UN Development Programme (UNDP) and Power Africa is to serve as a catalyst for change. They actively engage with governments, private sector entities, local communities and other stakeholders to raise awareness of the pressing need for reliable electricity in healthcare settings.

By highlighting the impact of inadequate energy access on patient care, medical equipment and overall healthcare services, they bring the issue to the forefront of public consciousness and policy discussions. A number of studies have been developed by development partners on health facility electrification (HFE), including:

- Energizing Health: Accelerating Electricity Access in Healthcare Facilities (WHO et al. 2023)
- Lasting Impact: Sustainable Off-Grid Solar Delivery Models to Power Health and Education (SEforALL 2019)

This State of the Market report on healthcare electrification stands as a valuable contribution within the landscape of recent publications due to its unique bottom-up approach, which leverages the most up-to-date data from 387 initiatives from 78 stakeholders in 89 countries. What sets this report apart is its foundation in SEforALL's Powering Healthcare Intervention Heatmap and Database, which is currently the most comprehensive and up-to-date source of information regarding HFE initiatives. This ensures accuracy and granularity in the analysis, offering a real-world perspective on the challenges, opportunities and best practices in healthcare electrification.

The report not only presents the current state of the healthcare electrification market, but also charts a strategic roadmap towards the market's sustainable growth. Drawing on insights gathered from in-depth interviews with approximately 20 key stakeholders and a thorough examination of over 100 reports and evaluations, the report offers a comprehensive and informed perspective on the healthcare electrification landscape, while also serving as a signpost for the strategic evolution and sustainable advancement of this critical sector. This report's unique blend of empirical data, expert insights and strategic vision positions it as an indispensable resource for policymakers, investors and practitioners seeking to drive positive change in healthcare electrification, aligning it with the SDGs and making a lasting impact on global health and well-being.

BOX 1.1 • **Use of the term "initiative" in the report**

The term "initiative" is central to the way we analyse the electrification of health facilities in this report. It is defined as a specific effort by an organisation to electrify a number of health facilities, i.e. a defined group of individual electrification projects. Initiatives can be small or large, in the sense that they can range from the electrification of a small number of health facilities to a much larger number, and can similarly encompass basic health facilities all the way up to district hospitals.

We use the number and nature of initiatives as the means of analysing and understanding the healthcare electrification market, including their size, duration, format and impact.

It is worth noting that individual initiatives often have names that include the terms "platform", "programme" or "project", but all are classified as initiatives for the purposes of this study.

1.2 SCOPE OF WORK

The analysis extends from primary health posts, which serve as the frontline of healthcare provision in local communities, to district and regional hospitals that cater to larger populations and offer more specialized medical services. By including this diverse array of facilities, we aim to gain a holistic understanding of the challenges and opportunities associated with bridging the electricity gap in healthcare settings at every level. This report underscores the significance of reliable electricity supply in improving patient care, supporting life-saving medical equipment and enhancing overall healthcare outcomes, irrespective of the facility's scale or location. The definition for each type of health facility is provided in Table 1.1.

TABLE 1.1 • **Definition of each health facility type**

District/referral hospital	A district hospital serves as the initial point of referral for a specific district or a defined geographic region with an established population, overseen by a political and administrative body such as a district health management team. The function of these hospitals within primary healthcare has evolved; they are no longer solely focused on curative and rehabilitative services, but have broadened their scope to encompass promotional, preventive and educational responsibilities within the framework of a primary healthcare strategy.
Health centre	Health centres operate as community-oriented and patient-guided entities, delivering cost-effective, easily accessible and superior primary healthcare to individuals and families.
Health post	Health posts function as community hubs or medical settings that offer a minimal number of beds and are equipped with basic resources for curative and preventive care, typically staffed by health workers or nurses.
Rural hospital	A rural hospital is a medical institution situated in a sparsely populated area, often far from urban areas.

Source: WHO 2023a

The scope of this report is both extensive and targeted, with a global perspective that emphasizes specific regions facing acute challenges in electricity access for healthcare facilities. The analysis spans various countries and continents, making it truly global in its outlook. However, our primary focus is on regions where the electricity gap in healthcare poses particularly critical issues. These regions include Sub-Saharan Africa, where many communities still lack reliable access to electricity, hindering healthcare services and exacerbating health disparities. Additionally, the analysis includes fragile countries in Latin America and the Caribbean, such as Haiti, which face unique challenges in achieving sustainable and resilient healthcare infrastructure. Moreover, the report delves into the Indo Pacific region, where the demand for electricity in healthcare is growing rapidly

due to population growth and expanding healthcare services. By narrowing our focus to these specific regions, we aim to shed light on the most pressing issues while identifying potential strategies and solutions that can have a transformative impact on healthcare outcomes.

The analysis encompasses three main categories of technologies utilized in electrification efforts, namely solar-based mini-grids, stand-alone photovoltaic (PV) systems and grid connection. By covering these technologies, we aim to provide a comprehensive understanding of the trends, challenges and opportunities that each electrification option entails, recognizing that they represent the large majority of, though not all, health facility electrification efforts. While some health facilities may rely on alternative energy sources like hydro or wind-based solutions, these cases are likely to be limited in number.

The analysis encompasses health facilities owned and operated by various entities, including public, private and not-for-profit organizations. By examining health facilities across different ownership models, the report aims to provide valuable insights into the variations in electricity access, infrastructure development and operational challenges faced by each type. The report sheds light on the unique dynamics of electricity supply and the implications it has for healthcare service delivery, patient care and overall sustainability, considering the distinct priorities and constraints faced by public, private and not-for-profit health facilities.

In this report, the analysis extends across multiple levels of service, comparable to Tiers 2 to 5 in the Multi-Tier Framework (ESMAP 2015). At the highest tier, the analysis includes the provision of continuous and reliable electricity to the entire facility, ensuring seamless operation of critical medical equipment, uninterrupted patient care and the effective functioning of healthcare services as a whole. Lower tiers include electricity provision for essential services such as lighting to enhance working conditions and patient care during night-time hours. Moreover, we examine the electrification of solar refrigerators, vital for the safe storage of vaccines and medications, as well as oxygen concentrators, crucial for patients requiring respiratory support.

The importance of the quality of power supply in healthcare electrification is also analysed, as it directly impacts the delivery of critical healthcare services and patient outcomes. The concept of critical loads is of paramount significance in this context, representing those essential electrical loads necessary for life-saving medical equipment and vital healthcare operations. Ensuring a stable and reliable supply of electricity to power these critical loads is imperative to safeguard the continuity of healthcare services, especially during emergencies or blackouts. System design plays a crucial role in guaranteeing the functioning of critical loads under such circumstances. Implementing backup power solutions, such as uninterruptible power supply systems or standby generators, becomes essential to provide immediate support in case of a power outage. These systems are strategically designed to automatically start during electricity disruptions, offering a seamless transition to backup power and ensuring uninterrupted operation of critical medical equipment, life support systems and other essential services. By prioritizing quality of supply and incorporating measures to safeguard critical loads, healthcare facilities can enhance their preparedness and resilience, ultimately contributing to saving lives and delivering optimal patient care even in the face of unforeseen power interruptions.

The electrification of health facilities has played a pivotal role in addressing the challenges posed by the COVID-19 pandemic. Access to reliable electricity has been crucial for powering essential medical equipment, such as ventilators and refrigeration units for vaccine storage, ensuring the effective treatment and vaccination of patients. As we look toward the future, HFE will be a fundamental aspect of addressing pandemics. It will be indispensable in facilitating the rapid deployment of medical technology and telehealth services, and maintaining vaccine cold chains.

CHAPTER ONE

Key Insights

BACKGROUND AND CONTEXT

→ Insight #1

The electrification of healthcare facilities plays a pivotal role in the achievement of several **UN Sustainable Development Goals (SDGs)**

3 GOOD HEALTH AND WELL-BEING | 7 AFFORDABLE AND CLEAN ENERGY | 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE | 13 CLIMATE ACTION

→ Insight #2

This report stands as a valuable contribution to the sector, including data from:

378 initiatives
78 stakeholders
89 countries

→ Insight #3

This report is both extensive and targeted, with **a global perspective that emphasizes specific regions** facing acute challenges.

→ Insight #4

This analysis includes:

a diverse array of facilities:

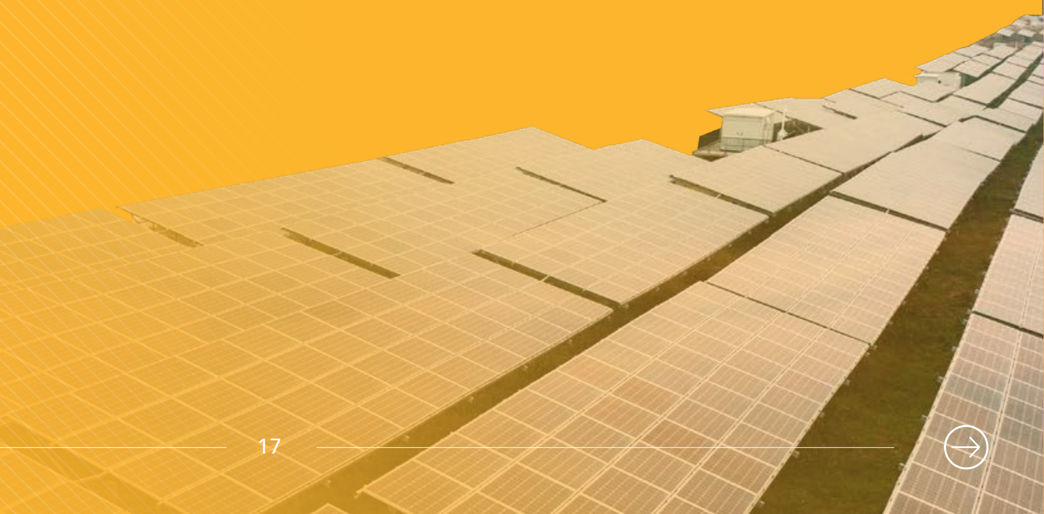
- Rural hospital
- Health post
- Health centre
- District hospital

owned and operated by various entities:

- Public
- Private
- Not for profit

and three main categories of technologies utilized in electrification efforts:

- Stand-alone PV
- Solar mini grids
- Grid connection



CHAPTER TWO

Current Status of Health Facility Electrification

2.1 MARKET OVERVIEW AND HIGHLIGHTS

According to the World Health Organization (WHO), an estimated 1 billion individuals across the globe currently have local healthcare facilities with an unreliable power supply. Moreover, in Sub-Saharan Africa alone, a staggering 25,000 healthcare facilities lack access to electricity entirely, while around 70,000 health centres contend with unreliable electrical services. The state of electricity access in the health sector is a critical issue that significantly affects the delivery and quality of healthcare services in many regions worldwide. This lack of reliable electricity access poses substantial challenges to healthcare facilities, hindering their ability to provide essential medical services, diagnostics and treatments.

In low-resource settings, health facilities often struggle to maintain consistent electricity supply, leading to various operational hurdles. Without reliable power, medical equipment such as ventilators, refrigerators for vaccine storage, and essential diagnostic devices may become inoperative, jeopardizing patient care and exacerbating health disparities. Moreover, health workers may find it difficult to perform life-saving procedures or even conduct basic medical consultations during power outages, compromising patient safety and well-being.

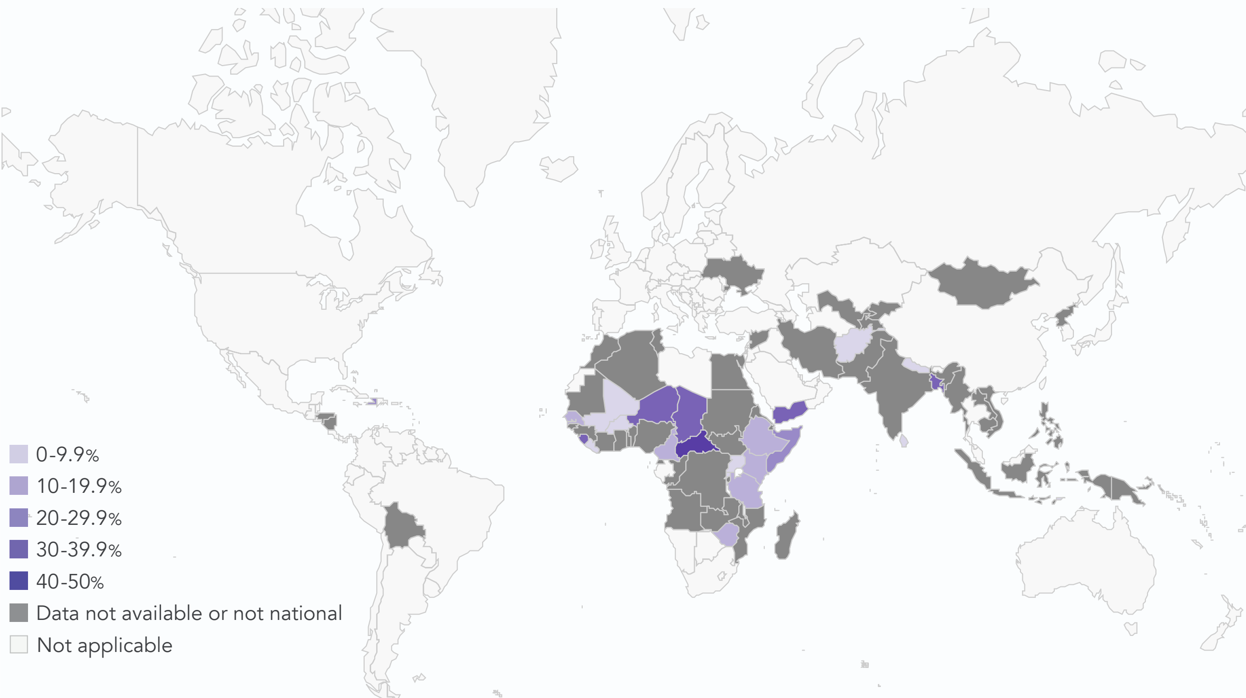
This lack of electricity disproportionately affects regions such as South Asia and Sub-Saharan Africa (Figure 2.1), where approximately 12% and 15% of healthcare facilities, respectively, have no access to electricity. Only about 50% of hospitals in Sub-Saharan Africa report reliable electricity access, indicating a critical need for improvements in this area. In South Asia, 12% of healthcare facilities lack any access to electricity, further emphasizing the urgency of addressing this issue.

The discrepancy in electricity access between urban and rural areas is also striking, with urban healthcare facilities generally reporting better access to reliable electricity than their rural counterparts within the same country. This disparity poses additional challenges to healthcare services in rural and underserved regions, where power outages can disrupt critical medical procedures, hinder the use of essential medical equipment and compromise patient care.

This underscores the importance of continued collaboration and investment in renewable energy solutions and electrification projects to ensure that all health facilities have reliable access to electricity, regardless of their location and economic status.

By addressing this issue, we can enhance the quality of healthcare services, promote better health outcomes and work towards achieving universal access to healthcare for all.

FIGURE 2.1 • **Percentage of healthcare facilities with no access to electricity, 2015-2022**



Source: WHO et al. 2023

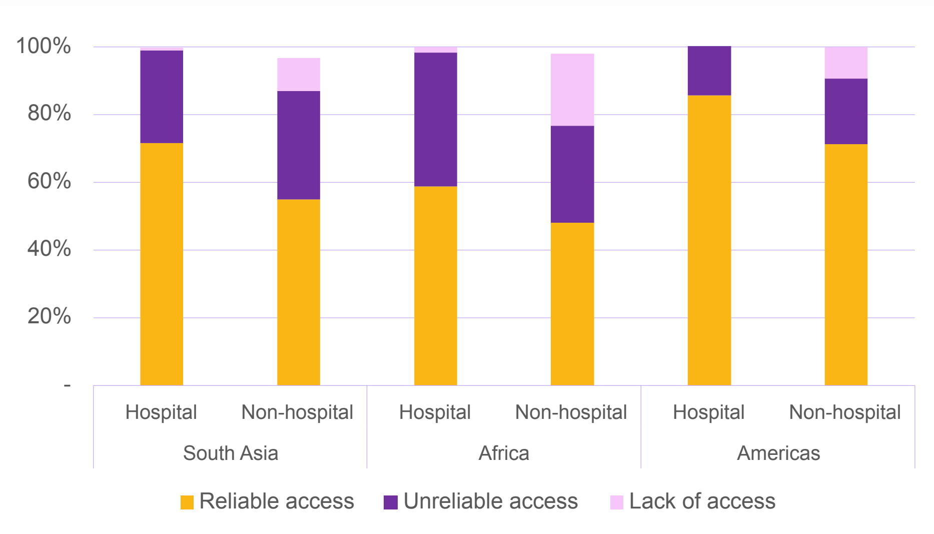
2.2 CURRENT STATUS

The analysis conducted as part of the Energizing Health report, based on 63 countries, highlights significant disparities in electricity accessibility in healthcare facilities (WHO et al. 2023). The countries in South Asia and Sub-Saharan Africa reported similar estimates for facilities lacking electricity access—12% and 15%, respectively. In contrast, those in the Americas, encompassing the Latin America and Caribbean region, recorded a slightly lower percentage of facilities with no electricity access, standing at 8% (Figure 2.2). The divergence becomes more pronounced on a country-specific level, with nations such as Burkina Faso and Rwanda indicating near-complete electricity coverage for their healthcare establishments, while others such as Bangladesh, the Central African Republic, Chad, Niger, Sierra Leone and Yemen revealed substantial gaps of 30-50% in regional electricity access for facilities

Furthermore, a discernible contrast emerges when dissecting the data according to facility types. Among the countries offering insights into hospital electricity access, more than half reported full or near-complete coverage, while non-hospital establishments exhibited a more erratic and dire picture, with a considerable range of 1% to 74% lacking electricity access. In Rwanda, for instance, 26% of healthcare posts are not connected to the grid, compared to 100% of tertiary and upper healthcare facilities being connected to the grid and having a backup genset (SEforALL 2023a). In Nigeria, equity considerations are increasingly being considered by government programmes in light of the contrast between low-tiered and higher-tiered healthcare facilities in terms of electricity access and given that the majority (85.3%) of health facilities in the country are primary healthcare centres (SEforALL 2022a).

This discrepancy is even more pronounced when considering low-income and lower-middle-income countries in urban and rural contexts (WHO et al. 2023). While electricity access remains generally high for urban healthcare facilities across regions, rural establishments encounter substantial challenges, highlighting the urgent need for targeted efforts to bridge these disparities and enhance the electrification of healthcare facilities more widely. A case in point is Sierra Leone, where the majority of healthcare facilities without access to the national grid are lower-tiered facilities located further away from large towns or cities (SEforALL 2023b).

FIGURE 2.2 • **Health facility electrification status in low and lower-middle income countries, 2021**



Notes: South Asia refers to Nepal, Bangladesh and Sri Lanka; Africa refers to Senegal, Kenya, Sierra Leone, Liberia, Ethiopia, Tanzania, Niger and Zimbabwe; Americas refers to Honduras, Bolivia and Haiti. Bars not summing to 100% is due to rounding.

Source: WHO 2023a

2.3 MARKET PLAYERS AND DELIVERY MODELS

2.3.1 Key market players

Several key market players have emerged in the dynamic landscape of healthcare electrification, each contributing significantly to the electrification efforts aimed at enhancing healthcare infrastructure and services. These organizations span international institutions, non-governmental entities, and initiatives specifically dedicated to improving access to reliable electricity for healthcare facilities. Below we provide an overview of these key players, shedding light on their roles in advancing the convergence of healthcare and sustainable energy solutions. The selection of players was made based on the number of initiatives undertaken.

- **World Bank:** The World Bank's Energy Sector Management Assistance Programme (ESMAP) provides funding and technical assistance for electrification projects in developing countries, including projects targeting healthcare facilities. In response to the COVID-19 pandemic, a number of projects aimed to accelerate the electrification of health facilities and provide cold chains for the deployment of vaccines through climate-friendly solutions across countries such as Liberia, Nigeria, Haiti, South Sudan, Niger, Zimbabwe and Comoros.

- **United Nations Development Programme (UNDP):** Within the health–energy nexus, UNDP's Solar for Health initiative has worked with 15 countries to equip rural health centres with solar PV systems. To scale up future work, UNDP aims to implement innovative business and financing models, leveraging the energy-as-a-service approach, which is currently being explored in five countries (Liberia, Malawi, Namibia, Zambia and Zimbabwe).

- **UNICEF:** UNICEF's worldwide initiatives for sustainable energy are aimed at supporting the most at-risk youth and children, especially those in remote, isolated communities that lack access to the gird, and in areas facing long-term humanitarian crises. These initiatives span from international efforts ensuring vaccines are kept cold, solar-powered water pumping, and even solar-powered seawater desalination projects, down to local energy solutions supporting educational and social welfare programmes. For instance, UNICEF has established projects to electrify healthcare facilities with solar power in countries such as Zimbabwe and Malawi.

- **SELCO Foundation:** SELCO aims to strengthen last mile health delivery for improved resilience of communities by powering healthcare infrastructure with sustainable energy and shifting to energy-efficient equipment and buildings. SELCO has committed to electrify 25,000 facilities by 2026, in partnership with the IKEA Foundation, which is the main funder of the USD 54 million initiative (IKEA Foundation n.d.).

- **Power Africa:** An initiative led by USAID, Power Africa aims to increase access to electricity in Sub-Saharan Africa, including for healthcare facilities. Through the Health Electrification and Telecommunications Alliance (HETA), Power Africa brings together renewable energy, digital technology and health solution providers to electrify and digitally connect 10,000 health facilities.

- **Gavi, the Vaccine Alliance:** Gavi supports the electrification of healthcare centres to ensure the reliable storage of vaccines and to strengthen immunization programmes in low-income countries.

- **World Health Organization (WHO):** WHO supports healthcare electrification by conducting energy needs assessments of healthcare facilities, helping governments to build an enabling framework to accelerate healthcare facility electrification, as well as engaging in high-level advocacy, coordination and mobilization of adequate resources for impact on the ground.

Table 2.1 summarizes the key market players along with information on the number of initiatives. Chapter 5 elaborates on the financing and investment needs related to healthcare electrification.

TABLE 2.1 • **Key market players**

Market player	Number of initiatives	Facilities electrified (2018-2023)	Average duration
World Bank	36	9,210	4
UNDP	36	2,632	4
Gavi	23	420	3
UNICEF	19	2,067	1
Power Africa	12	402	1
SELCO Foundation	6	93	2
WHO	4	41	3

Notes: The data include completed, ongoing and planned projects. The number of facilities electrified is larger than reported in this table due to missing values. The table does not include the 25,000 health facilities that SELCO Foundation has committed to develop.

2.3.2 Delivery model archetypes

A business model for healthcare electrification outlines the framework of the electrification initiative, including how the project is organized and executed. It clarifies the roles and responsibilities of each party involved in funding and implementing various stages of the programme's life cycle, as well as the ownership of assets and the contractual approach for handling these aspects.

Business models can broadly be divided into public and private. Asset ownership is the key distinguishing feature between the two categories: in public models, the electrification assets are paid for and owned by the public entities implementing the programme (government agencies, publicly run utilities, public institutions, donor agencies), while in private models, asset ownership lies with the private sector.

The **three key models** within these two categories are:

- **Engineering, procurement and construction (EPC) models** (public): public entities pay private companies to design and install the electrification systems, as well as operate and maintain them in the short term. For long-term operations and management (O&M), public entities either continue paying a private company to oversee it or assume responsibility for it themselves. Asset ownership lies with the public entities.

- **Energy service company (ESCO) models** (private): the public sector defines the programme goals and approach, while the design, installation and short-term and long-term O&M are the responsibility of the private sector, funded either exclusively by the public sector or with a combination of public and private funds. The ESCO agreement outlines the private sector's contractual obligations, including O&M responsibilities, which are monitored by the implementing partners.

- **Fully private models** (private): private sector companies fund, design and install the equipment (often with support from public grants). They are also responsible for the O&M of the systems, funded through their own revenues and guided by contractual reliability requirements. Ownership of the assets lies with the private companies.

Furthermore, **EPC models** can be divided into three subcategories, based on which public entity is responsible for paying in each life cycle phase:

- **Conventional EPC model**: a public entity commissions a private company (usually the company that installed the system) to conduct O&M for a short period of time (usually six months to two years). After this period, O&M becomes the responsibility of the public entity (ministry or district authority).
- **EPC model with long-term O&M**: a public entity commissions a private company (often, but not always, the company that installed the system) to conduct O&M for a long period of time, usually more than five years.
- **EPC contract with O&M paid by the healthcare facility**: the healthcare facilities are responsible for commissioning and paying for the O&M out of their own budget. Their budget may come either through government funding or own revenues.

Finally, **fully private models** can also be divided into two subcategories, based on whether ownership stays with the private sector or is transferred to the healthcare facilities:

- **Lease-to-own**: healthcare facilities pay the entire cost of the system, in small instalments over a period. After all payments are made, ownership of the system is transferred to them.
- **Fee-for-service**: healthcare facilities pay for electricity supply through a prepaid meter or on a monthly basis. Unlike the lease-to-own model, ownership of the system is never transferred to the facilities but remains with the developer.

The roles of the public and private sector in each of the key three models (and their subcategories) are summarized in the figures below.

FIGURE 2.3 • **EPC models**

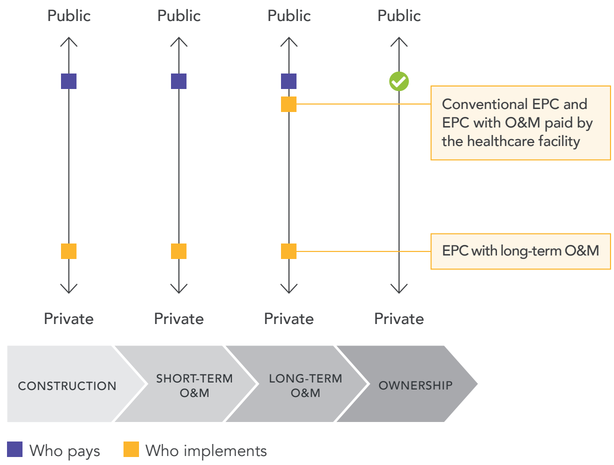


FIGURE 2.4 • **ESCO model**

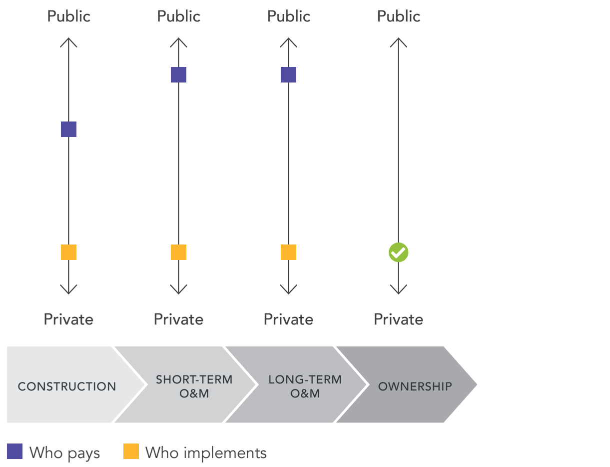
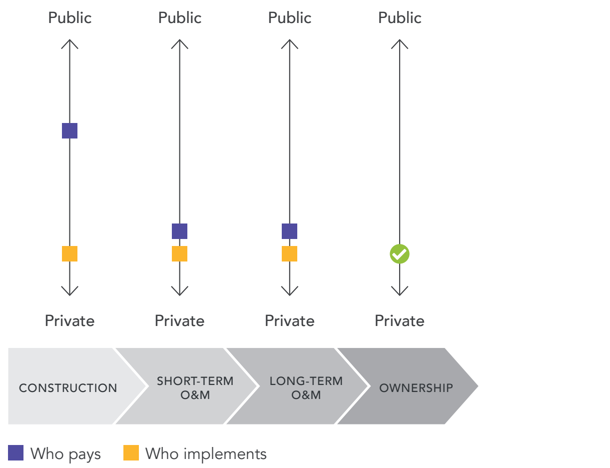


FIGURE 2.5 • **Fully private model**



Source: ECA analysis

CHAPTER TWO

Key Insights

CURRENT STATUS OF HEALTH FACILITY ELECTRIFICATION

→ Insight #1

An estimated **1 billion people** across the globe have local healthcare facilities with **an unreliable power supply**

→ Insight #2

Percentage of healthcare facilities with no access to electricity in:

12%
South Asia

15%
Sub-Saharan Africa

→ Insight #3

Generally, hospital electricity access is higher than in non-hospital facilities, whilst **urban settings** have higher access rates than **rural settings**

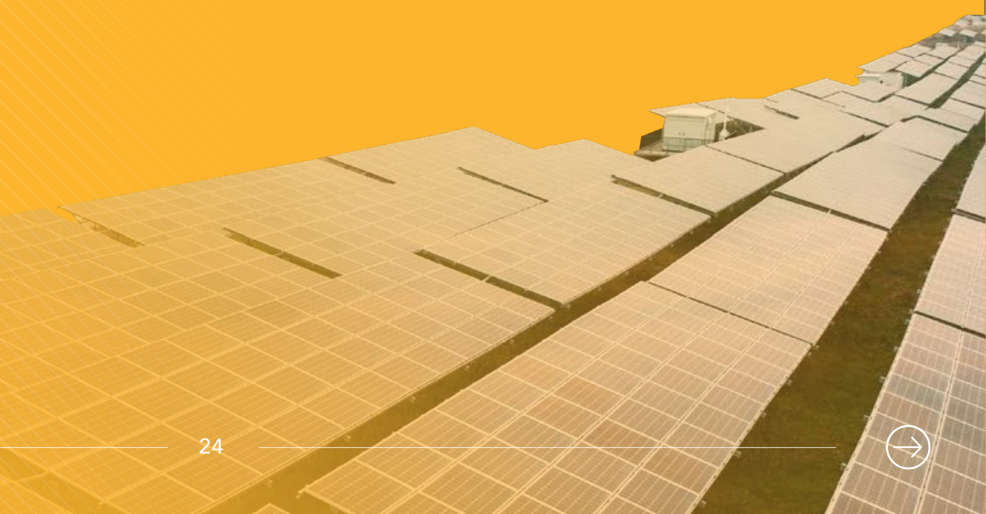
→ Insight #4

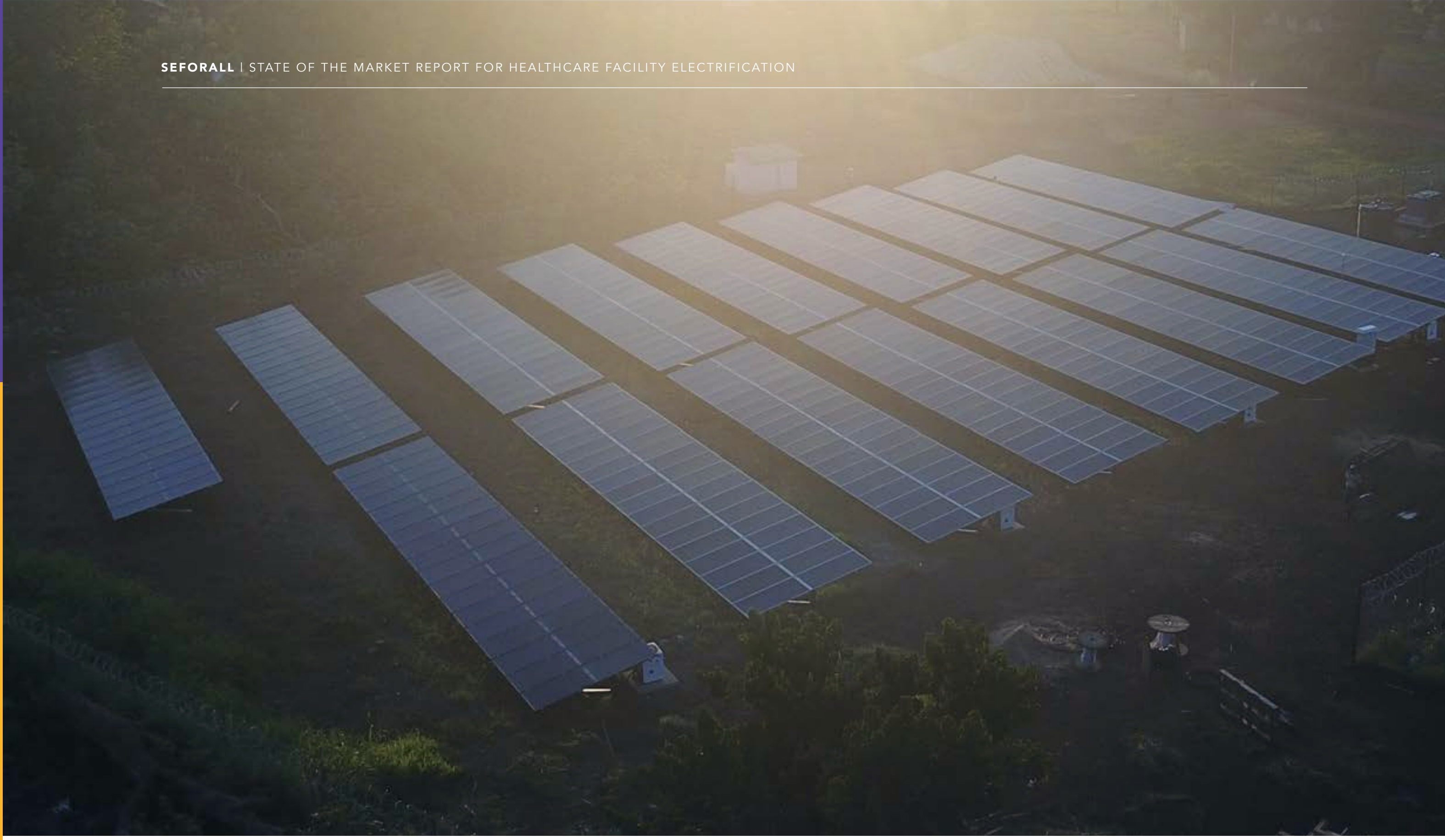
Key players include:

THE WORLD BANK, SELCO FOUNDATION, World Health Organization, POWER AFRICA, Gavi The Vaccine Alliance, UNDP, unicef

→ Insight #5

A **business model** for healthcare electrification outlines the framework of the electrification initiative, including how the project is organized and executed and funded





CHAPTER THREE

Healthcare Electrification Trends

The methodology employed in analysing the healthcare electrification trends presented in this report was a comprehensive and exhaustive process aimed at capturing the most accurate and up-to-date information from all healthcare electrification stakeholders. Over a period of three months we engaged with a diverse range of stakeholders, reaching out to international organizations, non-governmental entities, private sector actors and governments. Through this extensive outreach, we diligently collected data on past, current and planned healthcare electrification initiatives, totalling 387 initiatives across 89 countries, from 78 stakeholders. The trends presented in this section are rooted in the deep insights we derived from the meticulous analysis of this extensive dataset. Furthermore, to ensure a well-rounded perspective, we conducted interviews with approximately 20 key institutions deeply involved in healthcare electrification, allowing us to incorporate their valuable opinions and insights into the broader narrative of healthcare electrification trends.

Governments and international organizations have recognized the importance of electrification in the health sector and have implemented various initiatives and incentives to support electrification efforts. Public-private partnerships are being formed to mobilize resources and expertise, accelerating the implementation of electrification projects and driving progress towards achieving Sustainable Development Goal 7—ensuring universal access to affordable, reliable, sustainable and modern energy for all. Figure 3.1 provides the number of healthcare electrification initiatives according to SEforALL's existing Powering Healthcare Intervention Heatmap.

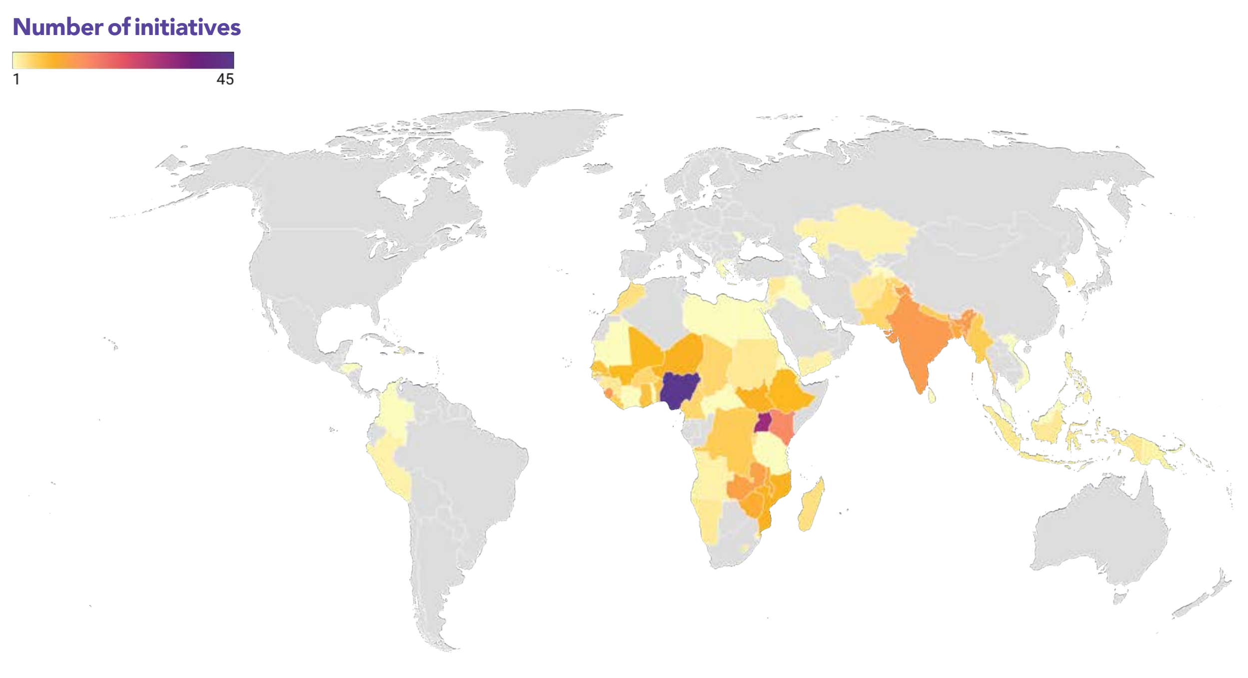


FIGURE 3.1 • **Healthcare electrification initiatives**

Note: Initiatives in this context refer to stand-alone projects that could include any or several of the following elements: energy needs assessments, implementation of power solutions, research and market intelligence.

Source: SEforALL 2022b

3.1 IMPLEMENTATION AND FUNDING OF HEALTHCARE ELECTRIFICATION INITIATIVES

Healthcare electrification surged during the COVID-19 pandemic; the momentum behind electrification has remained strong when compared to pre-2020 levels.

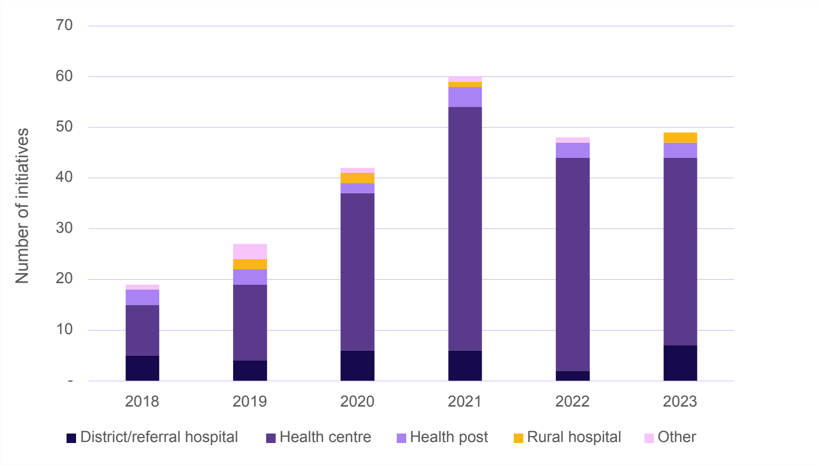
The trajectory of healthcare electrification initiatives witnessed a steady and encouraging ascent between 2018 and 2021, exhibiting a commendable annual rate of growth in the number of initiatives, averaging 47%. This remarkable progress signifies a commitment towards addressing the critical intersection of healthcare and electricity access. A notable catalyst for this surge in initiatives has been the heightened focus on health centres, which have emerged as the cornerstone of this transformative journey. These vital healthcare hubs have garnered substantial attention, not only for their essential role in delivering primary care, but also for their potential to significantly improve the overall healthcare landscape through improved access to electricity (Figure 3.2 below).

The urgency of the COVID-19 era prompted a surge of support for healthcare electrification efforts, with significant commitments and resources allocated to bolstering the energy infrastructure of healthcare facilities. Throughout the pandemic, healthcare electrification gained unprecedented prominence on the international stage, as governments, development partners and other organizations rallied to ensure adequate and reliable power supply to medical facilities grappling with the demands of treating COVID-19 patients. The recognition that a steady power supply is essential for running vital medical equipment, such as ventilators, oxygen concentrators and refrigeration units for vaccines and medications, served as a driving force behind these initiatives. During the COVID-19 pandemic, the number of healthcare electrification initiatives experienced remarkable growth, surging by 56% from 2019 to 2020 and a further 43% from 2020 to 2021.

There has been a decrease in the number of healthcare electrification initiatives as the world's focus has moved on from the pandemic. The number of healthcare electrification initiatives undertaken per year tapered off in 2022, with a 20% reduction compared to 2021, while the number of initiatives remained at the same level in 2023. However, the momentum behind electrification seems to have remained high when compared to pre-2020 levels. Given that most health facility electrification (HFE) initiatives last multiple years, preserving this momentum is crucial not only for the short-term functioning of healthcare institutions, but also for the overall quality and accessibility of healthcare services in the longer run.

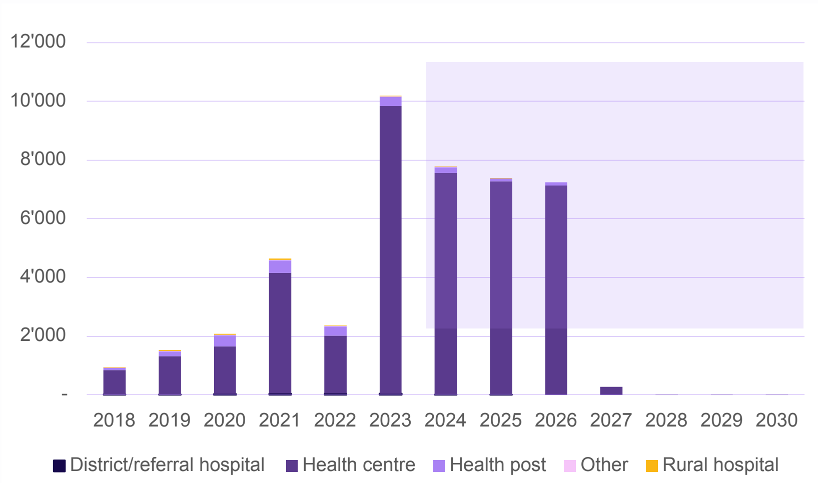
A decline was seen in the number of facilities electrified in 2022 compared with 2021, but this has since been reversed in the strong drive for healthcare electrification.

FIGURE 3.2 • **Number of electrification initiatives targeting healthcare facilities per year**



Source: Consultant, based on latest Heatmap survey data (SEforALL 2022b)

FIGURE 3.3 • **Number of healthcare facilities electrified per year**



Source: Consultant based on updated Heatmap survey data (SEforALL 2022b)

The number of newly electrified healthcare facilities steadily increased between 2018 and 2021 (Figure 3.3). The largest increase was reported in 2021, when the number of facilities electrified more than doubled compared to the year before.[1] This can be attributed to the COVID-19 pandemic, which necessitated rapid responses. Similar to the trend exhibited by the number of initiatives undertaken, in 2022 the number of facilities electrified fell by 49% compared to 2021. However, the data suggest a surge in healthcare electrification efforts beginning in 2023. In assessing the trajectory of HFE, it is crucial to acknowledge the inherent delay between the release of funds and the connection of facilities to a power supply. This report underscores that, despite temporal fluctuations, there is a sustained upward momentum in HFE, with projections showing continued growth from 2024 to 2026.

Looking ahead, there appears to be strong commitment from development partners. Existing commitments are targeting the

—

[1] The number of facilities electrified by multi-year initiatives has been spread equally over the years of each initiative's duration, instead of attributing the number to a single year.

electrification of 25,000 facilities, which is in line with the targets set under the Multilateral Energy Compact for Health Facility Electrification. It is worth noting that the large number of facilities being electrified is largely driven by the SELCO IKEA Foundation programme, which has secured funds to electrify 25,000 facilities in India by 2026, for instance. For the years beyond 2023, for which there is limited certainty over the realization of donor commitments, only the initiatives that have secured funding are included in the figure below. Therefore, given that a substantial number of planned projects are not taken into account, the number of electrified facilities is expected to be higher, indicating a positive outlook for the sector.

The composition of healthcare facility initiatives has exhibited a consistent pattern in recent years.

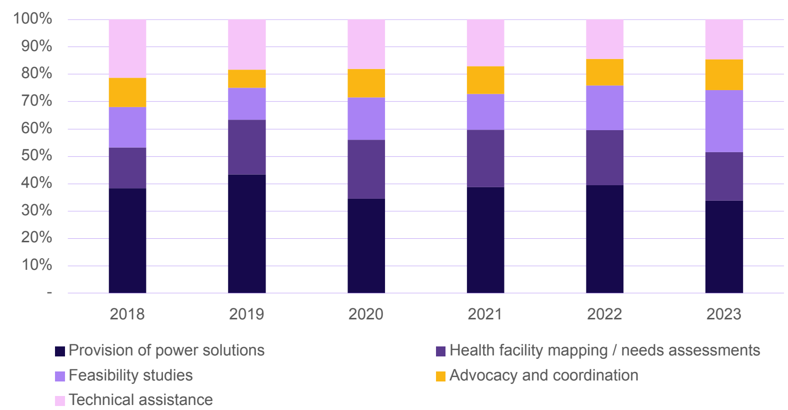
The provision of power solutions has consistently been the most common type of initiative related to healthcare electrification, commanding an average share of 38% during 2018–2023 (Figure 3.4). In addition, stakeholders are increasingly recognizing the importance of needs assessments, which have grown in number between 2018 and 2023 and account for an average share of 19%. Feasibility studies and technical assistance represent an average share of 16% and 17% respectively. Finally, advocacy and coordination initiatives constitute the smallest share of all initiatives, at an average of 10%.

The landscape of healthcare electrification has been dominated by stand-alone solar systems.

On average, 82% of electrification initiatives have opted for stand-alone solar technology, reflecting its popularity as a reliable and sustainable energy source (Figure 3.5). Among mini-grid options, hybrid mini-grids have emerged as a more frequent choice by implementers, compared to solar mini-grids (also see Section 3.5). Notably, there has been a steady upsurge in grid connections to power healthcare facilities, a trend that gained momentum from 2022 onward.

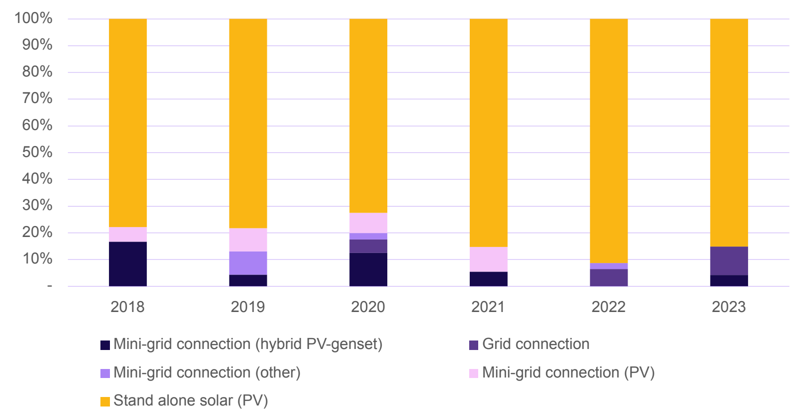
This trend is particularly pronounced in relation to district and referral hospitals. This is attributable to the substantial investment that numerous countries have made in recent years towards expanding their power grids. Consequently, by design, health facilities and hospitals, particularly those in more urban areas such as district capitals, stand to benefit from such expansion.

FIGURE 3.4 • **Types of initiative targeting healthcare facilities**



Source: Consultant based on updated Heatmap survey data (SEforALL 2022b)

FIGURE 3.5 • **Types of electrification solution used per year**



Note: Mini-grid connection (other) refers to either hydro mini-grids or mini-grids for which no information is available on the technology type.

Source: Consultant based on updated Heatmap survey data (SEforALL 2022b)

A pronounced transition away from smaller systems has been observed for health centres.

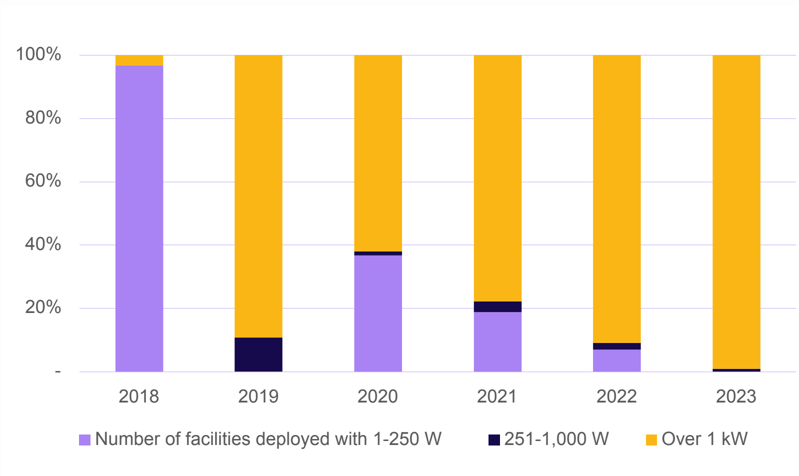
Stakeholders have been increasingly acknowledging the importance of designing systems that address the electrification requirements of facilities holistically. Indeed, 99% of health centres electrified in 2023 were provided with systems of over 1 kilowatt (kW) (Figure 3.6). This is a very significant shift in system design considerations, especially when compared to 2018 when 97% of health centres were deployed with systems up to 250 watts (W). In district/referral hospitals, conversely, systems larger than 1 kW have consistently been deployed since 2020 for all such facilities being electrified, which is crucial given the comprehensive services provided by hospitals, including diagnostics and surgery.

Restricted procurement is becoming more common.

For the supply of power solutions, more and more stakeholders are opting to establish framework contracts with carefully chosen private companies, as opposed to launching open tenders.

This approach expedites the progression of projects, facilitating swifter realization of critical healthcare electrification initiatives. Simultaneously, it provides programme implementers with a better understanding of costs, which facilitates budgeting during programme implementation.

FIGURE 3.6 • **Size of systems installed in health centres per year**



Source: Consultant based on updated Heatmap survey data (SEforALL 2022b)

BOX 3.1 • **UNICEF's long-term agreements with companies**

The UNICEF programme's approach to advancing the solarization of health facilities rests on strategic long-term agreements with eight selected companies for the provision of solar systems, including all equipment and services.

The solarization process begins with a collaborative relationship between the host country's ministry of health and UNICEF. The initial steps encompass site and facility assessments, targeting those areas in which immunization rates and other key indicators remain suboptimal. A common approach is to carry out in-depth needs assessments in sample facilities, which will later serve as representative models for others of a similar calibre. The facilities' energy needs and associated medical equipment and services identified during the assessments are also compared against the national standards and guidelines. The implementation phase comes into play based on this groundwork, validating the demand for solar solutions in each health facility. Facilities are stratified into categories of 1.5 kW, 3 kW, 5 kW, 8 kW and 10 kW, streamlining the process into manageable turnkey packages rather than intricate microanalysis and multiple bespoke designs. Facilities with demand beyond 10 kW can also be targeted under these long-term agreements, although a detailed analysis is then required to design the appropriate solution.

This strategic approach not only accelerates progress, but also underpins budgeting efforts as prices are predefined and agreed upon, minimizing uncertainty.

Source: Interview with UNICEF

Photo: UNICEF Ethiopia/2013/Ose

The process is underpinned by a rigorous pre-assessment of partnering companies to ascertain their alignment with the exact quality benchmarks stipulated by the programme implementers.

By imposing these stringent prerequisites, the programme builds in assurance that the companies are capable of completing the projects while meeting set quality standards, and that the installed systems have suitable long-term operational reliability, while also ensuring there is sufficient competition between companies. This not only leads to seamless project execution, but also engenders a level of trust between stakeholders and private entities, fostering a cohesive environment for collaboration.

The duration of initiatives has been falling since 2021

The evolving landscape of healthcare electrification initiatives is marked by a decline in their average duration across various facility types.

This could partially be attributed to factors such as the use of more streamlined processes or the increased availability of data, which implies that initiatives can deploy more standardized solutions, based on previous initiatives, instead of reconducting site audits in each country they engage in. Initiatives involving health posts and health centres have an average span of 2.3 and 2.5 years, respectively, spanning the period from 2018 to 2023 (Figure 3.7). In contrast, initiatives focusing on district/referral hospitals tend to be shorter, culminating in an average duration of 1.3 years.

This disparity in initiative durations highlights the nuanced nature of electrification projects, with health posts and health centres necessitating longer-term commitments to ensure that operations and maintenance (O&M) is conducted for at least 2 years, while for larger establishments that usually have a dedicated maintenance team, the initiative is shorter. Looking ahead, the emphasis on the ESCO model suggests that we can anticipate a marked increase in the duration of HFE initiatives, reflecting the inherently long-term orientation of these projects.

FIGURE 3.7 • **Average initiative duration, 2018-2023**

Source: Consultant based on updated Heatmap survey data (SEforALL 2022b)

3.2 STAKEHOLDER COLLABORATION

The collaboration between energy and health stakeholders is improving, but further progress is required

Energy and health stakeholders have undoubtedly made strides in their collaborative work in recent times (see Box 3.2). Global initiatives, such as the Health and Energy Platform of Action (including the High-Level Coalition on Health and Energy) and the Multilateral Energy Compact for Health Facility Electrification, epitomize the concerted efforts to forge a harmonious alliance between the health and the energy sector for the purpose of advancing healthcare electrification at a global level.

BOX 3.2 • Platforms for the improved integration of health and energy sectors

Acknowledging the inextricable link between energy (SDG7) and health (SDG3), the World Health Organization (WHO) is actively promoting closer collaboration between the health and energy sectors to leverage the potential synergies through multiple platforms, including the following:

The **Health and Energy Platform of Action** (HEPA) is convened by the WHO, together with the United Nations Development Programme (UNDP), the United Nations Department of Economic and Social Affairs (UN DESA), the World Bank and the International Renewable Energy Agency (IRENA). It aims to mobilize financial commitments for achieving SDG3 and SDG7, as well as enhance cooperation between the health and energy sectors. HEPA has been active in the effort to accelerate electrification of healthcare facilities.

The **High-Level Coalition on Health and Energy**, which supports HEPA, comprises leaders from governments, international organizations and other high-level health and energy champions. Other than strengthening cooperation between the health and energy sectors, the coalition aims to increase political momentum, spur investment, mobilize public support and drive practical solutions.

Initiatives by other key stakeholders include:

The **Health Electrification and Telecommunications Alliance** (HETA) is a USAID Global Development Alliance that aims to deliver health facility electrification and digital connectivity in Sub-Saharan Africa. HETA represents a partnership between the US government and the private sector, leveraging their combined resources and expertise to collaboratively design market-based solutions that meet facilities' and communities' needs. HETA supports business models that can secure sustainable revenue for O&M and provide lasting benefits at the energy-health nexus.

The **Distributed Access through Renewable Energy Scale-Up Platform** (DARES)—see Box 3.3.

The **Multilateral Energy Compact for Health Facility Electrification**, launched by SEforALL and Power Africa, with more than 20 other contributors (including IRENA, UNDP, UNICEF and Gavi), aims to provide a platform for key stakeholders from the energy and health sectors to exchange lessons learnt and share best practices, as well as leverage existing mechanisms at the global and national levels. The compact includes the Heatmap of HFE initiatives (see Figure 3.8 below), which provides a one-stop sectoral overview of healthcare electrification initiatives, thus facilitating stakeholder coordination.

FIGURE 3.8 • **Heatmap of HFE initiatives**

Sources: SEforALL 2022b; WHO n.d.

While effective collaboration among healthcare electrification stakeholders on a global scale is undoubtedly valuable, there is a pressing need for enhanced interaction at the country level. Currently, implementation partners often lack awareness of the activities undertaken by other stakeholders within a specific country. In certain countries, different implementation projects were collaborating with different ministries or distinct departments within the same ministry, thereby hindering effective coordination. This lack of coordination can lead to inefficiencies, redundancy and missed opportunities. To rectify this, it is imperative to establish a more robust framework for country-level coordination and a universal database documenting the work at a country or more localized level. By fostering greater transparency and communication among various institutions working towards healthcare electrification in a particular country, the risk of duplication is avoided while ensuring that resources are optimally utilized.

A challenge prevalent across many countries is the lack of clarity regarding the ministry that is tasked with spearheading electrification projects for healthcare facilities. Collaboration between the two ministries—health and energy—is inherently complex due to their differing priorities. The health sector, embodying the demand for electricity, seeks to enhance patient care and diagnostic capabilities in healthcare facilities. Conversely, the energy sector assumes the responsibility for supplying this electricity. Another complicating factor arises from the fact that in the majority of countries the health ministry tends to be highly decentralized, often granting significant autonomy at the district level. In contrast, the energy sector is typically characterized by its centralized nature. This disparity in degree of decentralization adds an additional layer of complexity to national-level coordination efforts, potentially involving multiple ministries or agencies. This complexity can further escalate when considering other critical areas such as water provision, climate resilience and built infrastructure, such as public works. Additionally, the delineation of responsibilities for ongoing maintenance remains uncertain. Recognizing the intrinsic interdependence of these sectors, it becomes imperative to dismantle silos and facilitate coordinated action to accelerate progress in healthcare electrification. This can include memorandums of understanding between the health and energy ministries, which can enhance coordination and clarity in communication.

An essential element in overcoming these challenges is enhancing data availability and establishing robust institutional coordination at a practical level. This is especially crucial at the policy, programme and implementation levels. By bolstering data sharing and aligning institutional frameworks, the synergy between energy and health stakeholders can be harnessed more effectively, leading to the seamless scaling up of healthcare electrification endeavours. Ultimately, this holistic approach not only bolsters the healthcare system's resilience and capacity, but also underscores the potential to significantly enhance patient care and well-being through reliable access to electricity in healthcare facilities.

Consulting the private sector on the sizing of systems is creating buy-in

The active involvement of renewable energy companies in the sizing of energy systems is emerging as a pivotal strategy, fostering a sense of ownership and alignment within the realm of healthcare electrification initiatives. This strategic cooperation underscores the fact that private sector entities have a wealth of know-how and specialized knowledge in system sizing. Their insights are grounded in extensive experience and understanding of how to calibrate energy systems to maximize operational efficiency and mitigate the risk of failure. By consulting private companies during the sizing process, healthcare electrification initiatives stand to benefit from a holistic perspective—one that encompasses not only immediate power needs, but also anticipates the dynamic evolution of healthcare facilities over time. However, these companies, particularly those specializing in energy access, often lack expertise in energy-efficient medical appliances.

This collaborative approach was followed by the Powering Healthcare programme in Ghana and Uganda, implemented by the United Nations Foundation (UNF), among other initiatives. The UNF leveraged the insights

BOX 3.3 • **Distributed Access through Renewable Energy Scale-Up Platform (DARES)**

DARES is a new initiative by the World Bank, the Multilateral Investment Guarantee Agency (MIGA), the International Finance Corporation (IFC) and other development agencies. It aims to promote private investment in distributed renewable energy systems to electrify targeted areas in Sub-Saharan Africa quickly and efficiently and achieve universal access by 2030.

DARES aims to leverage World Bank, MIGA and IFC expertise to create a **joint cross-sectoral approach to develop innovative financial and de-risking instruments**, to be rolled out at a regional level. These innovative risk mitigation solutions will be fit-for-purpose for the unique risks faced by investors and will create opportunities to combine public and private investment. The instruments will adopt different approaches to fit the unique country contexts and markets.

DARES will have five core areas related to SDG7: mini-grids; off-grid solar markets; systems for schools and health facilities; solar irrigation and cold chain for farmers; and innovative business models to displace diesel generation and improve access reliability.

and expertise of private sector companies to prepare detailed technical specifications, following rigorous energy audits conducted in each healthcare facility. This collaboration not only ensured accuracy, but also nurtured a profound sense of investment and partnership. Unlike the prevailing approach, where many projects narrowly address essential loads and selected buildings, the UNF's method encompassed the holistic energy requirements of entire healthcare establishments, including staff quarters and other infrastructure. This approach not only guarantees the resilience and longevity of electrification solutions, but also benefits from a collaborative synergy that strengthens the foundation of healthcare infrastructure electrification.

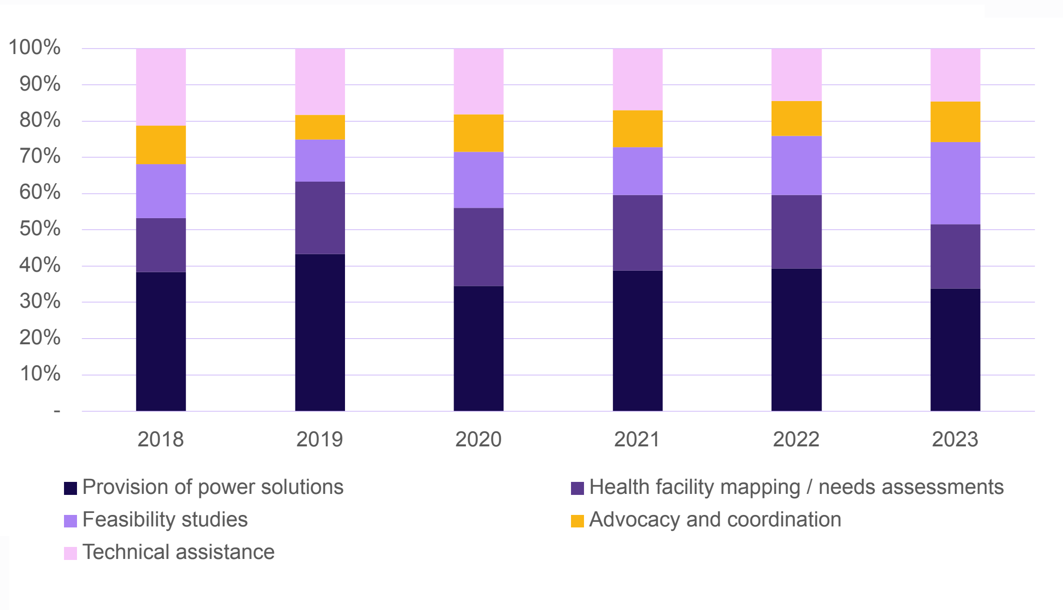
Those implementing initiatives realize the importance of conducting a needs assessment prior to an electrification project.

Different tiers of healthcare—ranging from health posts, clinics and health centres, to district, regional and provincial hospitals—have varying energy needs depending on the medical services offered, their respective appliances and staffing requirements. However, even within the same tier of healthcare, factors such as the socio-demographic profile of the population it serves, the prevailing diseases in the community and the energy efficiency of the medical equipment can affect the energy requirements of the healthcare facility, while climate conditions can affect system size requirements to meet energy demand across seasons (WHO et al. 2023).

Health and energy stakeholders involved in the electrification of healthcare facilities are increasingly acknowledging the importance of understanding the needs of individual facilities prior to project implementation.

According to the updated Heatmap of healthcare electrification initiatives, in 2023 18% of the initiatives included a needs assessment (Figure 3.9). This estimate is conservative, considering that a needs assessment may have been carried out for other projects, even if not documented in the Heatmap database. Thorough energy needs assessments are crucial for accurately evaluating the energy requirements of a healthcare facility, in relation to the specific services provided, the availability of trained staff and the medical equipment used (with the identification of critical and non-critical loads).

FIGURE 3.9 • **Types of initiatives**



Source: Consultant based on updated Heatmap survey data (SEforALL 2022b)

Thorough needs assessments have been instrumental in securing donor investment for healthcare projects.

The UNF's Powering Healthcare programme in Ghana and Uganda provides an example of energy needs assessments being the starting point for a project. The assessments included a detailed analysis of the electricity needs of the health clinics and their ability to pay, as well as an evaluation of the potential impact of income-generating activities at the facilities in order to fund the O&M costs. The needs assessments carried out between 2014 and 2015 resulted in a donor committing to finance the project for the period 2015-2019. A similar scenario unfolded in Sierra Leone, where the needs assessments by SEforALL, designed to guide its strategic roadmap, culminated in a donor providing financial support for the hospitals that were evaluated.

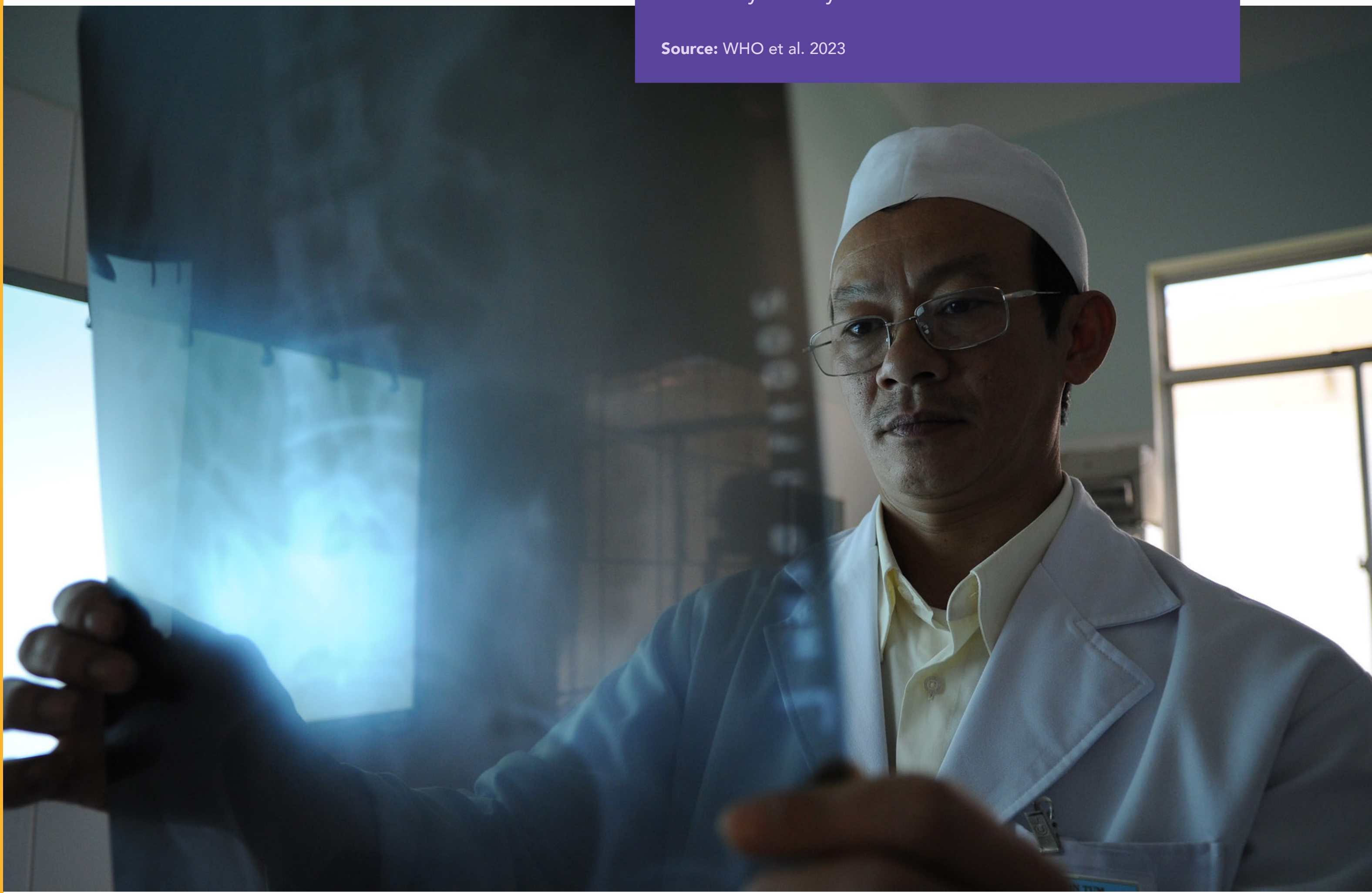
BOX 3.4 • **SELCO Foundation: Involvement of health facility staff in energy audits**

Since 2015, SELCO Foundation has been working with public health partners in ten Indian states on a decentralized model of healthcare facility electrification. The foundation takes a needs-based approach, with a focus on the efficiency, availability and functionality of medical devices and appliances. One major success factor has been the greater involvement of facility staff in the energy needs assessment phase. In particular, a health energy audit is completed by consulting with health experts to identify the energy inputs and appliance needs of each healthcare facility, taking into account the Indian Public Health Standards guidelines. A matrix of options is identified for the facility based on the level of healthcare provided and the funds available.

The energy needs assessment phase collects information through various sources, including energy meters, interviews, data recorded on healthcare appliances, and photographs.

This approach was adopted as an alternative to the **traditional model, which is supply (energy input) focused**, leading to incorrectly sized systems.

Source: WHO et al. 2023



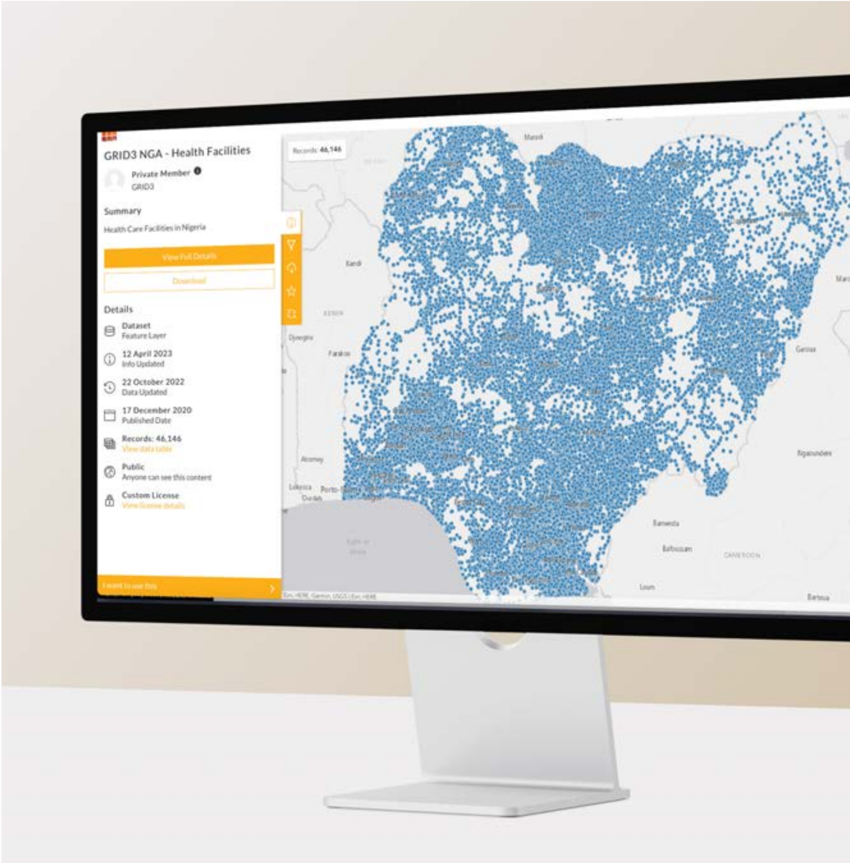
3.3 DATA-DRIVEN DECISION MAKING

In many developing and emerging economies, the historical lack of comprehensive digitalized health facility data — encompassing critical attributes such as location, coordinates, type, operational status, level of electrification and energy requirements — has posed significant challenges. Often, this vital information has been either limited, scattered, outdated or entirely unavailable. Consequently, the process of formulating data-driven policies and electrification programmes has been protracted and laden with difficulties. However, the landscape is evolving thanks to technological advancements and cost reductions relating to spatial tools and big data processing pipelines, including satellite imagery, cloud computing, machine learning and artificial intelligence (AI). This transformation is making geographic information system (GIS) approaches an increasingly popular and powerful tool for planning electrification interventions (Figure 3.10).

Within the realm of HFE, decision-makers are harnessing the progress made in geospatial technology to bridge data gaps effectively and prioritize the allocation of funds and investment under electrification initiatives. The consolidation of this information would ultimately support decision-makers in policy and investment decisions. Several initiatives have already embraced spatial analytics to inform HFE strategies. Notably, the World Bank has taken a proactive stance by maintaining the Global Electrification Platform, a geodatabase that offers insights into the least-cost electrification options for millions of unserved settlements across 58 countries, including the location and estimated energy needs of over 100,000 health facilities. The platform utilizes GIS-based analysis, considering factors such as distance to the grid network, proximity to functional service transformers, road accessibility, night light intensity and population density to identify the most suitable electrification option for each settlement. This approach inherently covers health facilities, aligning them with the least-cost electrification option for their vicinity. The outcomes of this analysis have contributed to global investment gap assessments.

Moreover, the World Bank has led country-level HFE assessments in countries such as Haiti, Mozambique, Nigeria and Ethiopia, tailoring new projects according to health facility characteristics, catchment areas and more. Another noteworthy example is the Electricity Access Health Facility Database in Africa, developed by the European Union Joint Research Centre. This database leverages GIS to inform interventions in the HFE domain. More recently, the World Resources Institute (WRI) has introduced a GIS-based methodology focused on estimating catchment areas and electricity requirements for thousands of healthcare facilities in Uganda. The spatial granularity associated with these studies enables seamless integration into data analysis platforms and aggregators, such as the Energy Access Explorer, Clean Energy Access Tool, SEforALL's Powering Healthcare Intervention Heatmap, and WHO's Geolocated Health Facilities Data initiative. VIDA has also made significant contributions to HFE by providing map-based software that enables efficient monitoring and decision-making in the field of electrification. Their innovative approach integrates various data streams, including satellite imagery, survey data and sensor data, to predict outcomes and facilitate the prioritization of health facilities.

FIGURE 3.10 • **Examples of GIS platforms**



Despite these advances, it is crucial to recognize the inherent limitations of GIS tools, which can impact their effectiveness and the decisions made based on their analysis. First, the accuracy and reliability of GIS outputs are fundamentally tied to the quality of the input data. In regions where data are poor or outdated, GIS tools may offer a skewed or incomplete picture, potentially leading to suboptimal decision-making. Second, it is also worth noting that while GIS can provide valuable estimates and allow prioritization, it cannot capture the full complexity of on-the-ground realities. Factors such as cultural dynamics, local politics and unplanned events are difficult to quantify and thus often remain outside the purview of geospatial analyses. Third, GIS-based models often involve assumptions and simplifications to make the complex real world computationally manageable. These models can sometimes miss critical nuances, resulting in an "order of magnitude" understanding rather than a precise one. Moreover, despite the significant advancements made in recent years, notable data gaps continue to persist, underscoring the critical role of high-quality data as the cornerstone of assessments in this field. Therefore, it should be recognized that GIS-based analysis and planning inherently have limitations with regard to both granularity and accuracy. As such, it is vital for organizations to combine GIS tools with the collection of data from actual observation, to validate and refine the findings from geospatial analyses. This combined approach typically yields a more accurate, context-aware and cost-effective strategy for large-scale projects.

Moving in that direction, healthcare electrification initiatives are also integrating remote monitoring technologies as the most efficient way to collect real-time data on the quality of service provided. This is particularly important for transitioning towards service-based delivery models, whereby government agencies need to have data on whether maintenance is being performed and solar systems are functional in remote areas, and to diagnose problems when the system is not working. The data can also be used to trigger the disbursement of funds under a results-based financing (RBF) scheme and can also provide useful benchmarks for demand assessments in future electrification initiatives by offering system dimensioning values derived from real-world instances. Remote monitoring is also needed to support energy certificates or other types of payment for impact assessment. Odyssey Energy Solutions offers an end-to-end platform for every stage of distributed renewable energy project development, providing remote monitoring and control tools to help solar companies and financiers track and manage asset performance. For instance, in a pilot programme developed in partnership with Shell Foundation to test viable, sustainable financing models for health electrification, Odyssey's remote monitoring tools are providing data to develop insights into the efficacy of various financing models at selected health facilities (see Box 3.5).

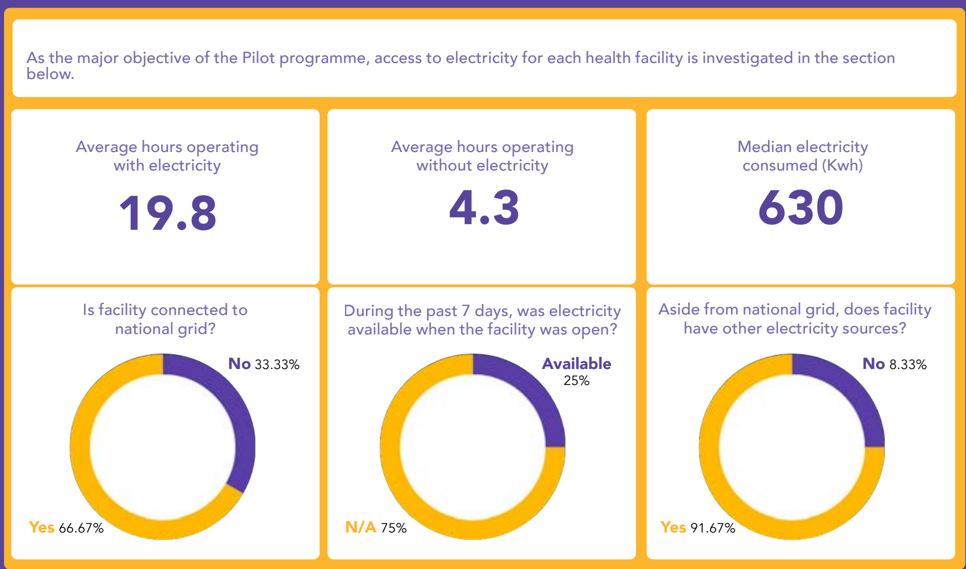
BOX 3.5 • **Shell Foundation Pilot Programme for Innovative Financing and Project Solutions, with data analytics from Odyssey**

The Shell Foundation Pilot Programme for Innovative Financing and Project Solutions was developed through a partnership between Odyssey Energy Solutions and the Shell Foundation to test health facility electrification models in Sub-Saharan Africa. Odyssey offers an end-to-end asset management and analytics platform, and with support from the Shell Foundation, the UK Foreign, Commonwealth and Development Office (FCDO) and USAID, has developed the Powering Health Platform for the design and implementation of health electrification financing programmes at scale.

The overall aim of this particular pilot programme is to collect data and generate learnings about the key success factors in health electrification, and to identify innovative financing solutions that can drive the long-term sustainability of such projects.

Odyssey's data analytics platform is being leveraged by site operators and renewable energy companies to visualize granular system performance and energy usage data (further discussed in Section 3.6.) At the same time, interactive dashboards showcasing broader health and impact survey data are allowing the Shell Foundation and other interested stakeholders to draw higher-level insights into the financing models deployed. As of August 2023, dashboards include data collected before project commissioning, and concluding survey data will be collected by the end of the year. Including before and after data ensures the dashboards will help identify trends and the achievement of health and impact key performance indicators (KPIs).

FIGURE 3.11 • **Access to electricity among health facilities**



The Access section of the dashboard paints a picture of access to electricity, whether that be through connection to a national grid or diesel generator, before project commissioning.

Source: Odyssey Energy Solutions (adapted)

As another example, A2EI, which is piloting a market-based approach to electrification of social infrastructure, has installed smart meters in 20 health facilities, which collect data on load profiles, energy consumption and peak demand, as well as on the quality of the signal of remote monitoring technologies. The data is visualized on an online platform (see Box 3.6) that can be accessed by interested stakeholders.

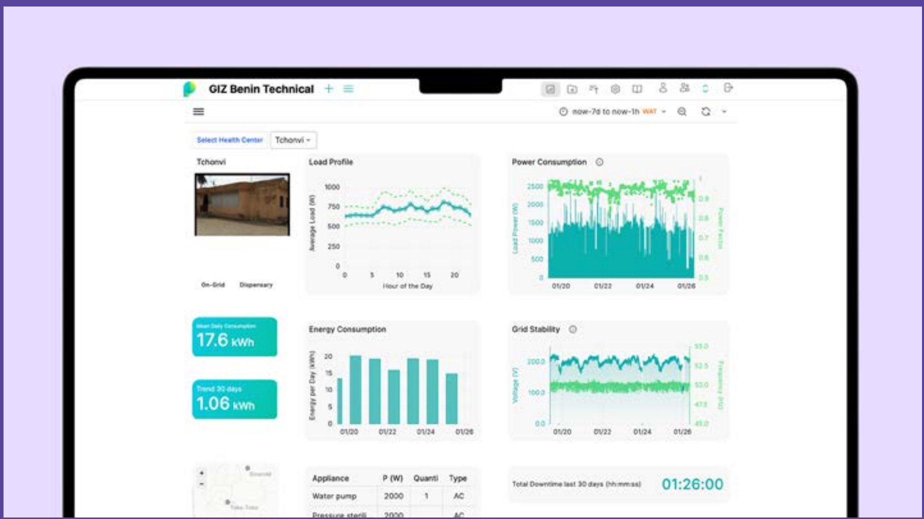
In addition to data-driven decision-making at the facility level, high-level policymaking has also been increasingly informed by data collected on the ground. Coordination across governance levels is crucial to prevent data scattering, reducing misalignments in policymaking and promoting efficient use of public funds. Box 3.7 presents an example of evidence-based decision-making.

BOX 3.6 • **Access to Energy Institute (A2EI): Prospect platform**

Launched by A2EI and GET.Invest in 2022, Prospect is the first global open-source, real-time and free-of-charge data platform to automatically collect, aggregate and analyse data on any country's energy services, ranging from solar home systems to large mini-grids and grid-connected distribution networks. It also covers productive use appliances, modern clean cooking solutions and systems installed in public institutions.

Prospect allows for instantaneous data sharing, monitoring and evaluation, while its built-in transaction functionality can facilitate data-driven financing and subsidy disbursements. Figure 3.12 is an example of the platform's customizable visualization: it allows users to see where exactly the different energy sources (grid, mini-grid, off-grid) are available in a region or country. Technical, maintenance, impact and financial data can also be visualized.

FIGURE 3.12 • **Prospect platform**



Source: GET.invest 2023

BOX 3.7 • **Harmonized Health Facility Assessment**

The Harmonized Health Facility Assessment (HHFA), supported by WHO, is a comprehensive health facility survey that assesses the availability and quality of health facility services in order to support evidence-based decision-making in health sector planning and policymaking. It builds on the WHO Service Availability and Readiness Assessment (SARA) as well as other global health facility survey tools and includes four modules (of which countries can choose to implement all or only some): 1. Service availability, 2. Service readiness, 3. Quality of care, and 4. Management and finance.

Source: WHO et al. 2023

3.4 CAPACITY BUILDING

Capacity building has become an indispensable component of health electrification initiatives.

The successful implementation of healthcare electrification initiatives calls for substantial in-house capabilities within the government departments that assume an active role. Ministries of health typically maintain robust Expanded Programme on Immunization (EPI) departments. These departments are crucial for the effective distribution and administration of vaccines, ensuring that immunization programmes reach vulnerable populations. Leveraging the existing infrastructure and expertise within EPI departments presents a unique opportunity to integrate healthcare electrification efforts with vaccination programmes. However, strengthening the government's capacity is often required for tasks such as identification and evaluation of sites, establishment and supervision of approval procedures, and oversight of competitive bidding processes. The government's capacity is also significantly bolstered by its ability to help with facility inventory and documenting the status of facilities' existing energy access and connection needs. This is particularly important for service-based models, as highlighted in Box 3.8.

A capacity needs assessment is an effective way of determining whether the relevant departments possess adequate personnel to manage these processes.

Encouraging cross-departmental coordination and knowledge sharing is valuable in cases where some departments exhibit stronger capabilities than others.

It is important to build consensus among regulators and social infrastructure that electricity is not free.

A common misconception among governments and beneficiary facilities that poses challenges for the sustainability of healthcare electrification interventions is that solar power is free. This is often reinforced by solar systems being installed through donor funding. The idea of a recurring cost for O&M is not easy to instil, and capacity building is increasingly incorporated into such interventions to ensure that when O&M responsibility is transferred to the relevant ministry, the officials in charge of allocating the budget understand the importance of O&M for ensuring that the systems are functional throughout their lifetime.

In the Energy for Rural Transformation (ERT) programme in Uganda, the initial capital cost is donor-funded, which contributed to the government's perception that solar energy is free (unlike electricity from the grid, for which there is consensus around the need to pay). This translates into districts being reluctant to allocate budget for the maintenance of solar systems (given the lack of earmarked funds), putting the project's sustainability at risk. Within the framework of the new World Bank programme in Uganda (Energy Access Scale-up Project [EASP]), it is anticipated that the government will assume a progressively larger share of the O&M costs as World Bank support gradually diminishes over time.

This consensus building is also crucial at the beneficiary level, where O&M is paid by the healthcare facilities. Conducting sensitization at each site helps staff realize the value and importance of proper maintenance and efficient use of systems, and promotes ownership. Moreover, it is important to highlight that while most studies indicate that O&M costs are similar to installation costs, when the system is adequately maintained these expenses are likely to be spread out over a 15- to 20-year period rather than being incurred upfront.

BOX 3.8 • **GIZ/GBE Benin: limited capacity within government**

The GIZ/GBE Benin initiative planned to implement a fee-for-service delivery model, whereby the viability gap between the state's ability to pay for social infrastructure and the private sector's capital costs of providing it would be covered through an RBF mechanism. A working group of about 10 companies interested in this model was created in order to design the RBF mechanisms; however, the model did not work out due to limited capacity within the Benin government to support the RBF programme.

A key lesson learnt was that extensive work was required beforehand on building capacity in the health sector, understanding the government's priorities, and improving/streamlining existing processes through digitalization. For instance, the Ministry of Health did not have a register of the country's health centres or their contacts. Working extensively with government stakeholders to understand such issues is a crucial prerequisite for the success of service-based models.

Source: Interview with GBE Benin

3.5 CLIMATE RESILIENCE AS A NEW AREA OF FOCUS AND FUNDING FOR HEALTHCARE ELECTRIFICATION

Reliable solar technology has become a cornerstone of replacing diesel generators in healthcare facilities.

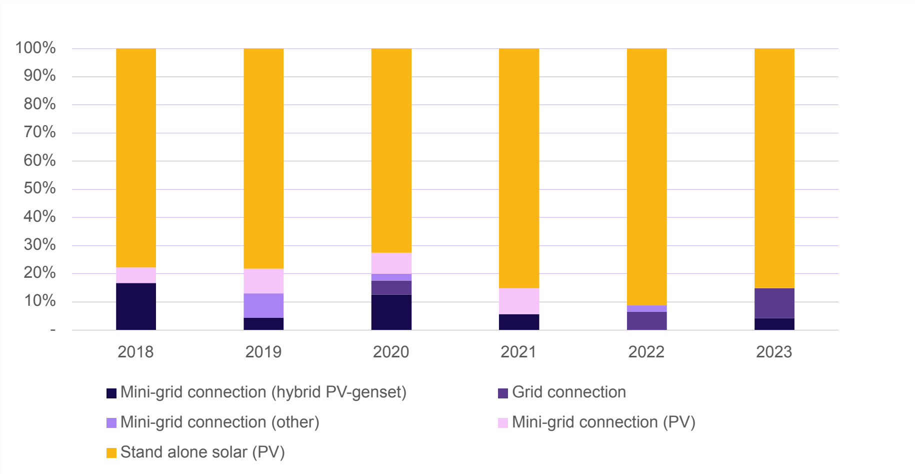
The scarcity of centralized electricity grids in areas where most unelectrified health facilities are located has led to their substantial reliance on diesel generators, where diesel is often heavily subsided. This phenomenon disproportionately affects marginalized communities, primarily those in rural and agricultural areas, who are also grappling with the ramifications of climate change. As diesel prices escalate, supply becomes intermittent and global energy markets remain uncertain, vulnerable populations bear the brunt of these challenges.

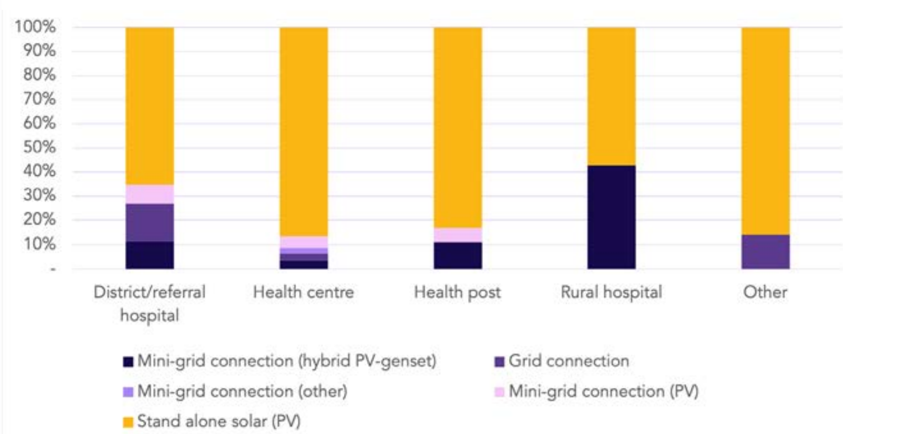
Recent developments have seen the emergence of off-grid renewable energy solutions, such as solar-powered systems and mini-grids, specifically designed to cater to the energy needs of health facilities in remote areas (Figure 3.13). These sustainable energy solutions offer a reliable and cost-effective alternative to traditional fossil fuel-based generators and can significantly improve electricity access in underserved regions. Additionally, advancements in battery storage technologies have contributed to enhancing the resilience of health facilities, ensuring uninterrupted power supply even during intermittent energy availability, with a payback period of 3-5 years.

The landscape of healthcare electrification has been largely shaped by the predominant utilization of stand-alone solar technology (Figure 3.13). This has emerged as the cornerstone of powering healthcare facilities, offering a reliable energy solution, especially for off-grid and weak-grid facilities.

The strategic direction of using solar systems to replace diesel generators offers significant advantages. First, leveraging solar power translates into significant cost savings for healthcare facilities over time, thereby releasing valuable resources that can be redirected towards patient care and medical equipment. Second, scaling up solar power enhances the resiliency of facilities and the healthcare sector, isolating key areas from destructive events such as flooding, drought and earthquakes. Third, the transition also results in a marked reduction in environmental impact at global

FIGURE 3.13 • **Types of solution by year and facility type**





Source: Consultant based on updated Heatmap survey data (SEforALL 2022b)

and national levels, consequently aligning healthcare operations with broader global sustainability goals. Box 3.9 below presents examples of this strategic transition. In practice, many of the systems devised for healthcare facility electrification adopt a hybrid approach. However, diesel gensets continue to fulfil a crucial role in safeguarding the reliability of energy supply, particularly in larger hospitals with systems exceeding 100 kilowatts peak (kWp). They serve as a dependable backup source, ensuring uninterrupted power during unexpected surges in energy demand or other unforeseen events. Achieving a 100% solar PV power solution would necessitate a significantly higher investment, for example approximately three times more than a hybrid system comprising 90% solar PV with the remaining 10% sourced from a generator.

BOX 3.9 • **Examples of initiatives aimed at replacing diesel generators with solar technology for healthcare electrification**

SEforALL Sierra Leone Hospital Electrification Project: After conducting detailed energy audits at key hospitals in Sierra Leone, SEforALL pinpointed six hospitals for a transformative initiative. This endeavour aims to replace the unreliable and polluting diesel generators with renewable energy solutions, thereby ensuring a consistent supply of dependable and clean power. The envisaged outcome encompasses the installation of approximately 530 kWp of solar PV capacity dedicated to the hospital's facilities, including staff quarters.

Solar4Health: In South Sudan, Solar4Health aims to replace diesel generators with reliable and clean solar energy by implementing an energy-as-a-service model. This shift not only replaces diesel generators, but also extends reliable electricity access to previously underserved health facilities. As the model gains traction, it is projected to reach hundreds of health facilities in South Sudan within a decade, effectively demonstrating that whole-facility solar power can be provided at a cost comparable to maintaining diesel generators (Crown Agents 2022).

Havenhill: This clean-tech utility company is establishing decade-long energizing agreements with private health facilities in Africa. Its approach revolves around substituting costly diesel generators with independent solar solutions, with the facilities making monthly payments for this service. After the initial ten-year period, the contract has the option to be extended. The projects are funded through a combination of borrowed capital and the company's own investment. The sizing and system design is based on the health facility's diesel consumption. Remarkably, there has been no instance of default thus far.[2]

SELCO Foundation and the IKEA Foundation: These two foundations announced a partnership to upgrade 25,000 primary health facilities in India with sustainable energy systems by 2026. The programme will add 100 megawatt (MW) of solar energy capacity, with an initial funding of EUR 48 million (USD 54 million) from the IKEA Foundation.

Nuru: Nuru, an international social enterprise working to address energy poverty, secured funding from Google to support the solarization of healthcare facilities. These funds were provided to Nuru in advance and, in return, Nuru committed to delivering the agreed-upon renewable energy certificates (RECs) within the initial five-year timeframe.

—

2 Interview with Havenhill.

Climate resilience is increasingly becoming a key design consideration at the regional and global level.

In light of increasingly frequent extreme weather events, renewable energy technologies play a crucial role in ensuring stable power system supply. Utilizing low-carbon approaches has the potential to enhance the resilience of healthcare systems, aiding their ability to adapt to the impacts of climate change. This can be achieved through innovative design and operational practices, such as on-site renewable energy generation, natural ventilation, energy-efficient medical equipment and alternative healthcare services, such as the incorporation of telemedicine. Not only do these strategies yield substantial cost savings in day-to-day operations, but they also contribute to increased facility climate resilience (World Bank 2017).

To enhance the preparedness of healthcare institutions, WHO and the Pan American Health Organization (PAHO) introduced the Safe Hospitals Initiative. The primary goal is to safeguard the functionality of hospitals during emergencies and disasters, ensuring the continuous provision of essential healthcare services. Building on this initiative, the Smart Hospital Initiative in the Caribbean aimed to assist healthcare facilities achieve dual objectives: improve their sustainability and enhance their resilience against disasters. The experience of one of the hospitals participating in this initiative is presented in Box 3.10.

BOX 3.10 • **Smart Hospital Initiative**

Participating in the PAHO Smart Hospital Initiative, Georgetown Hospital in St. Vincent and the Grenadines underwent extensive refurbishment to bolster its resistance to hurricanes and volcanic ash from a nearby volcano. The refurbishment included **reinforcing its roof, implementing a water storage system and installing solar panels for electricity generation**. Furthermore, it adopted various **energy-efficient measures**, resulting in a remarkable 60% reduction in energy consumption.

When a hurricane struck St. Vincent, Georgetown Hospital not only remained fully operational, but also maintained a reliable water supply, offering vital support to the hospital itself and the surrounding communities.

Source: World Bank 2017

Climate finance offers an opportunity for a new source of funding for healthcare electrification projects.

Climate finance, which has gained traction across numerous sectors, presents an untapped opportunity for funding HFE projects.They can be supported by harnessing climate finance mechanisms, such as dedicated funds, RECs, grants and concessional loans. The allocation of climate finance to HFE not only addresses the urgent need for reliable electricity, but also contributes to broader SDGs. It promotes access to quality healthcare, improves healthcare service delivery, enhances healthcare system resilience, and reduces greenhouse gas emissions by shifting towards cleaner energy sources.

For instance, distributed renewable energy certificates (D-RECs) can provide a mechanism for healthcare facilities to monetize the environmental benefits of their renewable energy installations. By participating in D-REC initiatives, healthcare electrification projects can access additional revenue streams that can be used to cover a portion of the O&M costs, while contributing to climate change mitigation efforts (Box 3.11).

Furthermore, by participating in compliance[3] and voluntary[4] carbon markets, and in particular by leveraging recognized trading mechanisms such as the UNFCCC's Clean Development Mechanism (CDM), healthcare electrification projects can generate revenue through the sale of carbon credits, created through the rigorous measurement and verification of emissions reductions. Currently, however, the use of CDM schemes specifically for healthcare electrification is very limited. It is also important to note that this avenue is typically more applicable to larger projects, as small-scale initiatives may not qualify for such credits.

Leveraging climate finance to incentivize the electrification of healthcare facilities through renewable energy sources is also important for mitigating climate change. The healthcare sector's global climate footprint is equivalent to 4.4% of global net emissions (2 gigatonnes of carbon dioxide equivalent). Energy, primarily the combustion of fossil fuels, makes up well over half of healthcare's climate footprint (Health Care Without Harm 2019). Electrifying health institutions with renewable energy sources reduces greenhouse gas emissions, thereby mitigating climate change. By transitioning away from fossil fuel-based electricity, these projects contribute to global efforts to reduce carbon footprints and combat climate change. They demonstrate a commitment to sustainable practices and address the health impacts associated with climate change.

BOX 3.11 • **Stella Futura D-RECs**

Stella Futura's approach to financing healthcare electrification projects within the Shell Foundation Pilot Programme (described in Box 3.5) involved a blend of innovative financial models. It initially partnered with a renewable energy financing firm in Norway, which offered a dollar-based contract. However, it quickly realized that this approach would not suit hospitals due to depreciation concerns.

To make its services affordable, Stella Futura leveraged grants from Shell and utilized D-RECs to offset costs. The grants reduced the hospital's financial burden by 40%, while the D-RECs further reduced it by 15%, resulting in a contract payment made in local currency, amounting to USD 0.13 per kilowatt hour (kWh).

Source: Interview with Stella Futura

[3] Under a compliance carbon market, entities are obligated by national or international regulations to trade carbon credits or comply with legally mandated emissions targets.

[4] Under a voluntary carbon market, entities choose to offset their carbon emissions voluntarily by purchasing carbon credits or offsets from projects that reduce or remove greenhouse gas emissions.

Photo: U.S. Agency for International Development

3.6 TECHNOLOGY TRENDS

Technological trends in components, manufacturing and the monitoring of health facilities are paving the way for new delivery models and for the long-term sustainability of energy systems. For one, with the expansion of the PV industry, grid-tied and stand-alone systems have become more cost-effective and innovative. Renewable energy companies scoping new development should consider the advantages and disadvantages of alternating current (AC) versus direct current (DC) coupled systems, depending on a variety of factors such as expansion expectations and energy usage. Other components, like batteries, have also seen major advancements, including quality and durability improvements. Even more so, remote monitoring and control tools have advanced to give stakeholders real-time insight into system performance and energy usage.

Innovations in PV technology have compounded over the last decade, drastically reducing the cost of these components and solar electricity as a whole. New materials and manufacturing methods have been introduced to make PV panels more efficient, flexible and durable, maximizing energy delivered and reducing the need for maintenance and replacement. Crystal polysilicon remains the dominant underlying material for solar PV, with a market share of more than 97%. A trend towards using more efficient monocrystalline wafers has also gained momentum in the last two years, and now represents nearly all crystalline PV production. More efficient PV cell design, called PERC (passivated emitter and rear cell), is also gaining traction and now holds over half of global market share. Management and remote monitoring and control tools (such as solar inverters and solar monitoring software) are also now able to help optimize the efficiency of PV by maximizing the utilization of solar energy and enhancing the solar fraction.

Importantly, as part of these trends, solar panel efficiency (or the solar fraction, measured as a percentage) has increased. Efficiency is influenced by a solar cell's material composition (monocrystalline silicon, polycrystalline silicon, cadmium telluride, thin-film, perovskite, etc.), positioning, external conditions, surrounding components, and the overall electrical configuration (including wiring) of the system. Most solar panels today have efficiencies between 17% and 20%, but this can vary depending on manufacturer and cost. Even though solar efficiency has increased over the last decade, experts expect even more technological advancements to come.

PV sizing requirements at health facilities have evolved over the past several years. Renewable energy companies and development finance institutions focusing on health electrification have noted that an emerging trend is to start smaller with PV sizing and, if needed, expand later. This has helped to avoid oversizing and the construction of unnecessarily expensive systems, which had been the status quo up until very recently. When starting with smaller systems, AC-coupled systems, rather than DC-coupled, have proven to be more beneficial when expansion is likely. Still, oversizing an array can still be an intentional tactic employed to increase days of autonomy, especially for designs with lead-acid batteries. Furthermore, opting to upscale systems can be a good approach for health facilities lacking critical appliances they ought to have, anticipating future needs rather than just current demand. It is challenging to predict whether the availability of increased power will catalyse the rapid deployment of additional appliances, which may not be accounted for if a needs assessment focuses solely on existing loads. An example of implementing modular solutions to rural health clinics is Zhyphen. Its Instant Grid system has a plug and play design consisting of standardized, prefabricated components. This approach allows Zhyphen to provide essentially instant power once equipment is delivered to facilities that lack a connection to the grid or have a very unstable connection.

Many renewable energy companies, including those with significant health electrification footprints, have increasingly integrated lithium-ion batteries in their systems, rather than lead-acid, due to their higher quality and longer expected lifetimes. Lithium-ion batteries are made from rare metals, including lithium, nickel and cobalt, which can only be found in a limited number of geographies. As a result, lithium-ion batteries have higher upfront costs, which are predicted to rise in the long term as demand increases. However, in the short term, their price is expected to continue declining to about USD 74 per kWh by 2026. Informing this prediction is the fact that prices have fallen in the past decade. Specifically, in 2021 the cost of a lithium-ion battery was approximately USD 123 per kWh and had fallen by more than 85% compared with 2010 (Mordor Intelligence 2023) and compared with an average of USD 200-220/kWh for lead-acid batteries (Mongird et al. 2020).

Lithium-ion batteries' longer lifetime can help to justify higher costs in projects where capex budgets are a little more flexible. Nonetheless, some projects may still opt for lead-acid. More recently, some key stakeholders have been considering the viability of second-life batteries to improve project economics, but more studies need to be done in this area (Kebir et al. 2023).

Batteries can still be affected by their surrounding environment, and factors such as high heat and humidity can degrade battery performance. However, advances in the remote monitoring of batteries allow operators to monitor battery status, health and performance remotely so that maintenance can be proactive and downtime can be avoided.

Climate-resilient designs are also increasingly becoming central to new health electrification projects. In their 2017 report, the World Bank explored interventions for healthcare infrastructure that incorporate climate resilience. Researchers highlighted the need for thoughtful orientation and siting of buildings to improve daylight exposure, facilitate natural ventilation and moderate temperatures in extreme heat or cold. Importantly, efforts to conserve water, through landscaping or stormwater recapture, are also critical in health settings, due to high water demand to support sterilization equipment and other critical health services. Energy companies are also increasingly considering higher quality, more durable building materials to mitigate the risk of natural weather events such as droughts or heavy rain. For instance, the solid mounting of external structures has been employed to withstand severe winds and storms. Retrofitting older buildings with higher-efficiency medical equipment and adding mechanisms to improve water conservation have also been an area of focus to improve the climate resiliency of existing healthcare facilities (World Bank 2017).

Regarding equipment procurement, the incentives are not necessarily in place to encourage manufacturers and suppliers to focus on health projects. Nevertheless, many projects have utilized some of the best-selling solar original equipment manufacturers available, including Huawei (inverters and batteries), Victron (inverters), Pylontech (batteries), and Jinko and JA Solar (PV). Future interventions could address this gap to ensure more cost-effective and timely procurement. Taking one example, efforts to aggregate the procurement of critical materials, such as PV cells and inverters, can help to create economies of scale and reduce costs and streamline delivery for health electrification projects. Odyssey Procure, for instance, pools together the equipment requirements of renewable energy developers to achieve lower pricing, better payment terms and financing options, and shortened lead times.

3.6.1 Energy efficiency, demand-side management and the demand evolution of basic healthcare appliances

Health facilities require especially energy-intensive appliances and equipment to provide adequate medical services and patient care. Energy-intensive equipment includes medical imaging appliances, space heating, refrigeration and cold chain equipment, sterilization and water filtration tools, and lighting. Exacerbating the intensive energy needs of specific types of equipment, health facilities are often required to operate 24/7, impacting overall load and energy demand. A report published by CLASP finds that key barriers to the large-scale deployment of energy-efficient medical equipment in off- and weak-grid clinics include: the complexity and variety of medical devices available on the market; immature regulatory frameworks that do not address energy requirements, efficiency or power supply; the narrow mandates of many large-scale public health interventions; and large-scale equipment dumping (CLASP 2021a).

Advancements in energy-efficient designs and technologies, like LED lighting, high-efficiency HVAC systems and energy-efficient water systems, are continuously being developed to reduce costs and overall energy consumption. The potential to revamp equipment and design should be considered when improving electricity access at health facilities. Rather than adhering solely to a standardized approach of aligning systems with existing facility equipment and designs, this innovative perspective encourages a more nuanced exploration of possibilities.

Design options are increasingly being aimed at energy conservation and the promotion of energy-efficient appliances. This shift in focus entails a holistic reassessment of health facility design elements, such as maternity and labour rooms, with the aim of reengineering

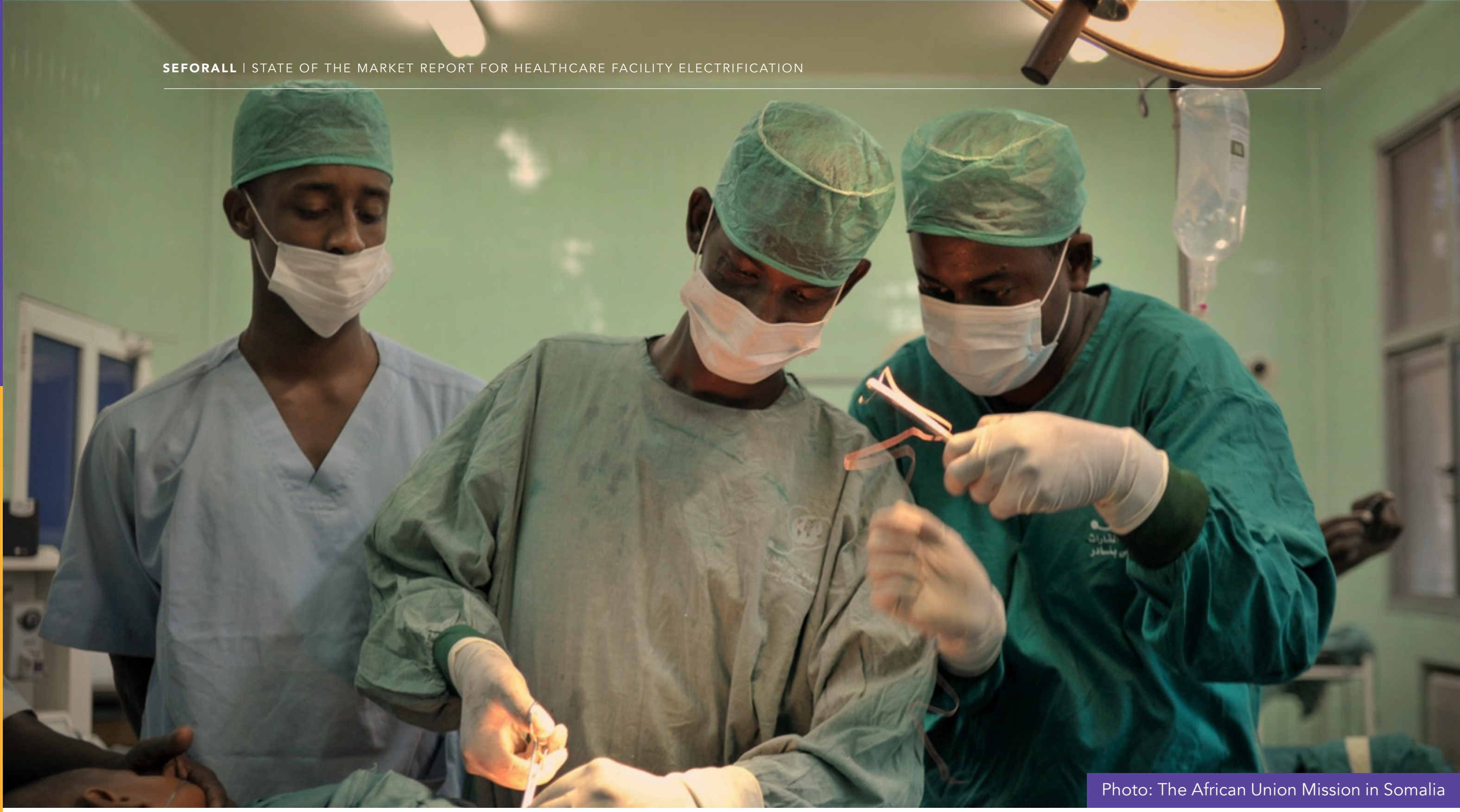


Photo: The African Union Mission in Somalia

them to be less energy intensive. Integrating principles of energy efficiency into healthcare facility design results in spaces being active contributors to sustainability, rather than just recipients of energy.

Smart sensors and remote monitoring systems can also ensure that energy is only used when needed, contributing to significant energy savings. For instance, a sensor might be used so that lights in certain wings of a hospital are only turned on when necessary or that the operation of certain pieces of equipment only occurs during sunlight hours. Moreover, smart sensors and remote monitoring systems can be used to collect data about the sector or, at a more granular level, about health facilities in specific regions, which helps bridge the data gap in the sector.

As mentioned in the previous section, the 24/7 energy needs of many health facilities add a complicating layer for demand-side management. Health facilities require a continuous and reliable power supply to support critical medical equipment and long hours of patient care. To be more specific, outages can put high-value medical equipment at risk through voltage surges, power cycling, incomplete calibrations and software crashes—further jeopardizing the health of patients. When power is restored after an outage, a voltage surge might cause an excessive amount of electrical current to flow through the equipment. This sudden increase in voltage can overwhelm the delicate electronic components of the medical device, leading to their failure or damage. In fact, in 2010 WHO estimated that nearly 70% of medical devices in the Global South did not function properly, and one particular study noted that one-third of equipment failures were due to problems with their power supply (WHO 2010a). These variables affecting demand-side management are discussed in Section 3.6.4.

3.6.2 Remote monitoring

As health facilities seek to ensure reliable and sustainable electricity, remote monitoring is helping to optimize the performance and long-term operation of solar systems. As A2EI summarized in a recent interview about health electrification monitoring, it is crucial and now technically possible to "stop guessing [and] use data".[5]

Real-time data collection and remote monitoring have become more feasible in many contexts, if the equipment that goes into an installed system is equipped with adequate communication and gateway capabilities. Some equipment manufacturers provide their own proprietary software to visualize data, while aggregating platforms, like Odyssey Energy Solutions and A2EI's Prospect, are equipment agnostic and can ingest data from a variety of brands and equipment types.

Smart meters, for example, can feed consumption and production data into aggregating platforms or may come with their own software for visualizations and analytics. UNDP, a leading administrator of health electrification projects, incorporates smart meters into all of its health projects. However, practical issues, like mobile network coverage, limitations of entry-level models and theft risk, can hinder the actual, long-term collection of data from sites. Remote monitoring tools that can transmit data at lower internet speeds, like 2G, or collect and save data locally while offline, can be useful alternatives when connectivity is a limited. Odyssey's FernFlex model and Sparkmeter are examples of tools that can store data for months at a time where internet connectivity is intermittent.

Remote monitoring tools might offer basic visuals to understand and track system performance, but they have also become far more advanced, providing logic loops for monitoring and advanced alert-setting. For instance, following a particularly overcast few days, a remote monitoring system's logic loop might detect a gradual decrease in PV output and battery charge levels. Before triggering a low-battery warning immediately, the system might take into consideration the clinic's historical energy consumption patterns to determine if energy supply is still able to meet expected demand.

Even more advanced, monitoring at health facilities has become granular enough to track metrics specific to individual pieces of equipment, such as vaccine fridges, water filtration systems and lighting sources. For instance, Odyssey's FernHealth monitoring system allows operators to track the temperature and energy usage of vaccine fridges and provides alerts if the temperature of that fridge goes above or below a certain predetermined threshold. Similarly, Nexleaf Analytics, through its ColdTrace technology, has done extensive work around its data tooling capabilities for monitoring, and even remotely controlling, sensitive temperature thresholds of vaccine fridges at health facilities.

Aggregating system performance metrics with broader health and impact metrics to provide a holistic picture to donors and other stakeholders has also become more common. As part of the Shell Foundation Pilot Programme for Innovative Financing and Project Solutions, for instance, Odyssey's data and analytics platform is ingesting system performance data, as well as survey data collected about the services a facility provides, its quality of care and energy savings, to show a comprehensive analysis of the impact of various types of health-specific financing models.

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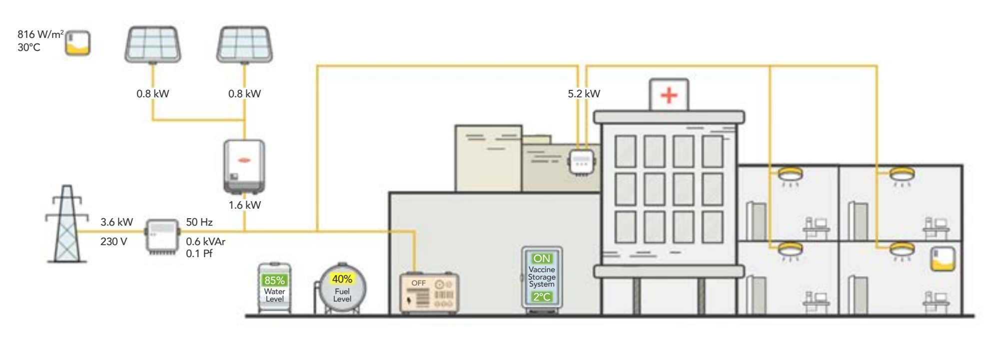
[5] Interview with A2EI.

BOX 3.12 • **Example of Odyssey's health monitoring and data visualization capabilities**

Odyssey provides remote monitoring and control tools specific to the needs of health facilities. Below is a screenshot of a sample dashboard developed by Odyssey, which includes real-time data on the energy usage of specific pieces of equipment, as well as the amount of energy imported by the grid or supplied by the system's PV panels. In addition to intuitive visualizations like this one, Odyssey allows operators to define custom alerts and logic loops to better control systems.

FIGURE 3.14 • **Odyssey sample dashboard**



Remote monitoring tools have recently also become beneficial as a trigger for payments. Objective monitoring data can act as a third-party arbitrator for transactions between financiers and end users, improving the efficacy of pay-as-you-go contracts or results-based initiatives.

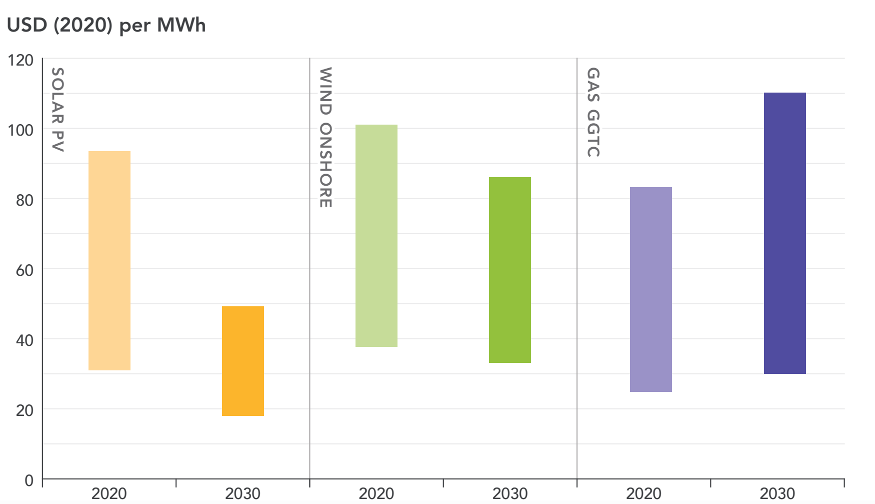
Remote monitoring has not only become central to tracking and controlling systems in real time, but also to improving demand estimation for the sizing of future electrification projects with practical examples. Oversizing was a consistent theme in conversations with renewable energy companies, leading to needlessly expensive systems, but this trend seems to be shifting. GIZ's country office in Benin, for instance, has worked to avoid oversizing at new sites by leveraging real-time operating data from existing systems.

It is worth highlighting that remote monitoring at a health facility requires several on-site essentials to ensure seamless data collection. Although data consumption for smaller systems is expected to be low (< 50 megabit/month), 2G internet connectivity at a minimum is required to transmit data, unless local data storage is possible. A data collection unit is also required, with a GSM-connected modem and international SIM card that can transmit data at 2G speeds (at a minimum) via a cellular network. The unit should be able to collect data from the main energy sources and components (such as an inverter or battery) via a communication port or through external sensors. Alongside on-site hardware, IT infrastructure or visualizing tools are required to actually manage and analyse the data that is being collected.

3.6.3 Quality standards for healthcare facilities

As discussed in Section 3.1, PV technology has evolved for the entire distributed renewable energy sector, with important implications for health projects in particular. Innovations and cost reductions in PV have improved the economics and technical viability of projects, paving the way for solar systems to leapfrog grid extension in many contexts. In fact, prices for solar energy generation have decreased substantially over the past several years, falling 77% between 2010 and 2018 according to the

FIGURE 3.15 • **Declining costs of solar PV**



Source: IEA 2022

International Renewable Energy Agency (IMF 2020). According to the Africa Energy Outlook report published by the International Energy Agency in 2022, the levelized cost of electricity generated from solar PV is expected to continue declining in the next decade (IEA 2022).

As described in Section 3.1, renewable energy companies have trended towards using lithium-ion batteries in their projects. Lithium-ion batteries offer several advantages over lead-acid varieties, including higher efficiency and energy density, longer life cycles and lower maintenance requirements. With the expected decline in lithium-ion costs in the next few years, yet anticipated increase in costs over the long term, battery usage will be an important trend to continue to follow.

Days of autonomy is an important consideration for health facilities and influences the design and incorporation of specific PV and battery components in any system. Days of autonomy might range from three to five days, but also could be as much as seven days or more when a health clinic needs consistent power to provide critical services. Some sector leaders suggest one to two days when critical loads are not present. A variety of factors determine the ideal number of days of autonomy for a system, such as the type of services provided, whether alternative backup power sources exist and local weather conditions.

To measure the impact of a health electrification project, several energy system and health KPIs have come to the forefront. When it comes to system performance, for instance, stakeholders often track any imported grid energy and its costs associated. Grid energy imported and exported is measured in kWh, while grid energy costs might be accounted for monthly. As discussed throughout this report, consistent, reliable power is of the utmost importance at health facilities to ensure equipment stays intact and that critical services can be provided. In that vein, stakeholders also collect data on battery systems and diesel generator runtimes, as well as the number of monthly outages. In short, system KPIs to be monitored over time include (Lighting Global 2023):

- Available energy per day > minimum allowable performance per day.
- System functioning > the minimum amount of time specified in the Power Purchase Agreement (PPA) or service agreement.
- Peak load < maximum power value specified in the PPA or service agreement.
- Depth of discharge < maximum recommended depth of discharge for the specific battery type and as specified in the PPA/service agreement.

In addition to KPIs directly related to the energy system, donors, health facility operators and government agencies have also increasingly become interested in broader health and impact metrics. Here, KPIs can capture improvements in access, such as a patient's willingness to travel a longer distance, operational hours of a clinic or hospital, changes in health-seeking behaviours of key populations, and expansion in the scope of service delivery. Health facility revenues and internal operations should also be considered as part of the broader impact of electrification. Here, KPIs that might serve as proxies include annual health facility revenues from core and non-core activities, savings on annual energy bills and staff turnover rate

3.6.4 Appliances for healthcare facilities, including medical equipment, water, sanitation and hygiene, and cooking[6]

Health centres are equipped with high-power and energy-consuming appliances, such as autoclaves, air conditioners, vaccine fridges, extensive lighting and water filtration systems. This equipment is what enables facilities to provide critical services, including basic diagnostic services, vaccines, light during emergency operations and specialized care. Many initiatives focused on health electrification to date have not given adequate attention to the supply chain and technical requirements for appropriately designed medical equipment.

However, the sector is increasingly recognizing the need for published standards and recommendations around health equipment, especially at facilities where electricity is unstable or unreliable. More broadly, the Efficiency for Access Coalition and Lighting Global are two groups that have made concerted efforts in recent years to promote a bottom-up approach to electrification, with a focus on standardization of demand-side appliances (Efficiency for Access 2023).

Medical devices pose an array of unique technical and commercial challenges to governments and donors implementing electrification initiatives. According to a recent CLASP report (2021b), such trends include:

- **Technical complexity and variation**: Solution providers often make arbitrary choices or, at best, explore a limited list of equipment and suppliers. The term "medical device" encompasses a staggering array of technologies, with over 2 million different kinds of devices spanning 22,000 categories. This diversity, though not all relevant to off-grid clinics, presents a navigational challenge for stakeholders.

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[6] This section was written in close consultation with CLASP.

- **Lack of guidance**: Energy solution providers struggle to identify medical equipment that will enable health providers to deliver the most impactful, appropriate and affordable suite of services. Unfortunately, the guidance on essential medical equipment required for the delivery of basic healthcare services is sparse, inconsistent and often inadequate. Guidance provided by national ministries of health can also vary widely in the number and specific types of equipment included. This leaves energy solution providers grappling with uncertainty regarding equipment selection.

- **Inappropriate design**: Most commercially available medical equipment is ill-suited for clinical settings with limited, erratic energy supplies and difficult operating conditions. Safety and reliability are the primary focus of design, with energy efficiency often a non-existent consideration.

- **Immature regulatory standards**: Global medical device standards primarily concentrate on safety and reliability, frequently omitting energy requirements, efficiency or power supply specifications, further compounding the challenge.

- **Narrow intervention mandates**: Funding constraints and competing priorities result in fragmented healthcare infrastructure development, with donor-driven initiatives tending to focus on specific health outcomes, sometimes overlooking broader healthcare equipment needs.

- **Equipment dumping**: Medical equipment is mostly brought to underserved health facilities through donations and are vulnerable to an influx of obsolete, low-quality and inefficient equipment. This practice hinders the development of higher-quality appliance markets.

- **Sectoral silos**: The health and energy sectors have historically worked in silos, and this remains an obstacle to health electrification efforts. These silos perpetuate existing challenges, but work is being done to bridge the gap.

According to CLASP, addressing these multi-faceted issues requires concerted effort and sustained, long-term investment. A cross-sectoral space that focuses explicitly on medical equipment is necessary for a deeper understanding of technical, regulatory and market challenges. Developing preliminary equipment guidance for community-level primary health facilities can provide a standardized framework for solution design, reducing uncertainty in equipment selection. Clinic electrification investments should incorporate both laboratory and field-based medical equipment testing to improve procurement decisions and establish quality assurance frameworks. Funding, especially funding dedicated to catalysing innovations and building markets in critical medical equipment categories, can foster innovation, reinforce local supply chains and break down existing silos.

WHO and others have already attempted to address this challenge and improve standardization by publishing quality assurance frameworks and consolidating international technical standards. WHO's Performance, Quality and Safety (PQS) Catalogue, for example, is a framework for quality standards and regulatory frameworks for off- or weak-grid medical appliances. The PQS Catalogue is frequently updated and aspires to build a more productive relationship across health facility end users, product development and donor partners. A wide subsector of manufacturers are encouraged to apply for prequalification to be included in the catalogue. Up-to-date data sheets, guidance notes and procedural recommendations cover categories that include cold

Photo: Rawpixel

rooms, vaccine carriers, injection devices for immunization and waste management equipment. In addition to WHO's work, USAID has worked to outline international technical standards for health-specific energy systems, such as those of the International Organization for Standardization, the International Electrotechnical Commission and the Institute of Electrical and Electronics Engineers (WHO et al. 2023). In a study of off-grid public institutions, Lighting Global also developed an evidence-based quality assurance framework for the design and ongoing O&M of solar systems. The study detailed requirements for equipment design, as well as laying out recommendations around the use of remote monitoring tools to support long-term O&M (Lighting Global 2020).

As previously mentioned in this report, inconsistent electricity in healthcare facilities can severely damage delicate equipment, but work is being done to mitigate this common cause of equipment breakdown. In their Energizing Health report, the World Bank cited a study of nearly a dozen low-income countries where an inadequate power supply was the number one cause of medical device failure (WHO et al. 2023). To compound this challenge, most equipment available in these settings comes donated from the Global North and requires a continuous supply of consistent electricity to function. Creating appliances that can endure severe voltage fluctuations or work with both AC and DC power sources could be a solution to prevent frequent equipment replacements or repairs. For context, appliances are often rated either for AC or DC, and where there is no direct compatibility, additional hardware, such as an inverter or rectifier, might be required (Efficiency For Access 2020). Nevertheless, there may not be sufficient motivation to design appliances suitable for these hybrid or energy-limited settings (Efficiency for Access 2021).

Strategic partnerships at the nexus of health and energy, while valuable so far, are still nascent, and more resources need to be devoted to address deeper technical challenges around equipment design and their commercial markets.

3.6.5 E-waste management policies

E-waste management is considered a critical component of the broader operation and maintenance needs of any electrification project. However, who owns e-waste management has historically been unclear with different actors involved, each taking some level of responsibility. Actors, whether from the government, health facilities, private sector or donors, do not always coordinate on how to address e-waste, aggravating the inherent challenge of e-waste management. Moreover, the ways these responsibilities are allocated can be difficult to track and depend on the specific business model being deployed.

Increasingly, however, service-based models with built-in O&M contracts have been implemented to ensure continued involvement from the private sector. Through this model, a private company handles the installation, operation and maintenance of systems, including the handling of component replacement or disposal. Service-based models can also help allocate responsibility for e-waste management across the private sector and the beneficiary health facility. With a shorter lifespan relative to other solar system components such as PV, the recycling or disposal of batteries constitute a sizeable element of what is needed from an e-waste management perspective.

Many countries with emerging economies still lack the necessary basic infrastructure or regulatory frameworks for e-waste management and recycling. Even if structures are in place at the project level, the actual application of best practices can be cost prohibitive or impractical, with only the largest companies able to devote resources to this area. Larger

Photo: Unsplash / Richard Catabay

companies often have adequate economies of scale to successfully internalize e-waste management for their off-grid solar projects. Off-grid health facilities are often in remote areas, and disposing of a faulty system or recycling certain components can be a real, practical challenge. In many cases, transport can only be made by authorized actors, and that authorization can be complex to attain. In Uganda, the closest recycling centres are actually cross-border, in Kenya, but exporting e-waste to Kenya requires a specialized authorization, which can only be attained if an operator reaches a critical threshold of recycling volume.

With this context in mind, the World Bank is developing an internal toolkit for e-waste management for off-grid projects. The objective of the toolkit is to provide project teams with the information and tools needed to develop appropriate environmental and social safeguard instruments for e-waste management of off-grid solar projects. The toolkit provides detailed and actionable guidelines to carry out e-waste risk assessments and design appropriate safeguard instruments as part of World Bank-funded off-grid energy access projects, or components of projects. The toolkit also provides tools to assist with developing policy and regulatory frameworks for sound off-grid solar e-waste management. The toolkit includes a survey questionnaire that poses questions such whether an e-waste plan has been formalized and safe storage of waste is available for that project.

The toolkit is currently being piloted in several energy access projects across Africa and e-waste considerations are being promoted at the company, sector, country and even regional level. Activities thus far have included implementing take-back schemes, promoting producer responsibility organizations, enhancing safe storage and collection, and promoting e-waste policies. The toolkit is a strategic and practical resource that will allow World Bank teams to support both the public and private sectors as they address e-waste risks from off-grid solar projects. As of late 2023, the World Bank is in the process of implementing this framework and experimenting with it in a growing number of pilot geographies and projects.

3.7 TRENDS IN DELIVERY MODELS

To date, most efforts to electrify healthcare facilities have relied on grants and donor support, mainly focusing on the procurement of solar PV assets. Engineering, procurement and construction (EPC) models have been widely used, given that they are easy to implement and can be delivered quickly; the implementing party simply selects a contractor who is responsible for ensuring that the project is completed within the agreed timeframe and within the budget agreed to by the implementing agency. In certain situations, EPC models can be the most viable choice, depending on the country's specific circumstances and the availability of funding. It is important to consider that some donors impose strict spending restrictions, limiting the feasibility of longer-term planning and making these approaches the most practical option in such cases.

However, this emphasis on EPC models often jeopardizes the sustainability of healthcare electrification interventions by shifting the focus from long-term O&M to rapid asset procurement. This is often due to tight project deadlines that require donors to spend the funds by a certain date, thus creating a mismatch between when capital can be disbursed and when it is needed (i.e. over the system's lifetime). EPC models usually budget for a short period of O&M after installation without the necessary provisions for long-term sustainability, such as budgeting for component replacement. This responsibility is often shifted to public entities after the expiry of short-term O&M contracts, entities that might not have the required financial or technical capacity to fulfil their obligations. A memorandum of understanding prior to the implementation phase can therefore be crucial in ensuring the effective transition of O&M responsibilities after the EPC contract has finished. Additionally, many governments perceive solar energy to be free, leading to O&M becoming ad hoc and reactive instead of being part of a consistent plan. Another contributing factor to the ineffectiveness of EPC models is the insufficient budgeting by governments for O&M, particularly battery replacement. In cases where funds are allocated, they frequently get diverted to address competing priorities.

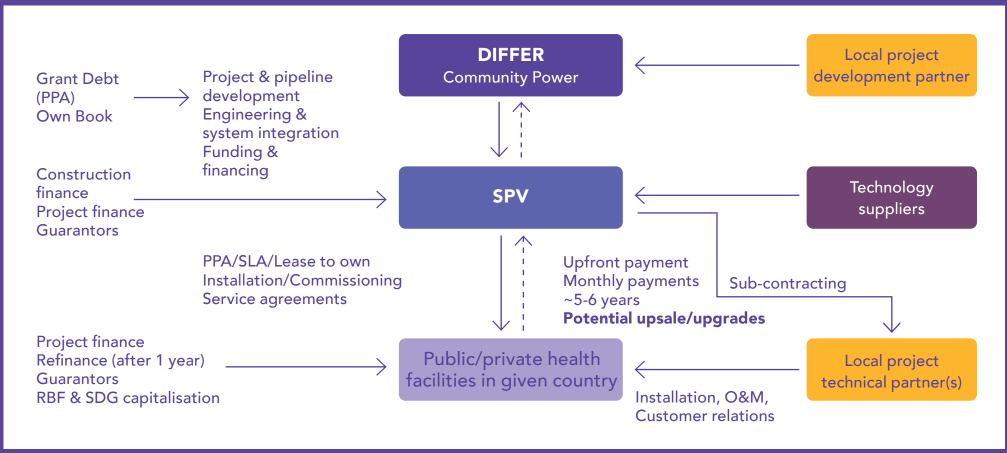
In light of the above limitations of EPC models, there is a growing trend for exploring innovative approaches to ensure sustainability, in particular moving from EPC to energy service company (ESCO) or service-based models, similar to that witnessed in the household electrification sector. Given the scale of investment needed to electrify healthcare facilities (see Chapter 5), private sector capital is required to supplement public financing. In service-based models, a service provider is selected to provide electricity services for a long period (typically 10 to 15 years) and raise the capital required (often with the support of public funding mechanisms),

BOX 3.13 • **Differ: Lease-to-own model**

Differ Community Power is an initiative implemented by the Norwegian company Differ AS, which aims to provide electricity services to private health facilities that currently rely on diesel generators.

As part of their lease-to-own model, several private health facilities are bundled into one financing vehicle, termed a special purpose vehicle (SPV), to secure financing (equity and debt) from impact investors and debt providers (Figure 3.16). The SPV is responsible for the installation of the systems, commissioning, O&M (through contractors) and component replacement. The SPV also ensures that clinics meet their pre-agreed payment obligations, i.e. monthly instalments for a period of four to six years. These payments cover the initial capex, a reasonable return on investment and the O&M. After that period, ownership of the solar system (and the responsibility for O&M) is transferred to the health clinics.

FIGURE 3.16 • **Differ Community Power delivery model structure**



Note: SLA stands for service-level agreement
Source: Differ (adapted)

while the government pays the provider in regular intervals. These models leverage the expertise of the private sector and ensure the quality and reliability of power through KPIs, thus providing a sustainable solution to the healthcare electrification challenge (SEforALL 2021a). Differ Community Power (see Box 3.13 above) provides an innovative service-based model that leverages private sector capital and has the potential to be replicated across the sector, if proven successful.

As a win-win-win model for the public sector (reliable service), the private sector (favourable contracts) and the beneficiary communities (improved healthcare), the service-based model is increasingly capturing the attention of the donor community. The World Bank, for instance, has designed its first private service-based delivery model under its Regional Off-Grid Electricity Access Project (ROGEAP), which leverages service contracts with ESCOs to supply, install, operate and maintain solar systems (Box 3.14). Due to ROGEAP's implementation being delayed, the model was first initiated under the EASP in Uganda (Box 3.15).

This model can provide a sustainable, long-term service to healthcare facilities. Under the arrangement, institutions are obligated to pay their monthly fee solely when the electricity supply aligns with the established agreement.

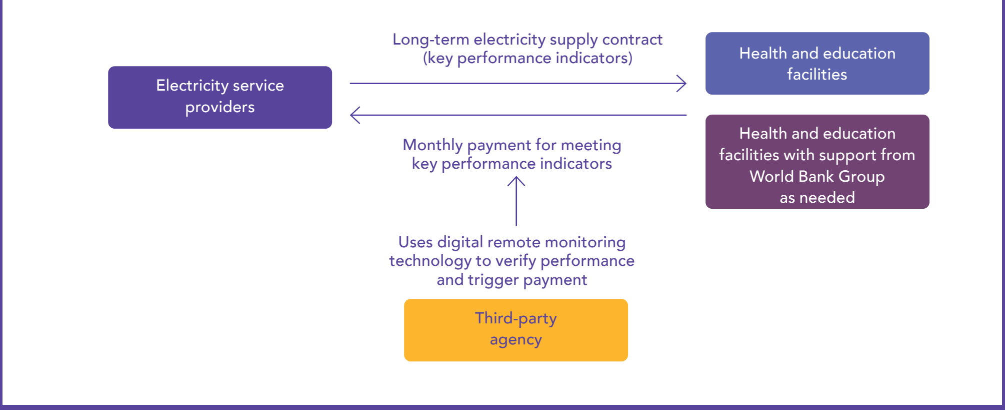
BOX 3.14 • **Regional Off-Grid Electricity Access Project (ROGEAP)**

ROGEAP aims to increase access to sustainable electricity services in 15 member countries of the Economic Community of Western African States and four additional countries (namely Cameroon, Chad, Mauritania and the Central African Republic). One of the components of the programme involves the electrification of public health facilities. A pilot phase will involve the electrification of about 15 health centres and schools in Niger and Nigeria to test the business model and assess the technological feasibility.

The business model implemented is an **ESCO** model (see Figure 3.17) and involves private companies supplying electricity to the facilities as opposed to supplying the equipment. Solar companies are encouraged to raise financing to install solar PV systems in clinics and provide long-term O&M services to the electrified facilities lasting between 10 and 15 years.

The government will pay a monthly fee to the participating companies, which will allow them to recover their capital cost in four years. Verification from a third-party agency with the help of digital remote monitoring technology triggers the disbursement of funds to companies, following satisfactory performance. Project funds will serve as a guarantee in the event of government non-payment. The objective is to leverage the pilot programme as a catalyst for expanding operations and implementing guarantees across the broader West Africa region.

FIGURE 3.17 • **ROGEAP's approach**



Source: World Bank 2020 (adapted)

Spreading the cost of the systems across many years reduces the financial burden on government budgets and allows them to increase the electrification of health facilities at a much higher rate than if systems had to be paid upfront. This model also provides an incentive to solar companies to ensure the functioning of the systems for a long period and helps them reduce their installation costs by exploring economies of scale.

The healthcare facilities are then responsible for covering O&M costs. Preliminary findings suggest that monthly payments for such costs are around USD 126, on average, which is nine times the reported willingness to pay for the solar systems' O&M. To bridge the affordability gap, the government of Nigeria provides around USD 327 a month to health centres to cover the O&M costs to solar companies participating in the ROGEAP model.

BOX 3.15 • **Uganda Energy Access Scale-up Project (EASP)**

Acknowledging the shortfalls of the ERT programme, in particular regarding the lack of long-term O&M arrangements, the new World Bank project EASP will transition from the traditional procurement-based approach to outsourcing the full service via rent-to-own arrangements using **energy service providers under performance-based contracts**. Thus, the private sector will not only finance and install solar PV systems, but also enter into medium- to long-term payment contracts with healthcare facilities to provide electricity as a service (based on KPIs) in return for fixed monthly payments covering the capital costs of equipment and installation, and the ongoing O&M costs over the contract period. At the end of the contract period, the service contract could be extended or handed over to healthcare facilities.

Under EASP, the World Bank will gradually reimburse O&M costs over a period of five years of engagement. Additionally, grants will be allocated to mitigate financing costs for private sector participants.

Source: Ministry of Energy and Mineral Development 2020

This incentivizes private firms to maintain uninterrupted system functionality, as long as the funding to compensate them for their services continues.

This encompasses routine preventive maintenance, timely replacement of faulty or expired components, and the adoption of durable, low-maintenance equipment to ensure consistent service quality.

The service-based models, however, are not a panacea for long-term sustainability—they come with their own set of challenges. A key factor that can deter service providers is the risk of non-payment, given the budgetary constraints often faced by public agencies. This risk is even more pronounced in the context of healthcare electrification because the service provider is reluctant to disconnect health facilities in case of non-payment, for fear of reputational damage. This risk would need to be mitigated, such as through the provision of guarantees by a development finance institution or implementing agency. Other options include dedicated escrow accounts or lockbox mechanisms for ring-fencing government budgets over the lifetime of the solar PV assets. Greenstreet Africa provides an example of a lockbox that can successfully improve the risk profile of public health facilities' electrification. If proven successful, this innovative model may become a key trend in the sector (Box 3.16).

BOX 3.16 • **Greenstreet Africa: Risk mitigation**

Greenstreet Africa is a public-private partnership initiative by GreenMax Capital Group to rapidly scale up distributed solar generation for public healthcare.

Greenstreet Africa prepares large portfolios of solar power projects at public institutions for implementation by private independent power producers or ESCOs, while working in partnership with government bodies to de-risk these projects and make them attractive for private ownership and operation. More specifically, the service providers are insulated from payment default by the ministry of health by a government guarantee to annually pre-fund a "lockbox" with budget allocation sufficient to pay for the coming year's expected energy services payments.

Source: Climate Policy Initiative 2020

Photo: PMI Impact Malaria

In addition, the higher risk profile of such projects due to the combination of cash flow uncertainties and long-term horizon might require innovative financing mechanisms that encourage private sector participation, beyond just mitigating non-payment risk. For instance, blended finance instruments, such as matching grants, RBF or D-RECs, will need to be increasingly utilized in order to transition towards service-based models.

The existence of an enabling policy and regulatory framework becomes crucial for attracting the private sector to engage in healthcare electrification over a long-term horizon. Including healthcare electrification in the country's electrification targets and strategies, adopting clear and transparent contract templates, and regulating grid interconnection risk signals an enduring commitment to electrifying healthcare facilities. For instance, Greenstreet Africa works together with the government to create a regulatory framework that is conducive to private sector-led electrification, de-risking the contracts with the government by promoting transparency.

Service-based models require sufficient capacity at the government level; the emphasis on EPC models so far has contributed to many governments' perception that solar power comes at no cost. Countries in the Global South often receive systems through multiple interventions, which reinforces this perception—when the systems break down, they are replaced via another electrification programme. Thus, transitioning to a service-based model that involves regular payments to the private sector will not be feasible without extensive capacity building to help governments understand that solar power entails a recurring maintenance cost.

Finally, under service-based models, the facility relinquishes ownership of the infrastructure, which in itself can pose considerable challenges. The precarious situation arises when the contracted company faces financial turbulence or even bankruptcy, jeopardizing the uninterrupted provision of essential services. Given that healthcare is fundamentally a public good, where consistent and reliable access is paramount, such a model introduces a delicate balance between leveraging the private sector's expertise and safeguarding the continuity of vital services. While the involvement of the private sector is undeniably pivotal, particularly in enhancing healthcare accessibility, ensuring long-term sustainability necessitates a judicious assessment of these inherent risks.

In light of the prerequisites and risks that come with the service-based models, it is important to highlight that there is no single solution to the healthcare electrification challenge. Other models, such as the EPC model with long-term O&M, should not be discarded, as they might fit better in certain contexts. Enhancing the enabling environment for such models, along with ongoing innovation within the service-based approach, is crucial.

3.8 Enabling Environment

A clear policy direction that underscores the importance of electrifying healthcare facilities is indicative of a trend that fosters a conducive environment for scaling up electrification efforts. An increasing number of governments are including HFE in their national electrification strategies or developing healthcare-specific policies that prioritize the electrification of healthcare institutions. The off-grid solar sector, which plays a significant role in healthcare electrification, often lacks comprehensive regulation. In order to signal their political commitment in a tangible way, specific financial incentives are offered to encourage investment in healthcare electrification, ranging from import tax exemptions for renewable energy equipment to renewable energy subsidies tailored to the health sector. For instance, as part of the ERT programme in Uganda, the government implemented tax exemptions for solar products used to electrify healthcare facilities, in order to reduce costs. Within the scope of the Rural Renewable Electrification Project (RREP) initiative in Sierra Leone, UNOPS collaborated alongside the Electricity and Water Regulatory Commission to formulate regulations for mini-grids. These regulations were designed to safeguard private operators against financial setbacks arising from the integration of the national grid with the mini-grid. Additionally, the guidelines establish clear parameters for determining mini-grid tariffs, including for healthcare electrification.

BOX 3.17 • **Sierra Leone's Rural Renewable Electrification Project (RREP)**

The RREP was grant funded by the UK FCDO and implemented by UNOPS in two work packages, the first of which follows an ESCO model. In particular, the government owns the assets, and the private operators are responsible for the O&M of the systems over a 20-year period, with the capex for the generation and distribution network equipment paid by the FCDO.

Under the first phase, 54 community health centres across 90 communities in 12 districts provided the land for the installation of 6.6 kWp of solar PV generation and battery storage plants (without backup diesel generation). In exchange, **they received up to 6 kWh of electricity a day for free**, which supported all medical appliances for treatment and health service delivery.

Under the second phase, private sector companies transformed 50 of the generation plans into small mini-grids in order to connect the surrounding communities. The capex (including additional generation and storage capacity and the distribution network) was funded through FCDO grants to the mini-grid developers. **The cost of O&M was covered through the mini-grid companies' sale of electricity to private customers** (residential, commercial, etc.).

To ensure that the projects were bankable, UNOPS, in coordination with the regulator, allowed operators to charge a cost-reflective tariff.

Source: SEforALL 2021b

Tariff regulation has been playing a critical role in either scaling up or delaying mini-grid implementation for healthcare electrification. The recovery of upfront costs needs to be guaranteed through regulations that enable the mini-grid developer to propose a tariff structure appropriate for the project. Allowing for cross-subsidization can be crucial given affordability constraints at healthcare facilities. RREP provides an example of cross-subsidization by mini-grids' private customers in favour of health facilities (Box 3.17).

Countries are working towards easing procedures and making regulations more light-handed to bring down regulatory costs and scale-up healthcare electrification efforts. Lengthy and cumbersome regulatory processes for licensing and permitting can slow down electrification efforts. Streamlining procedures and reducing bureaucracy for obtaining the necessary permits and approvals can significantly accelerate the implementation of healthcare electrification projects. Requiring licences only for larger mini-grids is one way of reducing costs both for the licensee and the granter of the licence. This is the case in Tanzania, where licences are required only for projects that exceed 1 MW, while smaller projects are allowed to register their businesses rather than apply for a licence, which does not require the approval of the regulator. Technical support might be required as part of donor-funded healthcare electrification, given that there is often a lack of capacity at the government level. For instance, as part of Sierra Leone's RREP, UNOPS provided capacity building and technical assistance to government counterparts aimed at creating a regulatory environment that is more conducive to private sector investment. In particular, UNOPS worked closely with the government to develop procedures for issuing licences and permits for mini-grid operators.

Lack of predictability of grid expansion and regulatory arrangements in case of grid arrival have been posing challenges for private sector participation in healthcare electrification. Private sector firms are often concerned about what happens to stand-alone systems and mini-grids if the grid is extended. Thus, it is crucial to select health centres that are unlikely to be connected to the grid for a long enough period to allow private sector companies to recoup their investment, in collaboration with relevant government bodies. In addition, mutually agreeable grid interconnection terms must be clearly specified in the long-term service contract and account for different scenarios whereby the mini-grid can continue its operations, either as a generation-only company, or a distribution-only company, or both (ESMAP 2015). If those scenarios are not feasible, a compensation mechanism should be put in place.

CHAPTER THREE

Key Insights

HEALTHCARE ELECTRIFICATION TRENDS

→ Insight #1

Increased health facility electrification activity since Covid-19: Annual growth rate between 2018 and 2021 averaged 47%

→ Insight #2

Provision of power solutions consistently the most common type of initiative in healthcare electrification, followed by needs assessments and feasibility studies

→ Insight #3

Decreasing duration of initiatives

- Can be attributed to streamlined processes and increased data availability
- Can indicate provisions for O&M lack long-term perspective

→ Insight #4

Increasing priority for needs assessments

53% of electrification initiatives prioritize conducting energy needs assessments of health facilities before implementation

→ Insight #5

Better collaboration between energy and health stakeholders, but further progress required

→ Insight #6

Data-driven decision-making becoming paramount, with geospatial technology leveraged to bridge data gaps

→ Insight #7

Climate financing emerging as a promising funding source for health facility electrification, aligning with broader sustainable development goals

→ Insight #8

Innovative business models being explored to ensure sustainability, like moving from EPC to ESCO or service-based models

→ Insight #9

Health facility electrification increasingly being included in government healthcare-specific policies and national electrification strategies

CHAPTER FOUR

Key Challenges and Lessons Learnt

Health facility electrification (HFE) initiatives that have been implemented so far have highlighted several challenges at both the planning and implementation stages. These financial, technical and institutional challenges need to be taken into account when designing future interventions in order to ensure their long-term sustainability.

The subsections below provide an overview of some of the challenges that donors and development agencies are attempting to address as a result of the trends we observe and explain earlier in this report.

4.1 LACK OF SUSTAINABLE O&M FRAMEWORK

One significant challenge in the sustainable electrification of health facilities is the limited duration of most donor programmes. Many of these initiatives, constrained by funding cycles, typically span only a couple of years. Consequently, they often fall short in incorporating a long-term operations and maintenance (O&M) framework, which is crucial for the sustained functionality of electrification systems. O&M encompasses routine maintenance, equipment repairs, replacement of faulty components and staff training, all of which are essential to ensure that healthcare facilities can consistently provide vital services. Without a sustained O&M plan, electrification systems may deteriorate over time, leading to disruptions in power supply, increased maintenance costs and potential setbacks in-patient care.

The absence of a long-term O&M plan can threaten the sustainability of HFE initiatives. The problem is often addressed through ad hoc framework contracts for O&M as an interim solution. For instance, in the Solar for Health programme in Zimbabwe and the Energy for Rural Transformation (ERT) programme in Uganda (see Box 4.1 below), such ad hoc O&M contracts were used once the initial O&M contracts expired. This strategy cannot guarantee long-term sustainability, as ad hoc contracts are commonly awarded to the least-cost bidders, with the scope of the maintenance services being limited by the available budget, without including component replacement or any expansions needed. Therefore, electrification initiatives need to include a comprehensive plan for both short- and long-term O&M. Myanmar's National Electrification Project, implemented by the Department for Rural Development (DRD) with funds from the World Bank, ensured that rural facilities, including healthcare, gained access to sustainable and reliable electricity solutions, with a strong emphasis on long-term O&M strategies (see Box 4.2).

BOX 4.1 • **Energy for Rural Transformation (ERT) programme in Uganda**

The ERT Programme is a long-term (2002-2023) three-phase initiative funded by the World Bank and implemented by the Government of Uganda that aims to increase access to electricity in rural areas. One of its components involves the provision of solar PV systems for health clinics, schools and water stations.

The second and third phase of ERT relied on World Bank funding for the construction and first year of O&M, whereas for years two to five, maintenance-only contracts were signed between the government agencies and private companies wherein the line ministry would be responsible for paying for O&M, but without any provision for replacement of components. Following the expiry or termination of contracts, local government was responsible for the maintenance of the systems.

The ERT programme has highlighted several limitations:

- The lack of a dedicated budget for O&M led to line ministries struggling to source sufficient funds to ensure that systems remain operational. Indeed, by the end of Phase II (2008-2016), 13% of health facility systems were not operational.
- After the five-year contract ended, local government with the responsibility for O&M preferred ad hoc repairs instead of tendering full O&M contracts due to a of lack of planning, which put the sustainability of systems at risk.
- Even when the maintenance-only contracts were in place, public procurement rules made the process of replacing the systems lengthy, leading to substantial downtime.

Source: Interviews with the World Bank

Electrification initiatives that transfer the long-term O&M responsibility to health-care facilities often disregard the fact that these facilities do not have the capacity to manage the installed systems. In most cases, significant support is required in the form of capacity building to ensure that the institutions' staff are aware of key information about the installed systems, their basic maintenance and their efficient use.

For example, the private companies that were contracted to perform short-term O&M in the UNDP-funded Solar for Health programme in Zimbabwe were required to train a team at each facility for O&M activities and provide guidance through a simplified preventive and corrective manual (UNDP 2023). A capacity assessment should be conducted as part of the electrification programme to ensure that healthcare facilities tasked with O&M responsibilities have adequate human and administrative capacity to do so.

BOX 4.2 • **The Myanmar National Electrification Project (NEP): Long-term O&M planning**

Myanmar's comprehensive electrification programme, the NEP, is unfolding in five phases to extend the grid across most of the country while earmarking remote areas for long-term off-grid solutions.

The Department for Rural Development (DRD) oversees the off-grid component, encompassing solar home systems and mini-grids, prioritizing energy access for community-serving rural facilities such as healthcare, educational and religious sites, and public streetlights.

The programme meticulously addresses short- and long-term O&M, with winning international tender bidders responsible for two years of O&M, including component replacements and after-sales commitments, funded by the project. A network of call centres managed by DRD ensures swift issue resolution by tracking faults, component performance and supplier response times.

Furthermore, the initiative focuses on sustainable long-term O&M solutions, with contractors establishing local service centres during their post-installation obligations. These centres, staffed by local supply company partners, undergo performance evaluation during the initial two-year O&M period. Based on performance and cost-efficiency, DRD determines the number of service centres required to serve consumers and issues calls for proposals for energy service companies (ESCOs) to operate these centres commercially for another four years, supported by initial seed finance and DRD assistance. ESCOs can anticipate long-term business opportunities, with all service centres expected to achieve full commercial viability starting from year three.

Source: World Bank 2015

4.2 INAPPROPRIATE DESIGN

Poor design and a lack of a thorough needs assessment can lead to a multitude of challenges in HFE, often resulting in inefficiencies, increased costs and reduced long-term viability. One critical issue that can arise is the oversizing of energy generation and storage systems. Without a proper needs assessment, there is a risk of overinvestment in capacity, which can lead to unnecessary upfront expenses and operational inefficiencies. Excessive capacity may remain underutilized, resulting in a poor return on investment.

Another significant challenge stems from the inadequate consideration of future energy needs. Failing to account for the future growth and evolving energy demands of healthcare facilities, as well as lacking a full view of energy use at hospital sites, can be detrimental. As healthcare services expand or technology requirements change, an inadequately designed system may fall short of meeting the facility's future energy needs. This can necessitate costly retrofits or additions, leading to budgetary constraints and operational disruption, which is why modular systems are often useful.

Mismatched technologies can also be a consequence of poor design. In some cases, electrification projects may incorporate technologies that are incompatible or poorly integrated, hindering overall system performance. For instance, integrating solar panels with inappropriate battery storage or inverters can lead to suboptimal energy utilization and reliability issues.

Moreover, a lack of accurate assessments can result in an unreliable power supply. Healthcare facilities rely on continuous power for patient care and equipment operation. Therefore, interruptions caused by an inadequate power supply can have life-threatening consequences, affecting patient safety and the delivery of essential medical services.

In addition to these operational challenges, there may be increased maintenance costs associated with a poorly designed system. Without proper consideration of factors like environmental conditions and equipment maintenance requirements, systems may deteriorate more quickly than anticipated, leading to higher ongoing maintenance expenses. A poorly designed system may not be sustainable in the long run, requiring frequent repairs, replacements or upgrades. This not only incurs additional costs, but also poses sustainability challenges in terms of energy source availability and environmental impact.

4.3 LIMITED CAPACITY AT THE GOVERNMENT LEVEL

The lack of consensus or awareness among government officials about the fact that the long-term operation of power supply systems entails a regular cost poses challenges for the sustainability of healthcare electrification interventions. This often translates into a lack of dedicated budget for O&M that can lead to the systems' failure. For instance, as part of the ERT programme in Uganda, government agencies became responsible for maintaining the installed systems after the expiry of O&M contracts with private companies. The widespread view among those in charge of budget allocations that solar power should be free led to the line ministries often struggling to source sufficient funds to ensure that systems remain operational. This challenge highlights the need for mindset change among government officials involved in HFE initiatives. This can help officials appreciate the importance of long-term O&M and ensure that those in charge of budget allocation dedicate funds for it when the O&M responsibility is transferred to the relevant ministry.

In addition to the lack of awareness regarding the necessity of budget allocation for long-term O&M, programme implementers often struggle to understand the full cost that needs to be covered. Stakeholders often underestimate the cost of replacing components, especially batteries, at the end of their lifetime, which leads to insufficient funds and system failure. Capacity building at the government level, conducted as part of electrification initiatives, should also ensure that O&M budgets include component replacement costs. In addition, offering warranties for components should be a prerequisite when selecting providers through a tender process.

Finally, given the importance of remote monitoring for preventing and correcting component failure and reducing operational costs, budget should also be allocated to mobile data subscriptions. This challenge was highlighted in the Solar for Health programme in Zimbabwe, where only a few of the remote monitoring systems installed were operational due to the lack of adequate budget allocation, which made it difficult for many sites to top up mobile data subscriptions.

When the government has an active role in the healthcare electrification programme, limited regulatory capacity at the government level can slow down the electrification process. In the Rural Renewable Electrification Project (RREP) in Sierra Leone, government officials lacked familiarity with the economics of mini-grids, which resulted in delays in the tendering process as well as in licensing and permitting. Training and regulatory handholding for the government needs to be included as part of HFE initiatives in order to speed up the related regulatory processes, thus reducing transaction costs and encouraging private sector participation. Furthermore, additional technical assistance might be required to create a regulatory environment that is more conducive to private sector investment, especially for aspects that are crucial for financial viability (such as mini-grid tariffs and grid interconnection arrangements).

4.4 LACK OF INSTITUTIONAL COORDINATION

Effective planning and collaboration are often hindered by the impact of institutional stakeholders in the health and energy sectors, and government departments, working in silos. A lack of institutional coordination hinders a comprehensive understanding of the healthcare electrification challenge and creates misalignments in decision-making. Improving data sharing between the two sectors, as well as collaboration with key donors and implementors, is crucial for leveraging the natural synergies at the policy and implementation levels.

The same challenge also applies to donors, who often engage in one-off projects without adopting a sector-wide approach. Donor coordination should be actively sought in order to maximize the effectiveness of public funding for healthcare electrification.

4.5 LACK OF UNDERSTANDING OF THE HEALTH SECTOR'S NEEDS RELATING TO ENERGY

The lack of a thorough understanding of the healthcare facilities' needs poses risks for the sustainability of relevant electrification interventions. Healthcare facilities have unique electrification needs, including reliable and uninterrupted power supply for critical medical equipment, refrigeration for vaccines and medications, and overall energy efficiency to reduce operational costs. Without a detailed demand assessment that informs the technical design of the installed systems, there is a considerable risk of failing to meet those unique needs due to undersizing. In the ERT programme, the lack of accurate load estimation resulted in the systems being unable to power small lab equipment. Detailed energy audits at the healthcare facility level should be incorporated into electrification initiatives, as was the case in the Powering Healthcare programme in Ghana and Uganda. The audits should take into account not just essential loads, but also facility-wide energy needs across all buildings, including staff quarters, as well as suppressed demand and future expansion plans, or upgrades to the healthcare facility. The scarcity of information surrounding energy-efficient medical and non-medical appliances within healthcare electrification initiatives underscores the need for a more

comprehensive understanding of the energy landscape in the healthcare sector. It is also important to assess the accessibility of energy-efficient appliances in the local market. Can healthcare facilities easily procure these appliances, or are they hindered by market limitations and pricing constraints? Examining the supply chain and market dynamics is essential to identify potential barriers to the adoption of energy-efficient technologies.

4.6 LACK OF FLEXIBLE FINANCING OPTIONS TAILORED TO HEALTHCARE ELECTRIFICATION

The electrification of healthcare facilities is associated with a range of financing challenges that developers must navigate. One significant challenge lies in serving different types of facilities, each presenting unique stability of payment and system maintenance frequency conditions. Most installations have historically relied on donor capital expenditure (capex) or community electrification initiatives. For smaller healthcare facilities, stand-alone solar installations have been suitable solutions. However, these installations are often not large enough to anchor a mini-grid. Additionally, there are limitations on system size due to factors like land availability and regulatory constraints regarding proximity to the grid.

Larger healthcare facilities tend to be publicly run, including referral facilities. These installations face challenges related to their ability to pay, and they often rely on grid connectivity supplemented by diesel generators for backup power. While solar solutions could offer savings and reliability, management personnel in such facilities may remain unconvinced. This is further compounded by the limited ability of these facilities to cover upfront capex costs, which are typically associated with systems capable of meeting peak energy demand or featuring significant storage capacity (SEforALL, CrossBoundary Advisory and Odyssey 2023).

Developers in this space often maintain strong relationships with commercial lenders and have capital available for bankable projects. However, the viability of investment in healthcare facility electrification depends on the facility's ability to pay (SEforALL, CrossBoundary Advisory and Odyssey 2023). There is a lack of certainty around government payments and often poor profitability in privately managed facilities, which makes it challenging for lenders and guarantors to underwrite projects due to uncertain revenue streams.

A key challenge for healthcare electrification initiatives is the significant investment required. Engaging private capital can help accelerate the implementation and scale-up of projects. To attract private investors, healthcare electrification ventures' financial viability and profitability needs to be demonstrated while using public funding to leverage private capital. This may involve exploring innovative financing mechanisms such as blended finance, public-private partnerships, energy service agreements or lease-to-own arrangements.

Risk mitigation instruments are particularly important, because the non-payment risk is a major challenge for private sector participation in the context of healthcare electrification. Use of guarantees can increase the bankability of private sector-led healthcare electrification projects and ensure that they are sustainable in the long-term, improving the resilience of projects when faced with shocks (e.g. COVID-19).

CHAPTER FOUR

Key Insights

KEY CHALLENGES AND LESSONS LEARNT

→ Insight #1

Lack of sustainable O&M framework:

- Limited donor programme duration hinders long-term O&M
- Facilities lack capacity for O&M

→ Insight #2

Inappropriate design leads to increased costs, inefficiencies, mismatched technologies, reduced long-term viability, etc.

→ Insight #3

Limited government capacity:

- Limited regulatory capacity slows down electrification process
- Lack of awareness about budget for O&M and other costs

→ Insight #4

Lack of institutional coordination: Institutional stakeholders in the health and energy sectors, and government departments, working in silos affects planning and collaboration

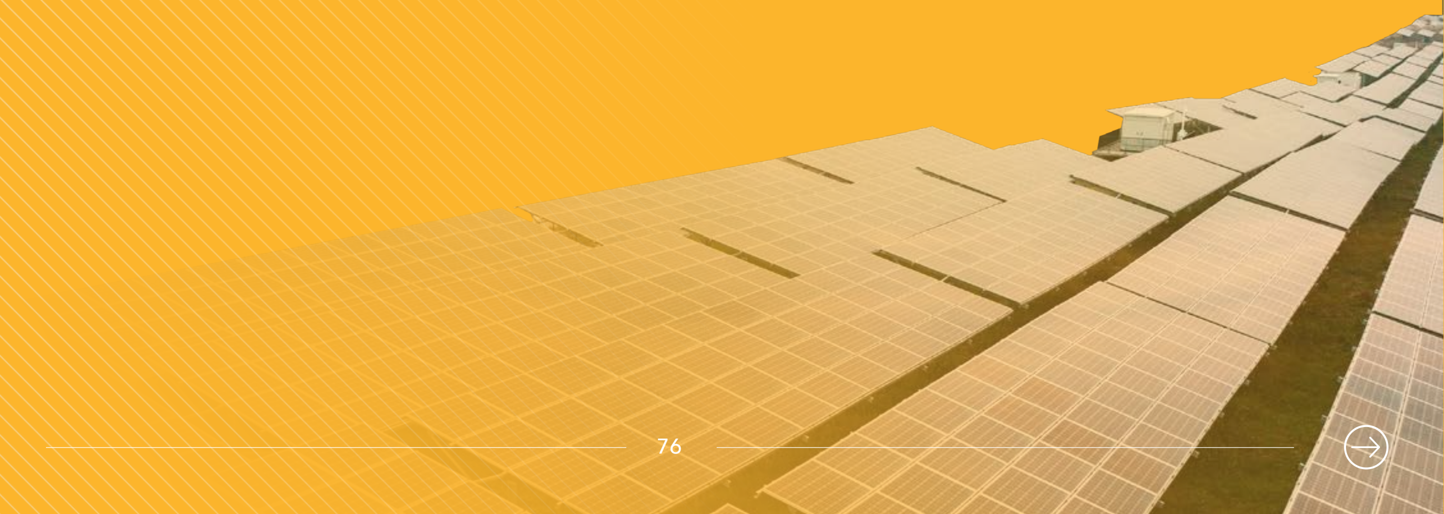
→ Insight #5

Lack of understanding of the health sector's needs relating to energy affects sustainability of electrification initiatives

→ Insight #6

Lack of flexible financing:

- Different types of facilities have varying stability of and system maintenance frequency conditions
- Risk mitigation instruments are important



CHAPTER FIVE

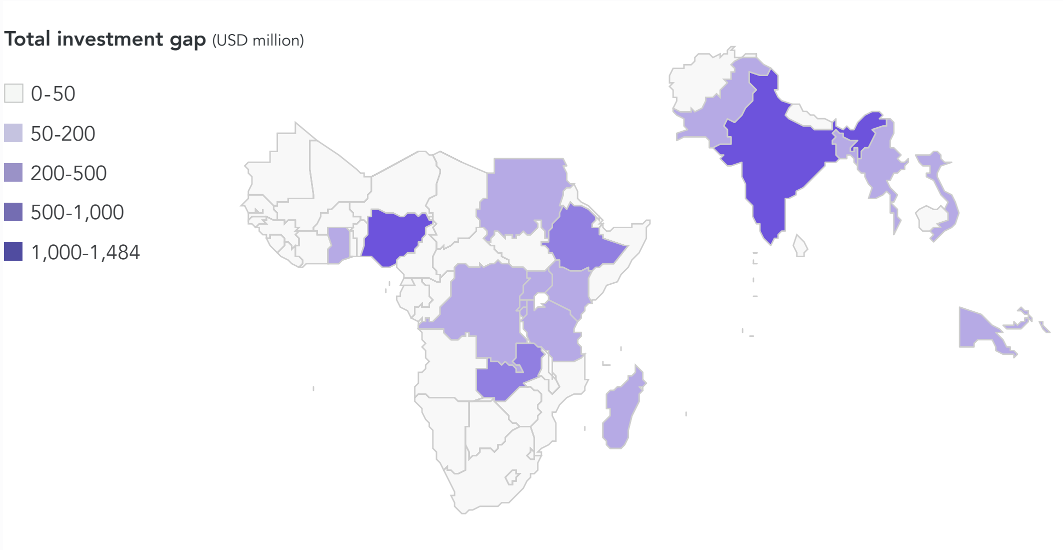
Financing and Investment Needs

5.1 FINANCING TO DATE AND THE INVESTMENT GAP

The recently published Energizing Health report estimates that about 64% of the health facilities in 63 low- and middle-income countries require an intervention regarding their power supply, in the form of either a new connection or a backup power system to improve faulty energy infrastructure that impedes effective healthcare delivery. This covers about 101,000 health facilities that need access to electricity for the first time and about 224,000 facilities that require a backup system to ensure constant access to reliable power (WHO et al. 2023).

It is estimated that the investment required to provide reliable power to these health facilities is approximately USD 4.9 billion (Figure 5.1). Capital expenditure (capex) comprises around 84% of the total investment requirement; operating expenditure

FIGURE 5.1 • **Estimated investment required (net present cost) to achieve access to reliable power services in countries with the highest electricity access deficit in health facilities**



Note: Net present cost to achieve reliable power in 325,000 facilities in the 63 countries with the highest deficit.

Source: Generated by the consultant based on WHO et al. 2023

(opex) costs were estimated at about USD 80-100 million per year (WHO et al. 2023). It is worth noting that many of the stakeholders interviewed for this report acknowledged that the proportion of operating costs may rise during the transition to more innovative financing structures with longer-term support schemes in health facility electrification (HFE) programmes.

The majority (71%) of the investment is required in non-hospitals, that is, primary health posts and rural health clinics/centres. The remaining 29% is required for higher service providing health facilities (e.g. referral clinics, hospitals), primarily for the provision of backup systems that can assure continuous power for critical loads (WHO et al. 2023).

Off-grid systems play an important role in helping to bridge the access gap. The Energizing Health report estimates that about USD 3.4 billion will be required to support HFE scale-up via the deployment of off-grid systems (WHO et al. 2023).

The investment gap is largest in Sub-Saharan Africa (USD 2.5 billion), where most health facilities without access are located. About 62% of the investment requirement is needed to connect 67,000 health facilities in the region for the first time. Moreover, about 62,000 facilities that currently have access to power require a backup system due to unreliable supply from the current provider. Nigeria, the Democratic Republic of the Congo, Kenya, Ethiopia and Tanzania show the highest investment requirements (see Figure 5.2)[7] (WHO et al. 2023).

The investment gap is high in the Southeast Asia region too (see Figure 5.3), estimated at around USD 2 billion. However, about 81% of this is required for stabilizing/reinforcing currently connected health facilities with backup power solutions. It is also noteworthy that India alone accounts for a major share (about 76%) of the estimated investment requirements required in the region (WHO et al. 2023).

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[7] Note that several factors contribute to the observed differences in health facility intervention requirements between countries. Firstly, the country's size, both in terms of land area and population, naturally leads to a higher count of healthcare facilities. Additionally, countries with a significant focus from the international community in recent years have benefited from increased data availability (at least in the open access domain), including the listing of healthcare facilities and surveys that record electricity status. This greater data availability also results in more accurate attribution of health facility types, characteristics and power availability, leading to more precise estimations of the required intervention

FIGURE 5.2 • **Estimated capital investment requirements (in USD'000) for achieving access to reliable electricity services in seven countries with the highest HFE programme activity**

	Tier 1		Tier 2		Tier 3		Health System Total
	Public	Private	Public	Private	Public	Private	
Tier Total	**$951,250**	**$656,530**	**$96,780**	**$46,040**	**$464,540**	**$250,990**	**$2,603,880**
% of total	**37%**	**31%**	**2%**	**3%**	**6%**	**12%**	**100%**
Sierra Leone	$794,290	$550	$420	$40	$3,350	$290	$11,000
Nigeria	$63,320	$97,980	$7,620	$28,670	$145,620	$78,410	$804,600
DRC	$79,510	$81,880	$6,950	$5,460	$128,590	$101,030	$428,110
Kenya	$410,380	$18,690	$1,130	$1,180	$84,970	$112,640	$234,530
Malawi	305,150	$830	$7,380	$1,100	$3,600	$2,400	$16,260
Zambia	$2,603,900	$3,620	$15,680	$3,680	$44,250	$10,380	$93,030
India	$362,070	$590,740	$24,140	$39,380	$0	$0	$1,016,330

Note: Achieving access means new connections and stabilizing backup generation. DRC stands for Democratic Republic of the Congo.

Source: SEforALL CrossBoundary Advisory and Odyssey 2023 (based on WHO et al. 2023)

For the remaining regions included in the Energizing Health report analysis (East Asia & Pacific region and Latin America & the Caribbean region) the investment gap is relatively smaller (about USD 374.8 million and about USD 33.3 million respectively) and is predominantly driven by the need for more reliable power supply through backup systems. It should be noted, however, that only a few countries were covered in these regions, and thus the findings are not necessarily representative of the whole region. The Energizing Health publication provides a detailed breakdown of the investment needs by country, type of facility and type of intervention in its web Annex G (WHO et al. 2023).

Similar conclusions are drawn by looking at the recently published HFE Capital Landscape report, in which the capital flow from 63 HFE programmes in seven[8] countries with high donor activity is estimated at around USD 105 million to date. The study estimates that an additional USD 70-145 million is also supporting electrification of health facilities as part of wider energy sector engagement programmes, bringing the total estimated capital flow in these countries to about USD 175-250 million (SEforALL et al. 2023). Figure 5.3 shows the donor funding deployed and the funding gap.

It is suggested that this is only approximately 10% of the actual investment required to provide reliable power to all health facilities in those countries, indicating a gap of around USD 2.3 billion (SEforALL et al. 2023). Similarly, a dive into the Energizing Health report reveals that the total investment required for universal health electrification in the seven selected countries is around USD 2.9 billion, a gap of about USD 2.7 billion when compared to what is currently being provided (WHO et al. 2023). This indicates that capital flows into HFE programmes need to increase considerably if the dual challenge of Sustainable Development Goals 3 and 7 is to be achieved within the next few years.

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[8] India, Nigeria, the Democratic Republic of the Congo, Kenya, Sierra Leone, Malawi and Zambia.

FIGURE 5.3 • **List of countries with the highest concentration of healthcare electrification initiatives and most active donors in HFE programmes**

	Sierra Leone	Nigeria	DRC	Kenya	Malawi	Zambia	India
Identified investment need	$11M	$805M	$428M	$235M	$16M	$93M	$1,0160M
Approx. donor funding deployed[1]	$5M	$83M	$13M	$10M	$14M	$1M	$52M
Funding gap	**$6M**	**$721M**	**$415M**	**$225M**	**$2.6M**	**$92M**	**$964M**

Source: SEforALL 2022b

5.2 SENSITIVITY OF RESULTS AND REFLECTIONS

The estimates presented above were based on the most comprehensive data publicly available and at the highest level of detail possible. However, global-level estimates may require assumptions and generalizations, which may influence the results. For example, the type of facilities differs by country and so does the type of services they provide, the equipment they have (or require) and thus the level of electricity needed. The electrification status of health facilities also differs, with each country defining their goals of what constitutes the minimum level of service to classify a facility as "electrified". The vector of power solutions might also be different based on the technology availability; is the grid available and reliable? Are off-grid configurations an option? If yes, at what cost? What is (or should be) included in these costs? All these require a more detailed analysis of the country-specific diagnostics of the sector in order to better estimate the financing needs.

Estimates vary considerably between different reports according to the assumptions made and the databases used. For example, according to the analysis conducted by the Energizing Health report, 527 health facilities in Sierra Leone were in need of power supply system improvements. In comparison, the SEforALL Sierra Leone Roadmap, which delved extensively into the HFE country diagnostics, estimated this number to be more than double, at 1,134 facilities (SEforALL 2023b). It is challenging to pinpoint the exact factors contributing to this disparity, as it may be a combination of assumptions, as discussed in the previous paragraph. However, the discrepancy can be attributed to variations in the depth of data collected (or the lack thereof) and inconsistencies in measurement approaches across different assignments. Furthermore, the authors estimated that if costs related to rewiring, civil works, safety and critical system component replacement[9] are also considered, the average capex cost of off-grid systems is around USD 8.2 per watt peak, 2.5 times higher than that estimated by the Energizing Health report analysis (based purely on technical system costs). Additionally, costs related to training of personnel to undertake repairs may increase the operations and maintenance (O&M) costs, which is something that many HFE

[9] This is related to the time horizon assumed by the electrification assessment; for example, if 2030 was assumed as the end year (as per the Sustainable Development Goals) then technology lifespan exceeds the timeframe of the analysis and replacement costs are not included. If the assessment is conducted considering a longer timeframe (e.g. 15 years) then key component replacement costs (e.g. batteries, inverter) will increase the total cost of the power solution.

programmes have raised concerns about. Similar studies (e.g. SEforALL Nigeria Market Assessment & Roadmap (SEforALL 2022a), IRENA Enhancing Healthcare Delivery in Burkina Faso (IRENA and SELCO Foundation 2022) also suggest higher deployment costs for off-grid technologies in HFE.

It is important to note that even the facilities currently benefiting from a reliable power supply may face interruptions in the future due to potential breakdowns in energy solutions. Therefore, the number of facilities requiring dependable power could increase if no proactive measures are taken. Consequently, the current investment requirements do not fully account for additional needs, such as O&M for facilities already connected to a stable power source. Moreover, when we consider that access to dependable electricity services extends beyond the scope of the WHO assessment, the estimated investment gap of USD 4.9 billion appears to be a rather conservative estimate.

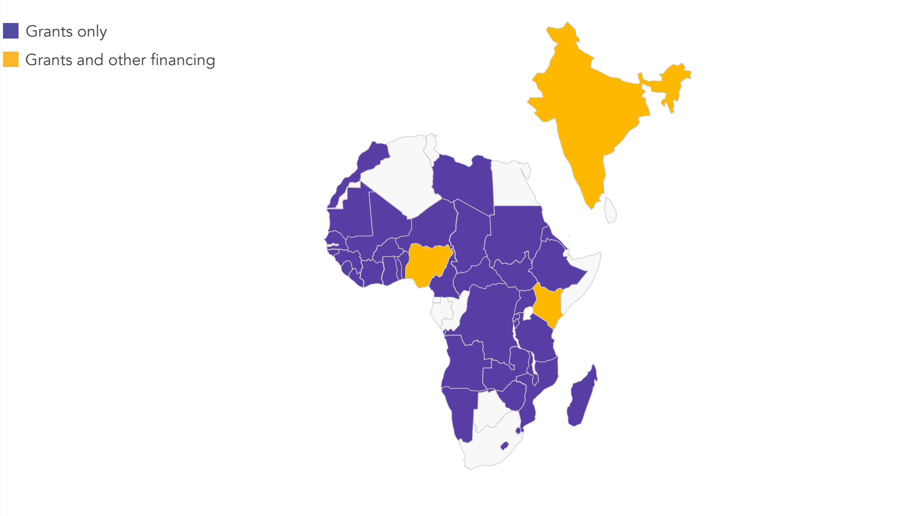
5.3 FINANCING SCALE-UP

As discussed above, the funds designated by governments, development partners, donors, philanthropic institutions and other relevant stakeholders to ensure reliable electricity access in healthcare facilities are inadequate and fail to recognize the critical role electricity plays in delivering essential health services. There is a pressing need to substantially increase these funds and to elevate the electrification of healthcare facilities to a top development priority. The HFE Capital Landscape study finds that about 70% of the investment flowing into HFE programmes is provided by multi-donor organizations (World Bank, USAID, UNDP, UKAID, GIZ, IKEA Foundation), while energy donors (e.g. Power Africa) provide about 23% and only 7% comes from health donors (mainly Gavi and the Global Fund) (SEforALL, CrossBoundary Advisory and Odyssey 2023).

The overwhelming majority of HFE programmes make finance available through capex grants (see Figure 5.4). There are a few examples (ENDEV RBF programme, GIZ GBE programme) where results-based financing or blended finance solutions have been tested, but to date it seems that commercial and/or blended financing solutions remained largely untapped (SEforALL, CrossBoundary Advisory and Odyssey 2023). It should be noted that many of the donors have recognized the limitations of existing programmes and have been transitioning towards more innovative financing structures in their imminent interventions.

Commitments for additional capital injection into HFE programmes are significant. The World Bank, USAID/Power Africa, UNDP, GAVI and the IKEA Foundation together with SELCO Foundation—among others—have been announcing interventions that aim to electrify approximately 98,000 health facilities over the next few years (SEforALL, CrossBoundary Advisory and Odyssey 2023). These new HFE financing packages need to be designed in a way that allows any new activity to continue where a previous one left off, effectively extending the overall programme duration. Moreover, the expansion of these programmes and the need for different financing models presents an excellent opportunity for new partnerships and collaborations between the public and private sectors.

FIGURE 5.4 • **Classification of HFE programme financing mechanisms based on type and volume of investment in Africa and India**



Source: SEforALL, CrossBoundary Advisory and Odyssey 2023

The interviews conducted as part of this study revealed that enhancing financing models is essential to accommodate these prolonged programme timelines and include provisions for O&M costs as well as component replacements right from the outset. In fact, the HFE Capital Landscape study finds that most developers (potentially) have financing available for bankable projects; however, uncertainty around the client's (government, health facility) ability to pay for O&M costs (or energy service provision) in the long term is a major barrier to unlock these funds. The provision of guarantees and the establishment and/or strengthening of de-risking mechanisms are essential for unlocking and capitalizing (commercial) debt finance (SEforALL, CrossBoundary Advisory and Odyssey 2023).

Strategies for reducing risks could encompass various approaches, such as offering guarantees to developers in cases where the government or the ultimate beneficiary (health institution) is unable to fulfil contractual obligations. Practices include utilizing donor-backed liquidity pools or sovereign credit guarantees.

A few examples are presented below:

STEPS (Sustainable Electrification of Public Services), funded in 2023 by Crown Agents, Integrity Action and Bamboo Capital, enables governments to actively participate in supplying energy to public facilities. This is achieved through collaboration with energy service providers that are motivated to assume responsibility for installing, operating and maintaining solar equipment. This initiative incorporates the creation of a dedicated Public Infrastructure Electricity Account, along with the provision of viability gap funding and subsidies, effectively reducing the risks associated with government repayments. Additionally, the programme emphasizes the importance of continuous monitoring and evaluation of energy service delivery to enhance the impact of each intervention. This approach not only encourages government involvement, but also promotes their willingness to financially contribute to the programme's success. A pilot initiative with an allocation of approximately USD 75 million, aimed at electrifying health facilities, is currently underway in Sierra Leone (Crown Agents 2023), (SEforALL et al 2023).

DARES (Distributed Access through Renewable Energy Scale-Up Platform) is an innovative platform that places a strong emphasis on mobilizing the private sector and collaborating to create solutions. Its primary goal is to foster cooperation among various sectors, including the World Bank Group, development partners, philanthropic organizations and climate finance entities. DARES aims to harness the expertise of the World Bank, MIGA (Multilateral Investment Guarantee Agency) and IFC (International Finance Corporation) to establish a collaborative, cross-sectoral approach to developing innovative financial tools and risk mitigation instruments that will be implemented at a regional level. Key components of this programme include: the support for long-term contracts to sufficiently cover induced O&M as well as replacement costs; the provision of capex grants disbursed over an extended period, typically five to seven years, to maintain the active participation of private sector stakeholders; the aggregation of interventions to reduce transaction costs and enhance operational efficiency; and the utilization of various guarantees (e.g. establishment of a revolving fund and an insurance solution, with MIGA playing a role in supporting private sector investments) (World Bank 2022), (SEforALL et al 2023).

HETA (Health Electrification and Telecommunications Alliance), funded by USAID/Power Africa in 2022, brings together the interests of the healthcare sector and the private business sector to jointly finance and develop renewable energy systems integrated with mobile networks. HETA, led by Abt Associates with USAID support, collaborates with a diverse array of partners, a number of African governments, RESOLVE and a growing number of private sector organizations. Together, HETA brings together partnerships to create solutions that cater to the power and digital connectivity needs of each healthcare facility through a public-private partnership model. Furthermore, these solutions extend the advantages of energy access to neighbouring communities, supporting various productive activities and accelerating the healthcare sector's transition towards environmentally sustainable practices (USAID 2023) (SEforALL et al 2023).

Another avenue is providing developers with concessional loans featuring below-market interest rates or extended repayment timelines. These measures can yield more favourable profit margins for HFE projects, thereby bolstering their long-term sustainability.

An example is **the Global Energy Alliance for People and Planet's (GEAPP)** engagement on rural public facilities in India, specifically those greatly impacted by the unreliable energy supply and the absence of backup generators. The risk mitigation strategy is designed to provide concessional loans with an interest rate lower than 3-4%, and these loans come with extended repayment periods of 10-20 years, addressing both capex and grants for ongoing operational costs. Moreover, the programme includes a first-loss guarantee for loans extended to energy service providers, as well as a minimum service fee payment that is guaranteed throughout the entire contract duration, usually spanning ten years (SEforALL et al 2023).

DESIREE (Demand-Side Management, Social Infrastructures and Renewable Energy Expansion) represents another initiative aimed at reducing the risks associated with HFE investment. Initially funded by the European Investment Bank in 2015, this initiative provides incentive schemes and promotes the expansion of private sector business models in lower- and middle-income

countries, including Ecuador, Côte d'Ivoire, Uganda, Kenya and India. The programme entails offering concessional loans for projects with a ten-year payback period, as well as establishing a reserve fund covering six months of O&M costs. Projects are pre-approved based on non-financial criteria, and the European Investment Bank conducts due diligence for final technical approval before disbursing funds (European Investment Bank 2023) (SEforALL et al 2023).

Other notable initiatives include **Climate Investor One** (CI1), a blended finance facility that supports the development, construction and operation of renewable energy infrastructure projects in emerging markets (European Commission 2023) (SEforALL et al 2023). The **Solar Facility**, consisting of the Solar Payment Guarantee Fund, Solar Insurance Fund and Solar Investment Fund, seeks to expedite the adoption of high-potential solar technologies in HFE. It achieves this by attracting private capital to underserved markets in Africa while providing a payment and insurance mechanism as a first-loss guarantee (International Solar Alliance 2023), (SEforALL et al 2023). **ISA CARES** aims to solarize approximately 1,200 primary health centres by offering grant support and technical assistance to promote widespread adoption of solar energy in health facilities across its member countries, including least-developed countries and small island developing states (Jayakumar 2020) (SEforALL et al 2023). Furthermore, the **Cold Chain Equipment Optimization Platform** (CCEOP), established by Gavi in 2016, is dedicated to enhancing the coordination of solar electrification efforts in healthcare facilities. CCEOP streamlines technology demands and procurement processes, capitalizing on economies of scale and aggregation benefits to improve cost-effectiveness and efficiency. Through collaboration with other donors and development partners, Gavi aims to play a pivotal role in electrifying as many as 10,000 facilities each year (Gavi 2023), (SEforALL et al 2023).

There is an additional potential de-risking option to consider: the integration of decentralized renewable energy certificates (D-RECs) into HFE initiatives. These certificates can be harnessed by developers or end beneficiaries to boost revenue, thereby contributing to the overall sustainability of the project. However, it is important to note that D-RECs can typically cover only a portion of the O&M costs, empirically about 15%.[10] Furthermore, while D-RECs are often simpler to manage than carbon credits, they still entail transaction costs, including regular power generation data monitoring and verification (SEforALL et al 2023).

Finally, raising awareness among key stakeholders such as government ministries, local authorities and health facility managers about both the advantages and costs linked to renewable-based electrification solutions is important, first, to lessen the effort and time developers need to expend in closing sales (e.g. during roadshows) and second, to enhance the mutual understanding among these stakeholders that renewable energy technology is not without its expenses.

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[10] Note that O&M costs are generally higher than the revenue D-RECS can provide; the value of 15% is based on empirical examples and was gathered during the consultant's interview with Stella Futura. This value may change depending on the specifics of each project.

CHAPTER FIVE

Key Insights

FINANCING AND INVESTMENT NEEDS

→ Insight #1

Approximately 64% of global health facilities lack adequate power supply, requiring an estimated total **investment of USD 4.9 billion**

→ Insight #2

The investment gap is largest in:

2.5 BN USD
Africa

2 BN USD
South Asia

→ Insight #3

The majority (71%) of the investment is required in **non-hospitals**, that is, primary health posts and rural health clinics/centres

→ Insight #4

Current capital flows into health facility electrification programmes are insufficient, indicating a substantial investment gap.

→ Insight #5

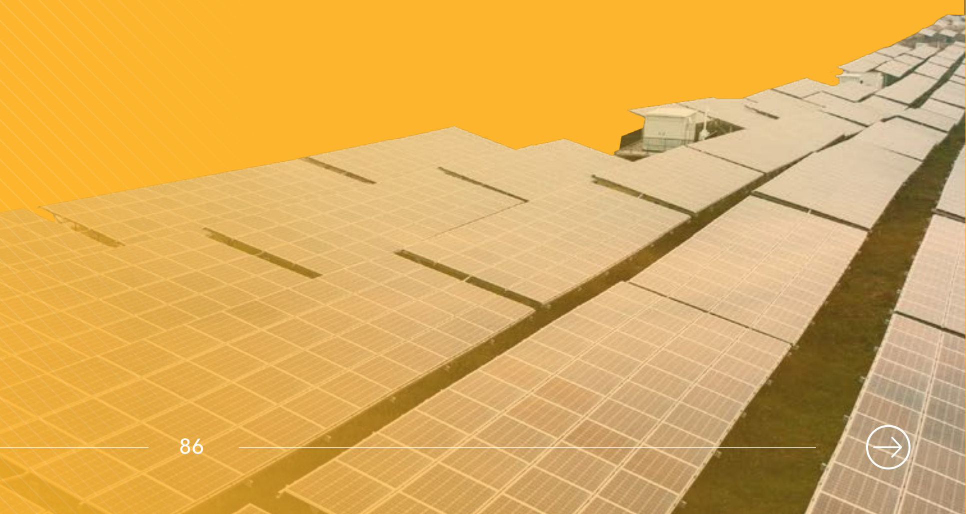
Commitments for **additional capital injection** from USAID/Power Africa, World Bank, UNDP, etc. into HFE programmes are significant

→ Insight #6

Financing models need to be enhanced, with a focus on innovative structures and partnerships

→ Insight #7

Recommendations for de-risking options include: guarantees, concessional loans and integrating decentralized renewable energy certificates (D-RECs) into HFE initiatives



CHAPTER SIX

Measuring Impact

6.1 WHY MEASURING IMPACTS MATTERS

In the context of healthcare electrification, measuring impacts is essential to assess the effectiveness and outcomes of initiatives aimed at providing reliable electricity to healthcare facilities. Government agencies, energy providers, international agencies and donors, and local communities all have a role to play in evaluating the effects of healthcare electrification. These stakeholders are interested in assessing a range of factors, including improvements in patient care and outcomes, the functioning of medical equipment, operational efficiency, and overall healthcare access and quality.

Measuring impacts of healthcare electrification projects allows for a thorough analysis of the cost-effectiveness of electrification projects, changes in energy demand, and the social and health impacts on vulnerable populations. By collectively measuring impacts, these stakeholders can determine the success of healthcare electrification initiatives, identify areas for improvement, and make informed decisions for future projects, ultimately contributing to improved healthcare services and better quality of life in electrified healthcare facilities and communities.

Indicators that measure impact are also critical for releasing payments as part of results-based financing (RBF) schemes or contracts with O&M service providers. Putting specific indicators in place is crucial for service quality assurance, as well as accountability and transparency. Key performance indicators (KPIs) establish clear performance expectations and provide a basis for evaluating the O&M contractors' performance. In the context of a traditional RBF approach, the KPIs could capture the energy delivered, or litres of fuel avoided in the context of D-RECs. In the future, other types of renewable energy certificates could be established that require the measurement of a range of social or health indicators.

As healthcare electrification efforts scale up, demand for accountability and demonstrated results is increasing. Tracking the progress made so far (through monitoring and evaluation of electrification initiatives' processes and outcomes) allows for the robust evaluation of which approaches have worked best, improved knowledge sharing and stakeholder coordination, thus leading to a more efficient use of healthcare investments.

6.2 HOW DO HFE IMPLEMENTATION INITIATIVES CAPTURE IMPACT?

In response to the need for accountability and tangible results, existing methodologies for capturing the impact of healthcare electrification initiatives incorporate quantifiable metrics. The first category of indicators used in HFE initiatives are energy-related. These are usually collected automatically through remote monitoring and include data on demand, such as kilowatt hours (kWh) consumed, as well as performance indicators frequently used in contracts with O&M service providers (see Table 6.1), such as system uptime and response times for unscheduled O&M activities. Such data is crucial for improving sector understanding of healthcare facilities' energy needs and ensuring that the facilities receive reliable, cost-effective and high-quality services.

TABLE 6.1 • **Example KPIs used in an O&M contract**

Core indicators	Reporting method	Monitoring method
System uptime for the PV array and battery	Calculated using load data (time with load > 0 kW)	Provide feed to independent monitoring platform
PV system production	1) home and solar generated (kWh) 2) battery discharged (kWh)	Provide feed to independent monitoring platform
PV array performance relative to benchmark established on commissioning	N/A	Open-circuit voltage measurement on commissioning and then at measurement interval
Battery bank performance relative to benchmark established on commissioning	N/A	Battery capacity test based on methodology agreed with O&M provider
Maintenance of all conditions required to demonstrate compliance with original equipment manufacturers' warranty requirements for batteries, inverters and PV modules	List relevant sensors and data feeds and ensure that data are captured and stored securely for the required period of time	Third-party remote monitoring of relevant data feeds
Response times for unscheduled O&M activities	Monthly reporting on all unscheduled incidents, resolutions and response times	Third-party spot-checking of monthly reports against O&M service provider records and via interviews with staff at affected sites

Source: Based on contracts currently being drafted for hospital electrification projects in Sierra Leone managed by SEforALL

Lighting Global has developed technical indicators of electricity service provision that can be used by the customer and operator to assess service agreement compliance (Table 6.2).

A second category of indicators is health-related and includes metrics on both service delivery/availability and health outcomes. Despite being the clear end goal of healthcare electrification initiatives, this category is not always included in the assessment of such interventions, as it requires regular and reliable data collection. This can pose significant challenges depending on the country context; UNICEF, for instance, is supporting governments to report on health indicators of healthcare facilities.[11]

TABLE 6.2 • **Lighting Global metrics of electricity service provision**

Core indicators	Description
Available energy	The amount of energy used and stored that is available to power loads.
Low voltage disconnect	Assessment of whether the battery discharge has been stopped to protect the battery.
Solar system uptime	The amount of time the system is available to power loads.
Peak load	The maximum instantaneous power required by loads during an evaluation period.
State of charge	The available capacity remaining in a cell or battery, expressed as a percentage of the rated capacity. If the state of charge is 100%, the battery is fully charged.
Depth of discharge	The amount of ampere hours removed from a fully charged cell or battery, expressed as a percentage of rated capacity. If the depth of discharge is 100%, the battery is fully discharged.
Days fully charged	The number of days over the evaluation period on which the battery reached a full charge. (This metric is only applicable to lead-acid batteries, as their useful life will be reduced if not routinely fully charged.)

Source: Lighting Global 2023

Establishing a causal relationship between the programme and health outcomes is also difficult in light of other potential confounding factors. Direct benefits stemming from electrification include extended operating hours, a wider range of medical equipment used and availability of vaccine storage. For initiatives with a longer-term horizon, health outcomes can also be observed, such as reduced mortality rates, improved patient outcomes, and enhanced maternal and child health.

A third category of indicators aims to capture broader social and environmental benefits from the electrification of health facilities. Social benefits include economic benefits, such as increased revenue for healthcare facilities due to extended services, reduced costs from improved energy efficiency, and potential job creation, as well as benefits regarding community development, such as positive spillover effects on education, overall quality of life and reduced gender inequality. Gender-based health outcomes, in particular, are increasingly becoming a key focus of the stakeholder community, including indicators such as availability of neo-natal practices.[12]

Environmental benefits include the reduction in the use of fossil fuels (in litres), which can be quantified in terms of tonnes of CO2 equivalent. These benefits can be directly monetized with D-RECs, thus offering

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11 Based on the consultant's interview with UNICEF.

12 Based on the consultant's interview with the FCDO.

additional revenue streams to the facilities, while contributing to climate change mitigation efforts.

An example of KPIs that have been used to assess the impact of healthcare facilities' electrification on service delivery, health workforce, health products and technology, as well as health finance is outlined in Table 6.3.

A comprehensive list of KPIs should measure impact in three key areas: readiness (whether the facility is better able to follow health protocols, or deliver health services); usage (whether more people are using the health services and whether more services are being offered); and quality (whether the quality of health services offered has improved as a result of uninterrupted power).

TABLE 6.3 • **KPIs used in the Shell Foundation Odyssey health electrification pilot project**

Core indicators	Metric
1. Service delivery	
Scope of service delivery	Extent to which additional health services are available
Willingness to travel longer distance to the powered health facility	Number of unique patients travelling longer distances to access services from the powered health facility (kilometres per USD 100 invested)
Additional operational hours	• Change in health facility's operating hours • Number of in-patient visits
Health equity	• Number of live births • Change in health-seeking behaviours of key populations (e.g. living with AIDS) and vulnerable groups (e.g. women and children)
Patient coverage	Number of patients served per USD 100 invested
2. Health workforce	
Staff efficiency	• Number of patients per healthcare worker for every USD 1 invested • Extent of manual tasks
Staff retention	Staff turnover rate
Jobs created	Number of jobs created per USD invested
3. Health products and technology	
Cold chain equipment availability (e.g. refrigerators and freezers)	Equipment availability
Autoclave availability	Autoclave availability
Information and communications technology/electronic medical record availability	Technology and record availability
Lab testing equipment availability	Lab testing equipment availability
Water purification equipment availability	Water purification equipment availability
4. Health finance	
Cost savings	Savings on electricity bills/alternative energy expenditure per USD 100 invested
Income generation	• Health facility revenues from core activities • Amount of government funding provided to support the facility (e.g. to purchase more equipment which the facility can use to increase service provision) • Health facility revenues from non-core activities

Source: Shell Foundation 2023

There are several challenges within existing methodologies, however, that hinder the effective monitoring and evaluation of healthcare electrification initiative impacts. Most crucially, collecting accurate and comprehensive data on health outcomes and related aspects throughout the years can be challenging, especially in remote and resource-constrained areas. Indeed, few developing countries are able to produce data of sufficient quality to enable regular tracking of progress in healthcare electrification (WHO 2010b). This is even more difficult for assessments that require data over time in order to capture long-term effects. Obtaining such data can be resource-intensive and time-consuming, while it also necessitates adopting a consistent, standardized approach to data collection. Given that the relevant line ministries often lack the required capacity for data collection, healthcare electrification initiatives sometimes use monitoring and evaluation contractors.[13] Furthermore, remote monitoring technologies are often leveraged as a reliable means of capturing impact, but they require substantial financial resources due to the additional transaction cost of data handling, processing and reporting by a third party.

In addition, unlike energy-related indicators that are automatically generated by remote monitoring technologies, or easily quantifiable metrics such as operating hours, the broader social benefits are harder to capture, given their qualitative nature. Secondary effects on education, communication, overall community well-being or equity (including gender equity) have not been adequately described as part of the existing methodologies; instead, they have been the subject of independent academic studies on the topic.

Even when data are robustly collected throughout the duration of the healthcare electrification programme, accurate data might be lacking to draw meaningful comparisons between pre-electrification and post-electrification outcomes. In other words, if baseline data are lacking or unreliable, it could be difficult to accurately capture the impact of the programme.

Furthermore, despite the existence of multiple standardized surveys, existing methodologies do not capture the contextual differences between, across and within countries. A one-size-fits-all approach is not recommended and tailoring the standardized tools to the extent possible can provide more valuable insights for the programme's impact.

Last but not least, there still seems to be too little focus on measuring the sustainability of healthcare electrification initiatives. Increasingly, as the strategic direction for healthcare electrification is now shifting from procurement-focused delivery models towards service-based models (see Section 2.3.2), the stakeholder community is acknowledging the need to assess the ongoing maintenance of energy systems, functioning of infrastructure and long-term provision of service.

In summary, existing methodologies for capturing the impact of healthcare electrification initiatives can offer a comprehensive snapshot of the progress made if implemented robustly. However, challenges related to data availability, accuracy and comparability require careful consideration when designing and implementing impact assessments. There is currently no uniform or commonly accepted list of key indicators that implementation projects could or should follow, but there are ongoing efforts to establish a standardized method (see HETA indicators in Section 6.4).

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[13] Based on the consultant's interview with UNICEF.

6.3 WHAT ARE THE MEASURABLE IMPACTS OF ELECTRIFYING HEALTH FOR SHORT-TERM AND LONG-TERM INITIATIVES?

With the increased demand for accountability and the need to demonstrate results at country and global levels, information is needed to track how healthcare electrification initiatives with a short-term or long-term horizon contribute to improved health outcomes.

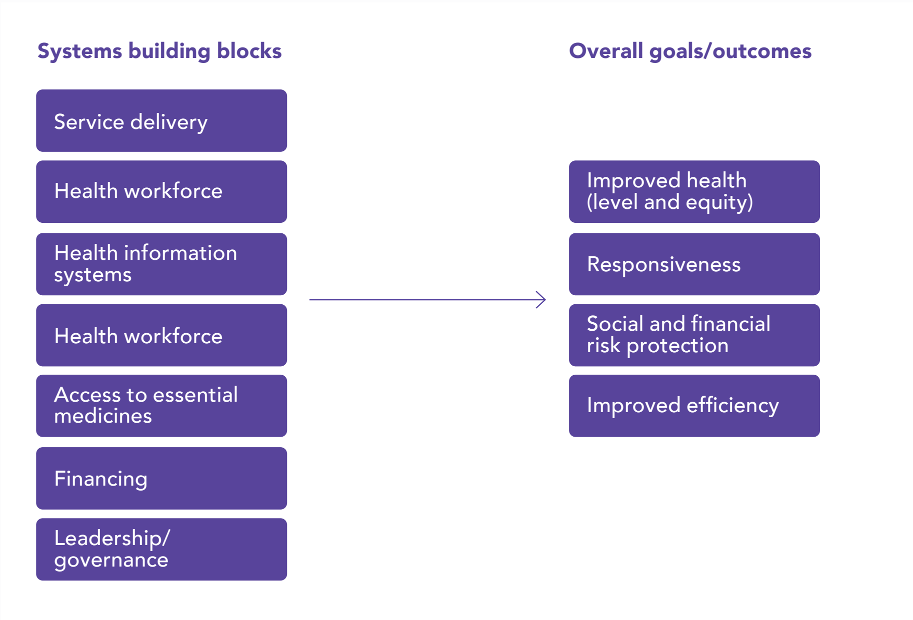
Initiatives spanning a shorter period can have quantifiable measurable impacts that include extended operating hours, improved patient comfort, availability of vaccine storage, functioning medical equipment, and data management systems.

Long-term initiatives, conversely, allow for the comparison of the health service availability and quality before and after the intervention for a broader set of dimensions (both quantitative and qualitative), including enhanced healthcare quality (in terms of improved patient outcomes and reduced mortality rates); utilization of a wider range of medical equipment; more efficient service delivery (such as reduced waiting times or fewer manual tasks); increased revenue for healthcare facilities; job creation; and increased resilience during emergencies, ensuring that critical medical services can continue without interruption.

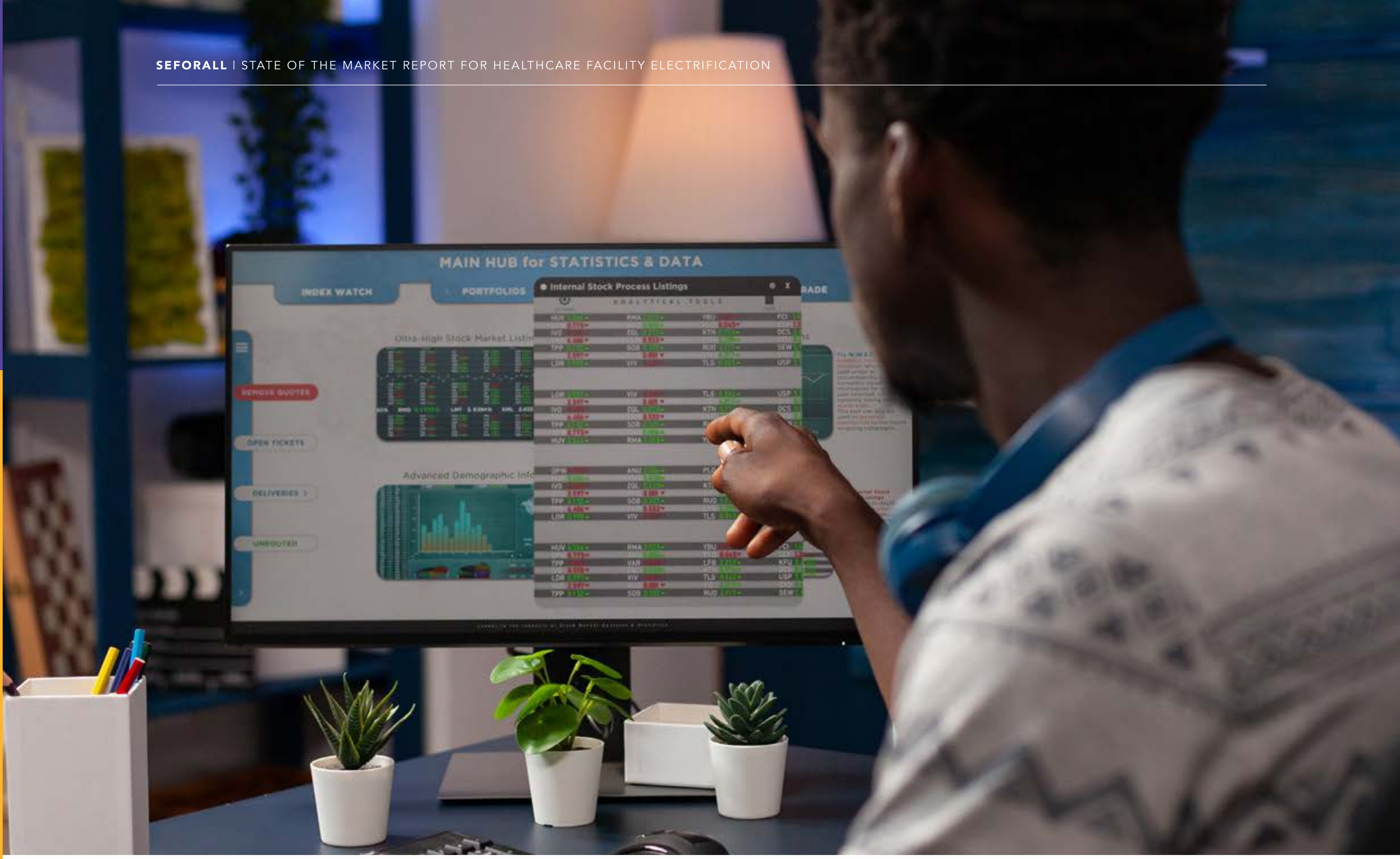
A consistent monitoring and evaluation framework that brings together the aforementioned short-term and long-term measurable impacts is crucial for scaling up healthcare electrification efforts. In this context, WHO has developed a "building blocks" approach that showcases how health *inputs* and *processes* (e.g. health workforce and infrastructure) are reflected in *outputs* (e.g. available services) that in turn are reflected in *outcomes* (e.g. coverage) and *impact* (e.g. morbidity and mortality) (WHO 2010b).

The framework includes six core components, namely service delivery; health workforce; health information systems; access to essential medicines; financing; and leadership/governance, presented in Figure 6.1.

FIGURE 6.1 • **WHO building blocks framework**



Source: WHO 2010b



When assessing service delivery in particular, the following characteristics should be taken into account (WHO 2010b):

- **Comprehensiveness:** A comprehensive range of health services is provided, appropriate to the needs of the target population.
- **Accessibility:** Services are directly and permanently accessible with no undue barriers of cost, language, culture or geography.
- **Coverage:** Service delivery covers all people in a defined target population (all income and social groups).
- **Continuity:** Service delivery can provide an individual with continuous care across levels of care and over the life cycle.
- **Quality:** Health services are effective, safe, centred on the patient's needs and timely.
- **Person-centredness:** Users perceive health services to be responsive and they participate in the design and assessment of service delivery.
- **Coordination:** Local area health service networks are actively coordinated, across types of provider, types of care, levels of service delivery, and for both routine and emergency preparedness.
- **Accountability and efficiency:** Health services are well-managed to ensure a minimum wastage of resources and managers are held accountable for overall performance and results.

6.4 IMPACT ASSESSMENT METRICS

A degree of standardization is crucial when measuring the impact of healthcare electrification interventions and to facilitate meaningful comparisons between and within countries, as well as before and after the interventions.

This is particularly valuable for sharing knowledge among stakeholders of the remaining challenges and lessons learnt. However, the country-specific context, including demographics, disease prevalence and health strategy objectives, needs to be incorporated into the impact assessment. Ideally, the impact assessment should include some core indicators that are standardized across countries and an additional set of indicators that can be tailored to the country context.

WHO and its partners, including the World Bank, the Global Fund to Fight AIDS, Tuberculosis and Malaria, GAVI and UNICEF, have been doing extensive work to reach a broad-based consensus on key indicators and integrating them into a systematic framework for assessing health outcomes. The core indicators for health service delivery, health workforce, health information, essential medicines and health financing are presented in Table 6.4.

TABLE 6.4 • **WHO core indicators for monitoring and evaluation of health systems strengthening**

Core indicators
1. Health service delivery
Number and distribution of health facilities per 10,000 population
Number and distribution of in-patient beds per 10,000 population
Number of outpatient department visits per 10,000 population per year
General service readiness score for health facilities
Proportion of health facilities offering specific services
Number and distribution of health facilities offering specific services per 10,000 population
Specific services readiness score for health facilities
2. Health workforce
Number of health workers per 10,000 population
Distribution of health workers by occupation/specialization, region, place of work and gender
Annual number of graduates of health professions educational institutions per 100,000 population, by level and field of education
3. Health information
Health information system performance index
4. Essential medicines
Average availability of 14 selected essential medicines in public and private health facilities
Median consumer price ratio of 14 selected essential medicines in public and private health facilities
5. Health financing
Total expenditure on health
General government expenditure on health as a proportion of general government expenditure (GGHE/GGE)
The ratio of household out-of-pocket payments for health to total expenditure on health
6. Leadership and governance
Policy index

Source: Shell Foundation 2023

Publicly available surveys could be leveraged in order to measure progress and monitor the scale-up of interventions. One such tool is the Service Availability and Readiness Assessment (SARA), presented Box 6.1, which builds on several existing approaches to assessing health facility service delivery and incorporates best practices and lessons learnt from countries that have implemented health facility assessment of service availability and readiness.

BOX 6.1 • **Service Availability and Readiness Assessment (SARA)**

Developed by WHO, SARA is a systematic survey that standardizes the assessment of health facility service delivery. It can be used to generate reliable information on service delivery including service availability and readiness of health facilities to provide basic healthcare interventions. The survey is publicly available and includes two key modules:

Module 1: Service availability
- Staffing
- In-patient and outpatient service utilization

Module 2: Service readiness
- Infrastructure (basic equipment, communications, ambulance, power supply, basic client amenities, precautions for infection control, processing of equipment for reuse, healthcare waste management, supervision)
- Available services (reproductive, maternal and newborn health, child and adolescent health, communicable diseases, non-communicable diseases, surgery)
- Diagnostic capacity
- Medicines and commodities

The SARA survey provides a useful tool to measure progress in healthcare provision over time, monitor healthcare interventions and guide more efficient investment in the sector. A snapshot of the publicly available survey is shown in Figure 6.2.

FIGURE 6.2 • **Snapshot of SARA survey**

Indicator code	Number	Question	Result	Skip
	415	CHECK Q410 AND Q411: FACILITY HAS A SOLAR SYSTEM ("3" CIRCLED FOR EITHER QUESTION)	FACILITY DOES NOT HAVE A SOLAR SYSTEM ("3" NOT CIRCLED FOR BOTH QUESTIONS)	Q417
	416	Is the solar system functional?	YES, FUNCTIONING....................................1 PARTIALLY, BATTERY NEEDS SERVICING/REPLACEMENT.........................2 NO, NOT FUNCTIONAL ....3 DON'T KNOW 98	

Source: Interviews with the World Bank

An adaptation of the WHO SARA tool has been used by an implementation research study conducted by WHO to capture the impact of electrification of rural primary care facilities in Ghana and Uganda on health facility readiness and availability of services. More specifically, the study was a post-implementation assessment of the Powering Healthcare programme (2015-2019), which electrified off-grid rural health facilities in Ghana and Uganda to improve the availability of maternal and child health services. The assessment aimed to capture changes in service availability and readiness, as well as in community satisfaction and use. The data, both qualitative and quantitative, were collected via interviews with key informants, focus group discussions with community members and health facility assessment checklists adapted from WHO's SARA tool (Javadi et al. 2020).

TABLE 6.5 • **HETA core impact assessment metrics**

Core indicators
Super goal: Improvement in health outcomes and sustained energy access
Number of beneficiaries (number of people in the catchment area served by the health facilities)
Number of facilities with increased use of electricity-dependent medical devices (including laboratory and diagnostic equipment)
Number of facilities with new or improved cold chain storage for medication, vaccines and other health products
Percentage of health workers reporting higher motivation or greater ability to perform their work
Number of facilities with increased use of digital reporting of health data and/or other uses of digital connectivity such as continuous learning and medical consultations
GHG emissions, estimated in tonnes of carbon dioxide equivalent, reduced, sequestered or avoided through clean energy activities
Key result: Increased number of health facilities with sustained access to clean, reliable energy and improved digital connectivity
Number of facilities with new access to renewable energy or backup power
Number of facilities gaining new or improved access to internet
Percentage of supported facilities meeting standards for electrical system up time
Intermediate result 2: Increased quantity and diversity resources for HFE
US government investment leverage: Total public and private funds leveraged by HETA for HFE
Amount of private investment mobilized for HFE
Number of new (first-time) funders for HFE
Intermediate result 1: Increased multisectoral partnerships for HFE implementation
Number of health facilities identified and visualized that represent current HFE needs and current electrification infrastructure across Sub-Saharan Africa using GIS or other geospatial mapping solutions
Number of partners with memorandums of understanding
Number of countries with implementation partnerships that engage government and the private sector
Intermediate result 3: Demonstrated sustainability of inclusive business models for O&M
Percentage of electrical systems with associated long-term O&M contracts
Revenue generated from installed systems
Percentage of women and youth employment in renewable energy and telecommunications companies working with or supported by the activity

Source: Power Africa 2022

The use of the core indicators in Table 6.5 will be required by all countries supported by HETA activities. In addition, non-core indicators can be added (but are not required), depending on the country context. The indicators (an indicative selection of which is presented in the table below) can be chosen by HETA in collaboration with stakeholders and the supported government/country.

TABLE 6.6 • **HETA indicative impact assessment metrics**

Non-core indicators
Number of health facilities gaining access to basic or advanced drinking water services
Improvement in timeliness and consistency of reporting of malaria cases
Number of deliveries attended by a skilled birth attendant at a health facility per year
Number of people vaccinated against COVID-19 at the health facility
Number of designated laboratories or facilities capable of COVID-19 testing and handling COVID-19 specimens
Number of facilities supported with required power to use/install oxygen-related equipment

Source: Power Africa 2022

Framing the impact assessment metrics within the context of contributing to the Sustainable Development Goals (SDGs) can also help unlock other forms of catalytic financing, such as climate financing. Investing in healthcare electrification projects can help achieve SDG7 (Affordable and Clean Energy), SDG3 (Good Health and Well-being), and SDG13 (Climate Action), thus attracting support from organizations dedicated to sustainable development, and facilitating partnerships that enhance project success. Given the stringent monitoring, reporting and verification (MRV) requirements associated with climate finance, establishing reliable, transparent and comparable impact assessment metrics is crucial for the effective utilization of climate finance for healthcare electrification in resource-constrained settings.

CHAPTER SIX

Key Insights

MEASURING IMPACT

→ Insight #1

Measuring impacts is pivotal to evaluate the success of health facility electrification initiatives and their cost-effectiveness, changes in energy demand, and the social and health impacts.

Indicators used in HFE initiatives:

- **Energy-related:** kilowatt hours (kWh) consumed, system uptime and response times for unscheduled O&M activities
- **Health-related:** includes metrics on both service delivery/availability and health outcomes.
- **Social and environmental benefits:** economic benefits, reduced costs, potential job creation, reduction in fossil fuel usage, etc.

→ Insight #2

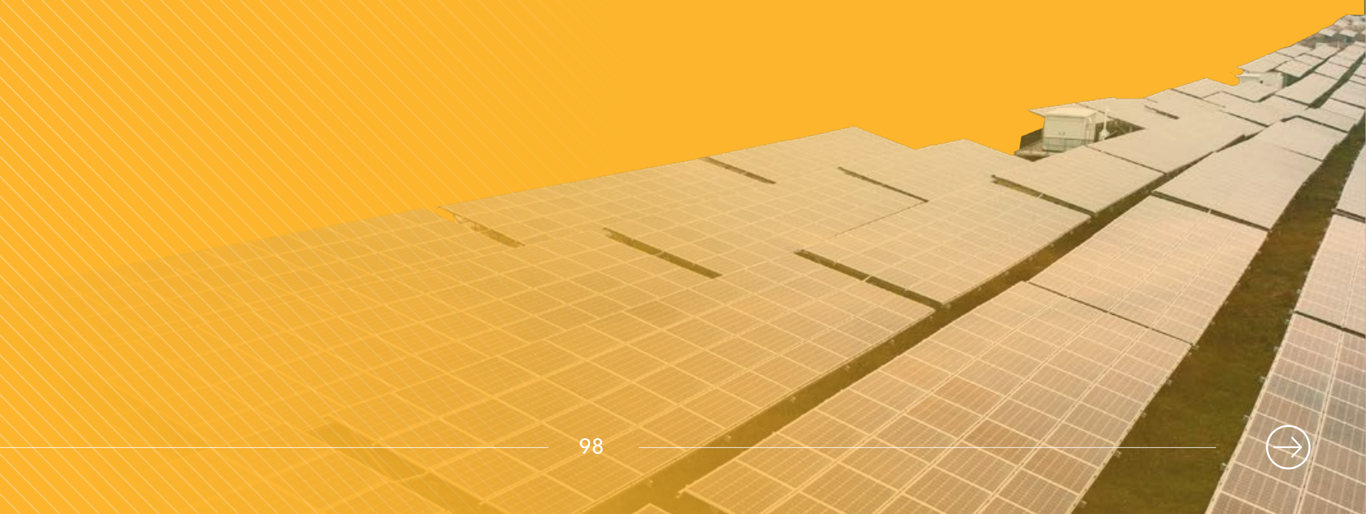
Indicators that measure impact are also critical for **releasing payments** as part of results-based financing **(RBF) schemes** or contracts with **O&M service providers**

→ Insight #3

A **monitoring and evaluation framework** that includes short-term and long-term measurable impacts is crucial for scaling up healthcare electrification efforts

→ Insight #4

A degree of **standardization** is crucial when measuring the impact of healthcare electrification interventions and to facilitate meaningful comparisons



CHAPTER SEVEN

Outlook

According to the analysis conducted in the previous sections, one of the paramount challenges in the context of healthcare electrification is ensuring both scalability and sustainability. Achieving this balance necessitates the adoption of models that emphasize long-term operations and maintenance (O&M). While the initial deployment of electrification solutions is vital, it is equally crucial to establish frameworks that can endure and adapt to the evolving needs of healthcare facilities. Scalability and sustainability, in this context, mean not simply providing electricity to one clinic, but creating a blueprint that can be replicated across multiple healthcare centres to ensure lasting impact.

Innovative sources of finance have emerged as a critical component of healthcare electrification. Beyond traditional funding mechanisms, in order to scale up, the sector will increasingly have to unlock additional and new innovative financing options, such as climate finance and distributed renewable energy certificates (D-RECs). These innovative financial instruments enable healthcare electrification projects to tap into climate funds and incentivize renewable energy investments, making it more financially feasible to electrify healthcare facilities in remote and underserved areas.

Major players are aligning their efforts to contribute to closing the energy access gap in healthcare. International development organizations, governments, NGOs and the private sector are recognizing the importance of healthcare electrification. Collaborative efforts between these entities are increasingly common, with partnerships aimed at developing sustainable, scalable and financially viable solutions for electrifying healthcare centres in underserved regions.

As regards technology trends, scalability remains a critical factor. Innovations in renewable energy technologies, battery storage and mini-grid systems are enhancing the scalability of electrification solutions. Decisions on whether to electrify entire clinics or address individual needs within these facilities are also being driven by technological advancements. Tailoring solutions to meet specific healthcare requirements is becoming more feasible, allowing for precise energy provision where it is needed most.

Geography plays a significant role in donor priorities. Donors often focus their efforts on regions with the greatest energy access disparities and healthcare challenges. Sub-Saharan Africa and parts of South Asia, for instance, are often high-priority areas due to the acute need for healthcare electrification. Donors seek to maximize their impact by targeting regions where healthcare facilities lack reliable electricity, ensuring that underserved communities gain access to essential healthcare services through electrification initiatives.

The following chapters provide insights into future projections for market-changing factors and drivers as well as risk factors for the market's continued development.

7.1 CURRENT AND EXPECTED SIZE OF THE OPPORTUNITY FOR HFE BY 2030

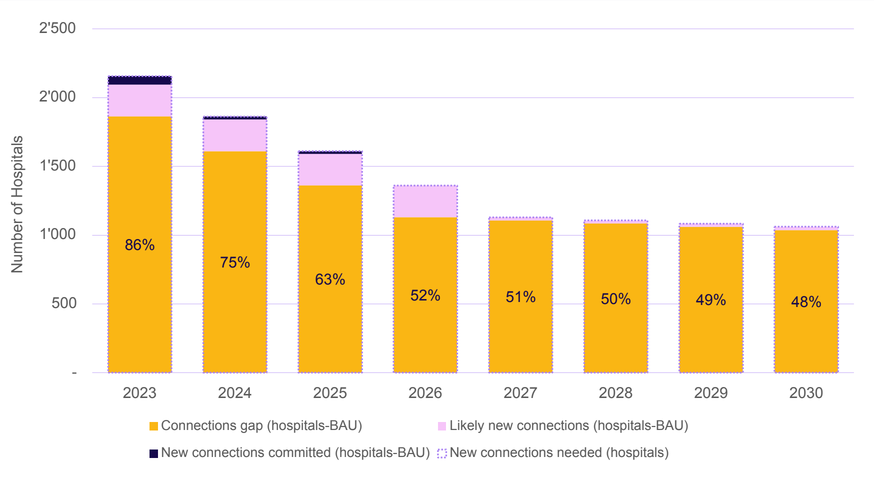
Health facility electrification (HFE) efforts have addressed a substantial share of the sector's electrification requirements in terms of the number of health facilities that have been successfully electrified. According to the latest Heatmap, tracking healthcare electrification initiatives from 2019 to 2023, between 16 and 93 hospitals were electrified annually, while in 2023 alone a staggering 10,000 non-hospital facilities were electrified (Figure 3.3).

Despite the progress, the electrification access gap among health facilities remains significant. According to recent analysis conducted by WHO in 63 countries, there are currently 1,863 hospitals and 99,063 non-hospitals that require a new connection (WHO et al. 2023). Current and planned initiatives for which funds have been secured account for roughly 4% of hospitals and 7% of non-hospitals that require a new connection.

Recent commitments highlight that the pace of HFE may be substantially higher. As seen in Figure 7.1 and Figure 7.2, major commitments from the World Bank, USAID/Power Africa and the IKEA Foundation aim to electrify over 50,000 healthcare facilities by 2026. This ongoing momentum may increase funding for such initiatives in coming years, reducing the connection gap.

To expedite the advancement of HFE, a substantial increase in financing is imperative, as highlighted in Section 5.3. However, beyond financial infusion, the key to accelerated progress lies in the synchronization of efforts across all stakeholders engaged in the process. This collaborative approach, characterized by coordinated action, holds the potential to

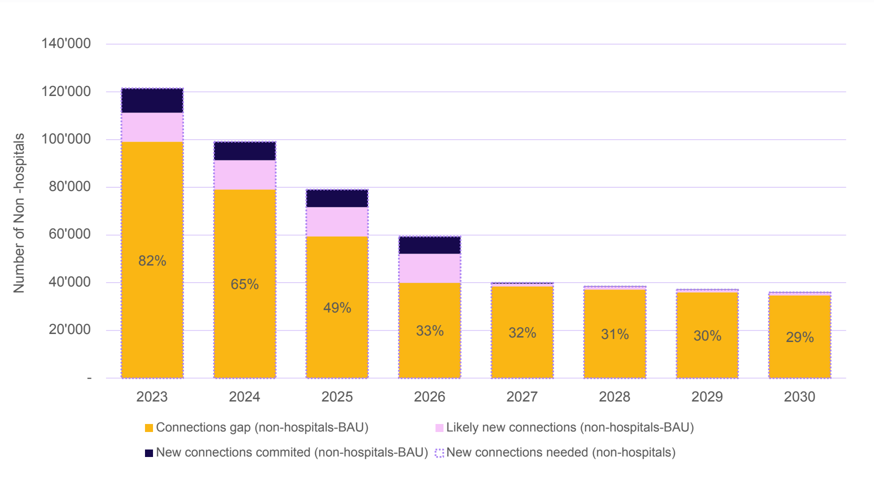
FIGURE 7.1 • **HFE progress in hospitals until 2030**



Note: BAU refers to the business-as-usual scenario, i.e. without any further support. Percentages refer to the share of currently unelectrified hospitals that remain unelectrified. 2023 values are based on data from the Heatmap database, including initiatives for which funds have been committed. Likely connections includes ongoing commitments from: USAID/Power Africa to electrify 10,000 facilities by 2030, the IKEA Foundation to electrify 25,000 facilities by 2026, and the World Bank to electrify 40,000-60,000 facilities, of which 20,000 are assumed to be healthcare facilities, by 2026.

Source: Consultant analysis

FIGURE 7.2 • **HFE progress for non-hospitals until 2030**



Note: Percentages refer to the share of currently unelectrified non-hospitals that remain unelectrified. 2023 values are based on data from the Heatmap database, including initiatives for which funds have been committed. Likely connections includes ongoing commitments from: USAID/Power Africa to electrify 10,000 facilities by 2030, the IKEA Foundation to electrify 25,000 facilities by 2026, and the World Bank to electrify 40,000-60,000 facilities, of which 20,000 are assumed to be healthcare facilities, by 2026.

Source: Consultant analysis

catalyse impactful change and drive the realization of HFE goals. These actions are discussed in Section 7.2 and Chapter 8.

While there are several opportunities to accelerate the growth trajectory of HFE, several potential risk factors loom on the horizon that demand careful consideration. These risks have been gleaned from interviews with key stakeholders, coupled with a comprehensive assessment of the sector's dynamics:

- **Political and site selection challenges:** One notable risk factor lies in the site selection process, which can often become entangled in political considerations, resulting in delays and resource consumption. The intricacies of site selection underscore the necessity for strong collaboration and alignment with governmental entities. A prime example is the solarization initiative for 300 healthcare facilities in Nigeria, where a dedicated government team was established to oversee the process. While involving the government can enhance the legitimacy of decisions, the potential for political influence may introduce complexities that could hinder the pace of progress.

- **Implementation timelines and logistical hurdles:** The successful implementation of healthcare electrification initiatives is contingent upon timely execution. The timeline for implementing a power solution in a healthcare facility is highly variable and depends on several factors, including the project's scale and geographical location, the regulatory processes, funding availability, the complexity of the installation and the political landscape's stability. The first phase, site selection and audit, typically spans three to six months from the initial contract signing. During this stage, suitable healthcare facilities are identified, site assessments are conducted, and energy audits are performed to evaluate the feasibility of solar installations.

  Following this, the procurement process comes into play, again lasting roughly three to six months. This phase encompasses a series of activities, including company selection, contract negotiations and the preparation of tender documents. Once contracts are finalized, equipment procurement is the next step, which can extend for another three to six months, depending on the availability of components and logistical considerations.

  The actual civil works and installation phase follows, which usually takes around two to four months per healthcare facility. Subsequent to installations, there is typically a testing and commissioning phase, which may last one to two months. This stage is essential to ensure that the system operates as intended, meeting both safety and performance standards. However, unforeseen logistical challenges, such as heavy rains or infrastructural limitations, can disrupt timelines and impede project advancement. Extended lead times for critical components, such as batteries, can also be a significant factor contributing to project delays.

- Addressing these challenges requires proactive planning and robust contingency measures to ensure that external factors do not compromise the delivery of essential electricity services to healthcare facilities.

- **Lack of holistic framework:** An overarching risk is the possibility of focusing solely on short-term installation goals without developing a comprehensive long-term framework. This approach could compromise the sustainability and impact of healthcare electrification initiatives. Mitigating this risk necessitates a concerted effort to account for the entire life cycle of projects, emphasizing ongoing maintenance, training and stakeholder engagement to ensure that the benefits endure beyond the initial implementation. The effective mitigation of this risk hinges on donor accountability and stakeholder engagement. Donors must exercise vigilance in ensuring that long-term O&M considerations are integral to project design and planning. Likewise, stakeholders need to actively participate in shaping the sector's growth, advocating sustainable approaches and holding all parties accountable for delivering on their commitments.

- **Financial challenges and public-private collaboration:** A critical hurdle to overcome is the financial landscape of healthcare electrification. While resolving government payment issues is pivotal, the greater challenge is for government to prioritize healthcare electrification within their budgets and establish an environment conducive to private sector involvement. Financing, a significant obstacle, can be tackled by aligning the interests of the public and private sectors, fostering partnerships and creating enabling frameworks that encourage private investment in O&M.

7.2 ROLE OF THE PRIVATE SECTOR

As discussed in the preceding section, the HFE gap presents a substantial challenge, underscoring the need for a multifaceted and concerted approach. Bridging this gap calls for more than just harmonizing the endeavours from the established stakeholders; it necessitates the active participation of new and innovative market players to accelerate the trajectory of electrification.

Several new market players are poised to play pivotal roles in scaling up healthcare facility electrification efforts. These players leverage innovative technologies, business models and partnerships to drive impactful change. They include:

- **Energy storage providers:** Companies focusing on advanced energy storage technologies contribute to ensuring uninterrupted power supply for healthcare facilities, even in remote or unstable regions. Battery providers can play a crucial role in addressing one of the primary challenges faced by health facilities: battery replacement. These technology providers can make a significant impact by extending warranty periods, offering robust after-sales support, and facilitating secure payment processes for replacement batteries. Examples of such providers include:
  - **Tesla Energy:** Tesla's Powerwall and Powerpack products are widely used in stand-alone systems and mini-grids. These lithium-ion battery solutions are known for their reliability and scalability.
  - **Luminous Power Technologies:** Luminous is an Indian company that offers a range of energy storage solutions, including batteries for stand-alone solar systems and mini-grids. They have a strong presence in several developing countries.
  - **Schneider Electric:** Schneider Electric provides energy storage solutions such as their Conext XW+ inverter/charger, which is used in off-grid and mini-grid applications.
  - **Blue Nova Energy:** Based in South Africa, Blue Nova Energy produces lithium iron phosphate batteries designed for use in off-grid and mini-grid systems. Their solutions are tailored to withstand harsh environmental conditions.
  - **Victron Energy:** Victron Energy offers a range of energy storage products, including batteries and inverters, that are commonly used in off-grid and mini-grid setups in developing countries.
  - **Renewable Energy World:** This company specializes in providing energy storage solutions, including batteries, for off-grid and mini-grid projects in Africa and other regions with limited access to reliable electricity.
- **National installers and O&M companies:** National installers and O&M companies are central components for the sustainable electrification of healthcare facilities, especially in regions with limited access to reliable energy sources. Their intimate knowledge of local conditions, cost-efficiency and community engagement make them vital for deploying and maintaining energy solutions tailored to healthcare needs. However, to enhance their effectiveness, capacity-building programmes, certifications and specialized training are imperative. These initiatives enable national entities to install and manage increasingly complex renewable energy systems while adhering to quality and safety standards, thus ensuring uninterrupted access to electricity for critical healthcare services and promoting economic development within their communities.

- **GIS (geographic information system) and geospatial companies and institutions:** GIS and geospatial companies and institutions, including Fraym, Waya, VIDA, WRI and JRC, can play a vital role in HFE efforts. They leverage advanced spatial data analytics, satellite imagery and geographic information to provide critical insights into identifying suitable locations for electrification, assessing energy needs, and optimizing the planning and implementation of electrification projects. These organizations enable data-driven decision-making, helping stakeholders prioritize healthcare facilities most in need of electrification and tailor energy solutions to specific geographic and demographic conditions. Their expertise contributes to the efficient allocation of resources, improved project outcomes and the overall success of healthcare electrification initiatives.

- **Technology giants:** Large technology companies have been offering financing for healthcare electrification initiatives. For example, Google is providing renewable energy certificates (RECs) to mini-grid companies that undertake electrification projects, including for healthcare, aimed at replacing diesel gensets.

- **Monitoring solution providers:** Remote monitoring technology companies, such as the Prospect platform from A2EI, offer real-time data collection and analytics, enabling efficient energy management, predictive maintenance and performance optimization for electrified healthcare facilities.

- **Local entrepreneurs and start-ups:** Local entrepreneurs and start-ups can bring fresh ideas and solutions to healthcare electrification. They are often well-acquainted with the unique challenges and opportunities within their communities and can develop tailored approaches that resonate with local needs.

- **Telecommunications companies:** Telecommunications companies have existing infrastructure in many underserved regions. They can leverage their networks to provide reliable connectivity and potentially support power infrastructure for healthcare facilities. For example, the Health Electrification and Telecommunications Alliance (HETA) has extended support to Resolve/Orange for the electrification of their telecom towers in Sierra Leone, and the surplus electricity generated will be made available to nearby health clinics.

- **System integrators:** System integrators are crucial stakeholders in HFE, offering tailored plug-and-play solutions designed to meet the unique needs of healthcare facilities. Their expertise lies in understanding the specific requirements of healthcare settings, which often demand uninterrupted power for critical medical equipment and lighting. Recent discussions with the open banking facilitator Okra in Nigeria underscore the importance of aligning these solutions with the real demand, reflecting the dynamic healthcare landscape. System integrators collaborate with healthcare providers to identify precise energy requirements, ensuring that their systems are reliable, scalable and capable of seamlessly integrating renewable energy sources like solar power.

- **Financial institutions:** Emerging fintech companies can offer innovative financing models, such as pay-as-you-go systems, to make healthcare electrification more accessible and affordable for healthcare facilities, particularly in resource-constrained settings. For instance, BBOXX, by leveraging mobile payment platforms, allows healthcare facilities to pay for their energy needs in instalments, making electrification more accessible and cost-effective.

- **De-risking facilities:** Institutions that provide de-risking instruments, such as the Multilateral Investment Guarantee Agency (MIGA) and programmes like the EU/Desiree programme, play a pivotal role in supporting HFE initiatives. These organizations help mitigate the financial and operational risks associated with electrification projects, which are often located in challenging or remote areas with uncertain economic conditions. MIGA, for instance, offers political risk insurance, guaranteeing investments against non-commercial risks such as expropriation or currency transfer restrictions, making it more attractive for private sector investors to engage in healthcare electrification projects. Similarly, the EU/Desiree programme provides grants and financial support to de-risk investments in sustainable energy solutions, including those for healthcare facilities. By reducing the perceived risks for private sector actors, these institutions attract much-needed capital, technology and expertise to accelerate healthcare electrification efforts, ultimately improving access to reliable electricity for medical services and contributing to better healthcare outcomes.
- **Academic and research institutions:** Universities and research institutions contribute by developing innovative technologies, conducting feasibility studies, geospatial modelling and providing knowledge transfer to enhance the electrification of healthcare facilities.

While current stakeholders are crucial in laying the groundwork, the introduction of new market players injects dynamic energy and transformative potential into the process. These new entrants bring diverse perspectives, cutting-edge technologies and innovative business models to the table. Their engagement not only bolsters the momentum of electrification, but also injects vitality into the evolving landscape. By forging partnerships and fostering collaborations with emerging market players, the collective capacity to address the HFE gap is magnified, enabling a more comprehensive and accelerated advancement towards equitable and sustainable electrification of healthcare facilities.

7.3 UPCOMING TRENDS

Based on the comprehensive analysis presented in the report, it is evident that the HFE sector is poised for several forward-looking developments that have the potential to transform the sector's progress.

The integration of energy-efficient appliances in healthcare electrification is likely to gather momentum in the next five years. This approach not only reduces the overall energy consumption of facilities, but also enhances the developmental impact of electrification initiatives. The inclusion of reliable and efficient medical equipment can directly translate into improved health outcomes and better resource utilization. By integrating energy-efficient appliances, such as advanced diagnostic tools, efficient lighting and reliable refrigeration for vaccines and medications, healthcare facilities can provide better patient care. Also, energy-efficient appliances allow healthcare staff to perform their duties more effectively.

More countries are expected to experiment with an "energy-as-a-service" model. This model involves a service-based approach to energy provision, where healthcare facilities pay for the energy they use rather than investing in the infrastructure itself. This shift from a capital expenditure model to an operational expenditure model will allow more healthcare facilities, especially those with very limited budgets, to access reliable energy sources. The adoption of this model can enhance O&M provision following healthcare electrification, fostering a more sustainable and long-term improvement in energy reliability. This model also encourages private sector participation, as it presents a viable business model for energy providers, contingent upon adequately addressing the ability of healthcare facilities to pay. As noted in Section 3.7, service-based models may not be suitable for every country. The success of these models hinges on the readiness and capacity of local governments and institutions,

which vary significantly across different regions. Recognizing this, donor organizations are increasingly focusing on technical assistance programmes. These programmes are designed to build and enhance relevant capabilities within government and relevant institutions, preparing them for the successful implementation of service-based models in HFE. As a result of these ongoing efforts, we can anticipate a rise in the adoption of energy-as-a-service models. This trend signifies a promising direction towards more flexible and accessible energy solutions.

Data analytics, remote monitoring and artificial intelligence (AI) are poised to improve the efficiency and sustainability of HFE initiatives. Recent significant advancements in AI technology will provide smarter and more efficient solutions for HFE. By harnessing the power of big data and AI, we can anticipate a more nuanced and dynamic approach to managing energy resources in health facilities. Data analytics will enable precise tracking of energy consumption patterns, allowing for the optimization of power usage and the identification of areas for energy-saving improvements. Remote monitoring can streamline and automate data collection, which can help improve monitoring and impact assessments. It can also allow real-time tracking of energy systems' performance, reducing the need for physical inspections and enabling faster responses to maintenance issues. Using AI algorithms can further enhance the identification of potential system failures or inefficiencies before they occur, ensuring continuous and reliable power supply.

It is anticipated that D-RECs and climate finance more broadly will play a pivotal role in financing HFE initiatives over the next few years. As the healthcare electrification sector evolves, it is becoming increasingly clear that traditional funding mechanisms are insufficient to meet the growing demand, especially in remote and underserved areas. An increasing number of renewable energy companies are accessing climate finance to develop HFE projects. D-RECs, in particular, offer a novel mechanism for healthcare facilities to capitalize on the environmental benefits of their renewable energy installations. By engaging in D-REC initiatives, these projects can unlock additional revenue streams. Although D-RECs may only contribute to a limited portion of the standard O&M costs, this additional revenue can play a crucial role in offsetting some of the costs, while simultaneously supporting climate change mitigation efforts. As these models continue to develop and gain traction, it is expected that more HFE initiatives will adopt D-RECs and similar instruments.

CHAPTER SEVEN

Key Insights

OUTLOOK

→ Insight #1

Innovative sources of finance have emerged as a critical component of healthcare electrification

→ Insight #2

Major players are aligning their efforts to contribute to closing the energy access gap in healthcare

→ Insight #3

The role of the **private sector** and **new market players** are needed to accelerate the trajectory of electrification. These include:

- Energy storage providers
- De-risking facilities
- Monitoring solutions providers
- Local entrepreneurs and start-ups

→ Insight #4

Integration of energy-efficient appliances in healthcare electrification is likely to gather momentum in the next five years

→ Insight #5

More countries are expected to experiment with an **"energy-as-a-service"** model

→ Insight #6

Data analytics, remote monitoring and artificial intelligence (AI) are poised to improve the efficiency and sustainability of HFE initiatives

→ Insight #7

D-RECs and climate finance more broadly will play a pivotal role in financing HFE initiatives over the next few years

CHAPTER EIGHT

Recommendations and Conclusions

8.1 RECOMMENDATIONS FOR ACTIONS BASED ON THE REPORT'S CONTENTS

8.1.1 Policy and regulatory change

→ Create the change in governmental perspective that is necessary for sustainable outcomes.

Governments in various low-income countries should acknowledge that solar energy systems require maintenance. The prevailing mindset that solar energy is free poses a significant challenge to sustainable electrification initiatives, especially those targeting healthcare facilities. To ensure the lasting success of such initiatives, it is imperative that governments recognize the critical importance of incorporating a comprehensive long-term operations and maintenance (O&M) strategy, along with allocating an adequate budget to support the execution of this O&M plan.

Moreover, the prevailing tendency among these governments to prioritize grid extensions as the primary solution for electrifying health facilities disregards the significant potential of off-grid systems, particularly stand-alone solar and mini-grids. Urgent action demands a broader perspective, considering alternative solutions that can swiftly provide reliable and climate- friendly electricity access, as well as creating national plans for healthcare electrification.

Historically, governments have expressed concerns about financing support and entrusting the private sector with the electrification of public facilities. However, the advent of cutting-edge technologies like artificial intelligence and remote monitoring offers opportunities for governments to closely monitor the performance of power systems. This enhanced oversight fosters confidence in private sector operations, and creates a conducive environment for effective collaboration between the public and private sectors. Other strategies include the establishment of clear regulations and transparent contracts with the private sector, encompassing well-defined key performance indicators (KPIs) and contingency plans for scenarios like bankruptcy. Additionally, maintaining government involvement, potentially through ownership stakes, and ensuring ongoing engagement through activities such as site visits and training initiatives are crucial steps in fostering trust and collaboration between public and private entities. These measures collectively contribute to the reliability and sustainability of electrification projects, reassuring governments of the private sector's commitment to the partnership. By embracing a holistic understanding of energy solutions, governments can bolster the sustainability of healthcare electrification, ensuring improved access to essential services and driving positive societal impacts.

The regulatory framework should establish relevant quality and performance standards to ensure the quality and sustainability of healthcare services.

These standards can cover aspects like reliability of electricity supply, maintenance protocols and adherence to safety regulations. This is particularly important in the context of healthcare electrification, given the sensitivity of medical equipment to voltage and frequency deviations. For instance, off-grid solar equipment should be required to meet or exceed Lighting Global/IEC component standards, be certified by accreditation bodies and test laboratories, and supported by test results.[14]

Finally, the regulatory framework should offer flexibility in terms of financing mechanisms that can be tailored to healthcare electrification. This could involve setting up dedicated funding mechanisms, establishing partnerships with development banks or international organizations, or allowing public-private partnerships to ensure sufficient funding for electrification projects.

→ Develop a healthcare electrification taxonomy

It is important to establish a comprehensive taxonomy of countries based on their existing healthcare electrification landscape. This taxonomy can serve as a foundational blueprint, enabling the creation of bespoke strategies that align with the unique needs and challenges of each category. Recognizing that nations embark on this transformative journey from disparate points, it becomes apparent that a one-size-fits-all approach is inadequate.

A critical consideration is the heterogeneous landscape of private sector development and governmental capacity from country to country. This variation significantly influences the feasibility and execution of healthcare electrification initiatives. For instance, a nation like Uganda, with a relatively more developed private sector and established government infrastructure, calls for a tailored strategy that capitalises on its existing strengths. Conversely, in countries like South Sudan, where these capacities might be less mature, a more adaptable approach is essential to foster sustainable and effective electrification efforts.

Crafting a uniform healthcare electrification programme would overlook these essential nuances. The complexities, challenges and opportunities inherent in each country demand an approach that is finely tuned to

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[14] More details regarding the quality standards of off-grid solar systems for healthcare facilities can be found in the Lighting Global report (Lighting Global 2023).

their specific circumstances. A comprehensive understanding of the local context is pivotal for designing initiatives that not only address the immediate gaps in electricity access, but also catalyse long-term growth and resilience within the healthcare sector.

The development of an in-country taxonomy is essential to effectively categorize various facilities based on their sizes and requirements. This approach ensures a tailored and nuanced strategy, as attempting a universal, "one-size-fits-all" method by implementing a standardized energy system is not advisable. By creating a taxonomy that takes into account the specific needs, capacities, and energy demands of diverse healthcare facilities, a more targeted and customized electrification plan can be crafted.

➜ Improve coordination between health, energy and climate stakeholders

The convergence of the health and energy sectors has enormous significance in driving the advancement of healthcare electrification. Traditionally confined to distinct domains, the need for greater collaboration is clear and compelling, with the aim of unlocking synergies and magnifying the overall impact. The importance of an integrated approach is underscored by the need for a comprehensive framework that encompasses the assessment, design, implementation and management of energy solutions tailored specifically for healthcare. This paradigm shift calls for a dynamic partnership in which both health and energy stakeholders contribute their expertise to develop a nuanced understanding of healthcare needs, bridging knowledge gaps and uniting their efforts to devise and execute joint solutions. It is important not simply to rely on individual projects to catalyse collaboration, but to establish lasting institutional frameworks that perpetuate coordination as an intrinsic, ongoing process. For instance, establishing formal multisectoral coordination committees at the country level can serve as vital conduits for seamless planning and effective investment.

Efforts to enhance coordination among donors should extend to in-country operations to effectively minimise the duplication of effort. Putting the emphasis on synchronizing work at the country level holds the potential not only to harmonize initiatives, but also to amplify these stakeholders' combined influence. The ministries of energy and health can jointly develop electrification strategies that prioritize healthcare facilities, allocate resources efficiently and streamline regulatory processes. This strategic alignment can serve as a catalyst, accelerating crucial healthcare electrification endeavours. By optimizing resource allocation and minimizing redundancy, stakeholders can collectively channel their energies into targeted actions that have impact, resulting in more efficient and enduring progress in healthcare electrification.

➜ Better coordination between the public and private sector

The private sector has the agility to venture into healthcare electrification environments where commercial viability is more apparent, benefiting from a favourable business landscape. Conversely, public sector organizations and development partners such as the World Health Organization (WHO), Sustainable Energy for All (SEforALL) and the World Bank, guided by motivations beyond profit maximization, can extend their reach to encompass regions that may not be commercially attractive. Effectively harnessing the synergies between these two spheres through coordinated efforts (such as forming working groups) holds immense potential to amplify impact. Again, it is critical to avoid duplication of effort, ensuring that development organizations do not inadvertently encroach into regions already attractive to private sector investment. By strategically aligning their objectives and coordinating their actions, these entities can optimize resource allocation and streamline intervention, thereby channelling efforts where they are most needed and effectively mobilizing resources to bolster healthcare electrification in underserved areas.

→ Build capacity at the policy, institutional and technical level—a prerequisite for long-term sustainability

Establishing a robust foundation for healthcare electrification entails an intricate web of effort that spans the policy, institutional and technical domains. This holistic approach is important to ensure the enduring sustainability of healthcare electrification initiatives.

At the policy level, crafting well-defined and forward-thinking frameworks becomes the bedrock on which successful electrification projects stand. Clear policies not only drive investment and funding, but also foster an environment conducive to innovation and collaboration. Policies that prioritize sustainable energy sources, incentivize private sector engagement and mandate energy-efficient technologies can guarantee the longevity of healthcare electrification. Moreover, these policies need to be adaptable to changing circumstances and emerging technologies, to ensure sustainability in the healthcare electrification sector.

Institutional capacity building forms the bond that connects policy aspirations with on-the-ground implementation. Strengthening institutions involves enhancing the capabilities of healthcare facilities, local government, regulatory bodies and community organizations. A skilled workforce is pivotal in managing and maintaining the intricate healthcare electrification infrastructure. Training healthcare personnel to operate and troubleshoot advanced medical equipment and energy systems ensures uninterrupted patient care. Additionally, local authorities and regulators need the expertise to oversee and optimize electrification projects. Collaborating with community organizations and involving them in decision-making fosters ownership and long-term commitment, promoting sustainable energy use behaviours.

On the technical front, bolstering expertise and innovation is the cornerstone of a resilient healthcare electrification ecosystem. Advancements in renewable energy sources, energy storage solutions and smart grid technologies have the potential to revolutionize healthcare delivery. Investing in research and development accelerates the deployment of cutting-edge solutions, driving down costs and increasing efficiency. Technical capacity building also encompasses robust maintenance practices, rapid response mechanisms and disaster preparedness strategies to safeguard against power disruptions.

Donor-funded healthcare electrification initiatives should support the development of local capacity within their frameworks. These initiatives can drive transformative change while emphasizing the imperative of equipping local markets with the necessary skills and resources. For instance, the ERT-3 initiative encouraged collaboration between international entities and local solar firms, bolstering not only the solar market but also enhancing O&M services vital for programme longevity. The ripple effects of such collaboration are felt on multiple fronts—from nurturing local service agents to cultivating a cohort of proficient technicians capable of ensuring sustained upkeep. The Rural Renewable Electrification Project initiative aimed to build local capacity by engaging Sierra Leonean technicians in site installations, thus harnessing local expertise. Simultaneously, this programme demonstrated its commitment to capacity building via comprehensive training that spanned both classroom instruction and hands-on field experience.

By embedding local knowledge and skills into the core of healthcare electrification efforts, these initiatives not only magnify immediate impact, but also encourage self-sufficiency within the communities they serve. Local community buy-in also encourages ownership of projects, which in turn should encourage people to look after systems better and reduce misuse or theft.

→ Work with champions

Recognizing and collaborating with champions for healthcare electrification can propel efficiency and encourage sustainability. These champions encompass government officials, influential cultural figures and healthcare workers, each contributing to the momentum required for substantial progress. Champions act as conduits of change, forging vital connections between regional health and energy departments. Through their networks, they can pool resources efficiently and orchestrate systemic transformation. Notably, champions extend beyond government corridors, with enterprises and NGOs that boast a history of engagement with local authorities also playing a significant role.

→ Look at the health facility in a comprehensive way

Electrification initiatives should adopt a holistic perspective. The essence lies in comprehensively electrifying the entire health facility, viewing it as an integrated ecosystem rather than isolating individual components. This approach ensures that all facets of healthcare delivery, from diagnostics and treatment equipment to lighting and staff housing, benefit from a consistent and reliable power supply. By electrifying the entire facility, a robust foundation is established, enabling uninterrupted and efficient medical services, enhancing patient care and ultimately contributing to the overall well-being of the community.

While it is essential for electrification initiatives to adopt a holistic perspective, singular applications like electrifying a refrigerator for vaccine storage still hold value, particularly in emergency situations. These specialized solutions, exemplified by initiatives such as Gavi's, are designed to respond rapidly

to critical healthcare needs during crises or emergencies. Therefore, they should not be eliminated entirely from the electrification landscape. Instead, they should complement broader electrification efforts, serving as crucial and targeted interventions to ensure the reliable storage of vaccines and medications in urgent situations where healthcare infrastructure may be compromised.

→ As a donor initiative, ensure buy-in from the government

Achieving sustainable healthcare electrification hinges on securing robust government buy-in. The active engagement and endorsement of government entities play an important role in ensuring the long-term success of electrification initiatives in the healthcare sector. Government support not only bolsters financial commitment, but also leads to regulatory frameworks and policy incentives that create an enabling environment. By aligning healthcare electrification with national development agendas, governments can prioritize the allocation of resources, facilitate streamlined coordination among relevant ministries, and foster collaboration with international partners and donors. A supportive government can facilitate new partnerships between healthcare institutions, energy authorities and private sector stakeholders, thus mobilising diverse expertise and resources to tackle the multifaceted challenges of healthcare electrification including planning and budgeting for O&M.

Additionally, government endorsement can inspire confidence among private investors, fostering a favourable climate for innovative funding mechanisms and public-private partnerships. Ultimately, the resonance of governmental buy-in amplifies the transformative potential of healthcare electrification.

To ensure buy-in, government should be involved in all critical aspects of the electrification programme, such as site selection, where their insight into local needs and priorities can guide the strategic placement of electrified healthcare facilities. Moreover, the government's facilitation of comprehensive feasibility studies ensures a well-informed approach, addressing technical, logistical and community-centric considerations. Government officials should actively participate in capacity building endeavours. Their direct participation in these activities fosters an environment of collaboration, where local expertise is nurtured and harnessed to manage and maintain the electrification infrastructure effectively. Government as a partner in capacity building not only leads to knowledge exchange, but also instils a sense of ownership and accountability, contributing to the programme's long-term success.

Initiatives focused on healthcare electrification require a strategic connection with the appropriate department or agency within government. Unfortunately, instances abound where various programmes collaborate with different ministries or even within distinct departments of the same ministry, leading to fragmented efforts and inefficiencies. It is incumbent upon the government to establish clear oversight by designating a specific agency or department and delineating its mandate, roles and responsibilities. This includes responsibilities such as guiding site selection, standardising minimum technical specifications across different electrification programmes, and ensuring cohesive and coordinated efforts in pursuit of effective healthcare electrification.

8.1.2 Project design

➜ Every HFE programme should start with a country roadmap

Starting a healthcare electrification programme with a comprehensive country roadmap is a critical step in addressing the energy needs of healthcare facilities in resource-constrained settings. These roadmaps, like SEforALL's publications for Nigeria, Sierra Leone and Rwanda and the International Renewable Energy Agency (IRENA) Burkina Faso roadmap, serve several vital purposes:

- **Data and status assessment:** These roadmaps begin by presenting the latest data and a comprehensive status assessment of health facility electrification (HFE) in the country. They provide a clear picture of the existing gaps and challenges, including the number of unelectrified facilities, the energy sources currently in use and the reliability of existing systems.

- **Technical solutions:** Country roadmaps delve into appropriate technical solutions to address supply and demand imbalances in meeting unmet energy needs. They consider the specific energy requirements of healthcare facilities, such as medical equipment, lighting, and refrigeration for vaccines and medicines.

- **Innovative delivery models:** To tackle the unique challenges of HFE, these roadmaps explore potential new and innovative delivery models. They may include pay-as-you-go systems, off-grid renewable energy solutions and partnerships with private sector entities.

- **Financing mechanisms:** Country roadmaps also reveal the potential for innovative financing mechanisms to fund electrification initiatives. This can involve blending public and private sector investments, leveraging international financing sources, and exploring carbon credits and impact investment opportunities.

- **Practical recommendations:** Ultimately, country roadmaps, when made public, provide a clear and actionable roadmap for public agencies and their development partners. They offer practical recommendations on the policy changes, regulatory frameworks, capacity building and collaboration strategies needed to scale up healthcare electrification interventions.

→ A needs assessment should be the cornerstone of every healthcare electrification programme

The energy needs assessment should encompass the entire health compound, considering not only existing healthcare facilities, but also staff quarters, storage rooms and potential future expansion or upgrades to the healthcare infrastructure. Suppressed demand also needs to be taken into account, given that the electrification of the facility can lead to changes in consumption due to the admission of more patients, the addition of new services and appliances, and the extension of operating hours.

It is essential that the needs assessment encompasses an accurate and pragmatic evaluation of the facility's electricity requirements. While ensuring an adequate power supply is paramount, an overestimation of these needs could inadvertently result in the installation of oversized energy systems. This outcome can lead to a counterproductive situation where the energy solutions become prohibitively expensive for the facilities to sustain.

By meticulously gauging the precise energy demands of the health facility, the needs assessment can play a pivotal role in striking an optimal balance between functionality and affordability. It provides a compass to navigate the fine line between addressing the facility's energy deficits and avoiding the financial strain that might arise from excessive investment in energy infrastructure.

Conducting a comprehensive needs assessment involves not only a quantitative analysis of energy consumption patterns, but also a qualitative understanding of the facility's operational intricacies. Factors such as peak usage hours, the types of medical equipment in use, and potential future expansion should all be carefully considered. By doing so, the assessment can facilitate the design and implementation of tailored energy solutions that precisely cater to the facility's requirements, without introducing unnecessary burdens on its financial stability.

Ultimately, the success of healthcare electrification initiatives hinges upon striking the right equilibrium between enhancing energy access and ensuring economic viability. A needs assessment that thoughtfully accounts for the facility's current and projected electricity needs serves as an indispensable tool in achieving this equilibrium, steering the trajectory of healthcare electrification toward sustainability, efficiency and long-term feasibility.

→ Streamline transaction costs and administrative burdens on grant recipients

It is important to streamline the reporting requirements for grant recipients in healthcare electrification projects. Once donors have diligently assessed and selected the implementing company or institution, it becomes imperative to empower them to fulfil their role unhindered. The emphasis should shift from an excessive reporting burden to a trust-based approach, allowing grantees to focus on the successful execution of the electrification programme. This strategic shift not only optimizes the efficient use of resources, but also acknowledges the expertise and capacity of the chosen partners. By minimizing onerous reporting demands, these recipients can fully concentrate on leveraging their skills and experience to achieve the programme's objectives, ultimately accelerating the positive impact on healthcare services and fostering sustained progress within communities.

→ Seek out economies of scale

Seeking and capturing economies of scale in healthcare electrification initiatives increases efficiency and cost savings, thus maximising the impact of the intervention. Scaling

enables the bulk procurement of materials and equipment in larger quantities, at lower unit costs, and it gives the implementing agency greater negotiation power with suppliers and contractors, leading to more favourable terms and conditions for service provision. This may, however, be challenging for smaller companies operating on a smaller scale. Administrative and transaction costs associated with project management can also be greatly reduced.

In addition, larger-scale projects are often more attractive to potential funders, including governments, international organizations and investors. The ability to demonstrate a broader impact and higher return on investment can lead to increased funding support. In terms of broader positive outcomes, scaling up can provide a stronger market influence and incentivize the private sector to innovate and offer competitive pricing. Scaling up can also create an impetus for policy changes that can foster an enabling environment for sustainable healthcare electrification. Financing institutions like the Multilateral Investment Guarantee Agency (MIGA) similarly tend to prioritize their support for larger transactions, underscoring the significance of aligning healthcare electrification initiatives with substantial projects to garner the requisite financial backing.

→ Recognize the importance of starting small with a pilot

Piloting a healthcare electrification programme on a small scale allows for identifying potential challenges and risks before expanding it to more countries, while also incorporating valuable lessons learnt. A pilot generates valuable data on aspects such as policy and regulatory bottlenecks, as well as technical insights regarding energy consumption, operational requirements and community needs. This data can inform evidence-based decision-making, helping to finetune the programme's design, implementation processes and stakeholder engagement strategies and ensuring that any identified challenges are tackled effectively before further expansion. For instance, the GBE Benin programme identified several challenges on the ground, including lack of capacity at the government level and the absence of digitalized processes and centralized information for the health sector; capacity building on those aspects before initiating the programme, for instance through a partnership with the Clinton Health Access Initiative (CHAI), would have facilitated its implementation and is among the programme's lessons learnt.

Starting small also allows for the identification of a viable delivery model for healthcare electrification tailored to the specific country context. When multiple delivery models are considered viable, more than one pilot might be needed to allow for comparisons of the results. For instance, the Regional Off-Grid Electricity Access Project (ROGEAP) programme is initially carrying out a pilot in Niger and Nigeria to test the business model and evaluate its sustainability, and is then expanding it to other West African countries.

Finally, a successful pilot serves as a tangible demonstration of the programme's value to stakeholders, including government agencies, donors, healthcare providers and local communities. This is crucial for securing funding, facilitating buy-in and maintaining engagement as the programme grows, and attracting partnerships with various stakeholders, such as NGOs and international organizations, which can enhance the programme's reach and impact.

→ Consistently measure and monitor impact

The success of healthcare electrification interventions should be evaluated not solely by the number of installations, but also by their operational continuity in the long term. Initiatives should track the ongoing operation of systems and correlate healthcare electrification efforts with health-related results. Remote monitoring can streamline and automate data collection in this regard. Including impact assessments in these programmes is pivotal, not only for advancing the understanding of how electrification positively impacts health, but also for addressing stakeholder requirements that emphasize the importance of individual, community and population health outcomes.

Using health indicators to compare health outcomes before and after the installation requires good quality data, including at the baseline. Therefore, it may be necessary to provide technical assistance to government so as to streamline data collection processes; alternatively, outsourcing data collection to contractors can provide a solution, as used by WHO in certain cases.

8.2 CONCLUSIONS ON AREAS OF ACTION FOR EACH OF THE KEY STAKEHOLDER GROUPS

To accelerate the electrification of healthcare facilities and ensure sustainable outcomes, policymakers, the private sector and donors/investors need to orchestrate a comprehensive roadmap of policy actions. The following strategic actions outline the trajectory towards bridging the healthcare facility electrification gap:

→ Policy actions for policymakers:

- **Adopt a change in perspective:** Policymakers should undergo a transformative shift in their perception of solar energy systems, recognising the need for long-term O&M strategies. Governments must actively promote the integration of comprehensive O&M practices to ensure the sustained success of electrification initiatives.

- **Promote a holistic approach:** Policymakers should advocate the adoption of holistic healthcare facility design, encompassing energy-efficient appliances and innovative layouts to optimize energy consumption. Emphasis should be placed on designing energy-efficient rooms, reducing the overall energy footprint of healthcare facilities.

- **Buy into electrification:** Policymakers must actively engage with electrification initiatives by participating in site selection, feasibility studies and capacity building activities. Governments should align healthcare electrification with national development agendas, establish supportive regulatory frameworks and prioritize long-term financing mechanisms.

→ Policy actions for the private sector:

- **Enhance coordination:** The private sector should actively collaborate with governments, NGOs and international organizations to foster a harmonious synergy. This collaboration should prioritize areas with less commercial viability, ensuring equitable energy access in underserved regions. This can be achieved through the implementation of targeted financing support mechanisms.

- **Adopt innovative funding mechanisms:** Private sector entities should adopt innovative funding models that involve long-term engagement beyond capital recovery. By contributing to the O&M costs of electrification solutions, the private sector demonstrates a sustained commitment to programme success.

→ Policy actions for donors/investors:

- **Revisit funding cycles:** Donors and investors should revisit funding cycles to accommodate the long-term nature of electrification initiatives. Funding models must include mechanisms to ensure operational sustainability.

- **Provide robust financial flows:** Donors should channel increased financial resources towards healthcare electrification initiatives, while differentiating between financing models to promote long-term sustainability. Efforts should be made to ring-fence funds on both the government and private sector sides, facilitating continuous support for electrification initiatives.

➜ Shared responsibilities:

- **Develop a healthcare electrification taxonomy:** Stakeholders should collaboratively establish a comprehensive taxonomy for healthcare electrification, categorising countries according to existing infrastructure, private sector development and governmental capacities. Tailor strategies to accommodate the unique challenges and strengths of each category, ensuring effective deployment.

- **Coordinate between sectors:** It is important to foster enhanced coordination between health and energy stakeholders to streamline efforts, reduce duplication and maximize impact. Establishing multisectoral coordination committees at the country level encourages seamless planning and effective investment.

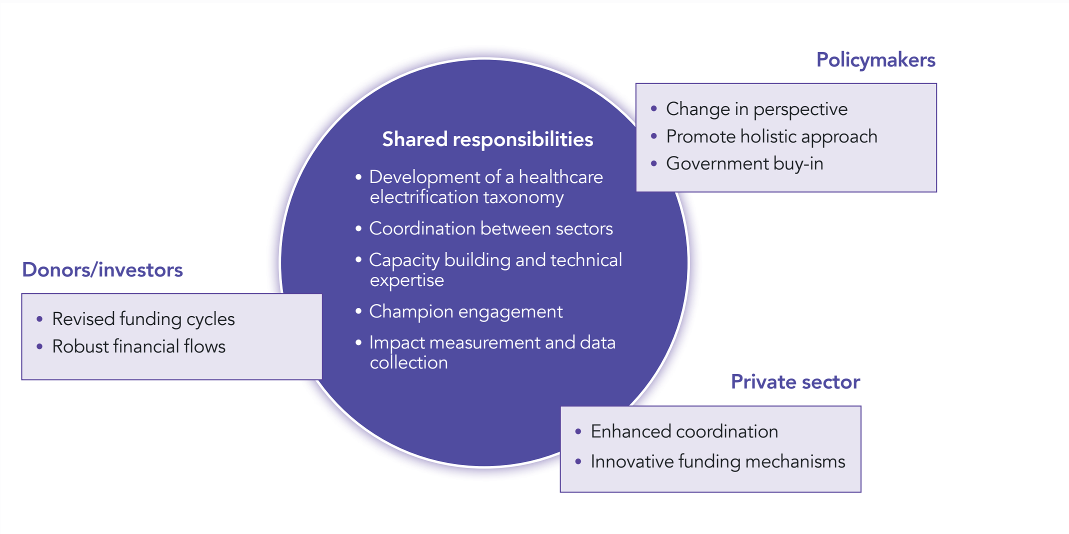
- **Build capacity and technical expertise**: Collaboratively building capacity at the policy, institutional and technical levels helps ensure long-term sustainability. Stakeholders should develop skilled workforces, facilitate comprehensive feasibility studies and embrace cutting-edge technologies for effective O&M.

- **Engage champions:** Identifying and engaging champions within government, among cultural figures and within the healthcare workforce can mobilize support for and drive momentum behind electrification initiatives.

- **Focus on measuring impact and collecting data:** Focusing on consistently measuring the impact of electrification initiatives, not only through installation numbers, but also by evaluating long-term operation and health-related outcomes, allows impacts to be fully understood. Remote monitoring technologies and streamlined data collection processes should be leveraged for accurate impact assessments.

By collectively embracing these policy actions (summarized in Figure 8.1), governments, the private sector and donors/investors can catalyse transformative change in healthcare facility electrification. This multi-stakeholder roadmap creates a robust foundation for sustained progress, fostering improved healthcare access and lasting positive impacts on communities.

FIGURE 8.1 • **Areas of action for each stakeholder group**



Source: Consultant

CHAPTER EIGHT

Key Insights

RECOMMENDATIONS AND CONCLUSIONS

→ Insight #1

Policy and regulatory change is essential. A shift in perspective is needed to recognize the importance of long-term O&M strategies

→ Insight #2

It is crucial to develop a **tailored method of categorizing countries**, considering their unique electrification landscapes and capacity

→ Insight #3

Enhanced coordination between health, energy and climate stakeholders is vital

→ Insight #4

For long-term sustainability, it is crucial to **build capacity** across the policy, institutional and technical levels

→ Insight #5

Engaging with champions, including government officials and healthcare workers, is important

→ Insight #6

Project design needs to be more **structured and streamlined**. Every project should commence with a **detailed country roadmap**

→ Insight #7

It is critical to substantially **increase financial flows** towards healthcare electrification initiatives, elevating them to a **top development priority**

→ Insight #8

A **multi-pronged strategy** involving policymakers, the private sector and donors/investors is essential

ANNEX 1

Stakeholders interviewed

TABLE A.1 • **Stakeholder interviews**

Organization/Company
AE2I
CHAI
Differ
ENGIE
EU
FCDO
GBE Benin
Havenhill
IFC
IRENA
Nuru
REA Nigeria
SEFA
SEforALL
SELCO Foundation
Stella Futura
UNDP
UNICEF
WHO
World Bank

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ABOUT SEforALL

Sustainable Energy for All (SEforALL) is an independent international organization that works in partnership with the United Nations and leaders in government, the private sector, financial institutions, civil society and philanthropies to drive faster action on Sustainable Development Goal 7 (SDG7) – access to affordable, reliable, sustainable and modern energy for all by 2030 – in line with the Paris Agreement on climate change.

SEforALL works to ensure a clean energy transition that leaves no one behind and brings new opportunities for everyone to fulfil their potential. Learn more about our work at www.SEforALL.org.

SUSTAINABLE ENERGY FOR ALL