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Environmental and Financial Impacts of Electrification of Healthcare Facilities in Selected Humanitarian Settings

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Nearly 1 billion people in low- and lower-middle-income countries rely on healthcare facilities with limited or no access to electricity, severely constraining the quality and scope of medical services available to them. The situation is particularly acute in sub-Saharan Africa, which hosts 34%[1] of displaced people globally, and where many communities are affected by crisis and endemic fragility. In the region, 15% of healthcare facilities have no electricity access, while 40% – representing over 68,000 facilities – depend on unreliable power sources.[2]

To address the electricity access gap in health facilities across selected humanitarian and fragile settings, the GPA Coordination Unit partnered with NORCAP and the Health and Energy Platform of Action (HEPA), a WHO-hosted network, to identify electricity needs and estimate solarisation costs for an initial set of 176 healthcare facilities across 15 countries in sub-Saharan Africa and Asia. Needs assessments had already been conducted for the facilities, revealing that all require either first-time electrification or refurbishment of existing solar systems that have been poorly maintained. **Full solarisation of all 176 facilities would require an estimated $4 million over 10 years, which includes $2.4 million in upfront capital expenditure and $1.76 million in operations, maintenance, and battery replacement costs.**

The traditional source of electricity for humanitarian operations has been diesel generators. This technology is quick to deploy and easily accounted for within the standard budgeting structure of humanitarian organisations. However, as the cost of renewables declines, diesel no longer represents the most cost-effective electricity source for humanitarian contexts. Additionally, the emissions footprint generated from burning polluting fossil fuels undermines organisations' commitments to decarbonisation and environmental preservation under the Environment Charter for Humanitarian Organizations[3] and other climate commitments.

For example, among the facilities identified in this research, 91 are currently using diesel generators to meet their electricity needs. Solarising these facilities would eliminate the 901 tonnes of CO_2-eq per year produced from these generators and reduce annual fuel costs by as much as $313,000. On the other hand, if all 176 facilities were to depend on diesel generators, their total fuel and maintenance costs would reach $7.7 million over 10 years. **The costs of powering all facilities with solar over the same period would be approximately 50% lower**. While solarisation requires higher up-front capital expenditures than generator procurement, the system costs could be paid back within 5 years as a result of the cost savings associated to not purchasing diesel and maintaining generators.

[1] UNHCR (2025) "Global Overview: Forcibly Displaced People."
[2] WHO, World Bank, SEforALL and IRENA (2023) "Energizing Health: Accelerating Electricity Access in Health-Care Facilities."
[3] Priority Action 8 under the Climate and Environment Charter, which has been signed by 468 organisations and the European Union member states, calls for the phase out of fossil fuel generators where possible, reduced energy consumption, and a transition to renewables.

Case Study: Somalia

In partnership with the Government of Somalia, WHO Somalia carried out energy needs assessments for 49 healthcare facilities and used the collected data to develop a standardised solar energy system design to meet the energy needs of a facility comparable to the Primary Health Centre systems referenced in the study. Solarising all 49 facilities would cost around $490,000 in CAPEX and $363,000 in for operations, maintenance, and the replacement of batteries and other components over 10 years.

Somalia's electricity system, both on-grid and off-grid, is primarily fuelled by diesel, and these 49 facilities would consume around 110,000 litres of fuel in a year, costing as much as $106,000. Switching to solar would lead to savings on fuel costs of more than $200,000 over a 10-year period, which could be used to solarise additional facilities in the region or reallocated for healthcare expenditures.

Achieving the cost savings, environmental benefits, and improved healthcare outcomes enabled by the solarisation and effective maintenance of these facilities will require collaboration from a global consortium of humanitarian, development, government, financial, and community partners. These partners must **coordinate and mobilise the necessary long-term technical assistance and financial resources for installation and operations and maintenance (O&M) in humanitarian and fragile settings**. This can be done by either identifying appropriate individual donors, pooling global resources, or integrating humanitarian healthcare facilities into existing country-level funds for health and electrification in cooperation with relevant governments. While global coordination at the global level is essential, partners must also **develop decentralised implementation approaches that build the capacity of local ecosystem players**, including government, private sector, civil society, and community partners, to implement large-scale healthcare solarisation programmes that include planning for long-term O&M of the installed systems.

The multi-country pipeline identified in the brief presents an example of facility needs and does not aim to identify these sites as a priority compared to facilities in other humanitarian settings. The list and information included in this brief presents an opportunity to pilot new approaches, in line with the needs identified above, that can subsequently be adapted and scaled across different contexts to close the humanitarian healthcare electrification gap, saving lives through strengthened healthcare delivery to people living in displacement and fragile settings.

Pipeline Overview & Methodology

The pipeline was built using data inputs from field-based technical staff from NORCAP deployed to UNHCR and WHO country offices as well as IOM. In all cases, staff had visited the facilities and/or conducted recent assessments of their electricity needs. Three facility categories were considered based on standardised profiles of public health facilities in rural settings developed by WHO et al.[4] which provides daily energy consumption ranges based on the number and type of services delivered.

Cost estimates for the installations and 10 years of O&M for the solar systems (including solar panels, battery, and inverter) were based on figures provided by UNICEF's supply division based on its experience installing solar systems at 2,000 comparable facilities across sub-Saharan Africa via the Cold Chain Equipment Optimisation Platform jointly implemented by Gavi, the Vaccine Alliance; UNICEF; and WHO, with technical support from SELCO Foundation. A detailed overview of the methodology, data sources used, and limitations is included in the annexes.

Country	Health Facility Types Based on Estimated Demand			Total Cost in USD (Including CAPEX and OPEX for 10 Years)**
	Health Post (4.5 kWh)	**Primary Health Centre** (18.4 kWh)	**Small Hospital** (54 kWh)	
Chad	-	17	62	1,835,880
Somalia	-	49	-	852,600
Cameroon	-	8	1	164,040
Djibouti	1	2	3	124,260
Nigeria	-	5	-	87,000
Niger	-	3	10	300,600
Other Countries*	-	15	-	261,000
Total	2	120	80	3,625,380
+10% Buffer				362,538
Total				**3,987,918**

**Countries for which only one IOM-run primary health centre was identified include Pakistan, Kenya, Indonesia, Burundi, Tanzania, Zimbabwe, Philippines, and Sudan.*

***The CAPEX estimate based on figures provided by UNICEF accounts for the cost of the equipment as per UNICEF's supply catalogue, the cost of the installation, the international and in-country logistics and transportation costs, the cost of complete re-wiring of the facility, and the cost of providing lighting at the facility level. The OPEX estimate includes the cost of communications for remote monitoring and the cost of battery replacement, including the physical battery and related replacement works. Note that while these estimates are based on experience from a large sample size of 2,000 facilities spread across four countries (Zambia, Ethiopia, Pakistan and Uganda), costs may still vary significantly across countries and regions, particularly given the specific characteristics of different fragile and hard-to-reach humanitarian settings. Other operational expenditures may also arise.*

[4] WHO, World Bank, SEforALL and IRENA (2023) "Energizing Health: Accelerating Electricity Access in Health-Care Facilities."

Call to Action

Humanitarian and development partners, donors and financiers, policymakers, and communities must act urgently to deliver reliable electricity access to the 176 facilities identified in this research and, more broadly, support the solarisation of the over 93,350 health facilities in sub-Saharan Africa that have either no access, or unreliable access, to electricity.

This briefing provides an evidence-based framework for estimating lifetime costs and long-term savings of solarising health facilities in humanitarian settings. Additionally, the Briefing on Healthcare Electrification in Humanitarian Settings provides detailed recommendations on how partners can work together to realise the environmental and financial benefits of healthcare solarisation in humanitarian settings.

Furthermore, the GPA calls for all relevant stakeholders to develop three key mechanisms and partnerships for closing the humanitarian healthcare electrification gap:

Pooled O&M Financing Facility: Many health facilities that have already been solarised lack reliable electricity access today because sufficient planning and funding for long-term O&M were not put in place at the outset. In some contexts, O&M funds can be effectively mobilised by integrating the humanitarian health facilities into national health services and transferring the associated O&M funds to the appropriate authority. However, national healthcare funding may be limited and the resources available, if not earmarked, could be reallocated to higher priority activities, leaving solarised facilities in hard-to-reach settings without long term O&M. Partners must, therefore, come together and pool funding to cover long-term O&M in instances where alternative mechanisms are not available or under development. This would not only ensure the long-term operations of the systems installed but could also be utilised to build local capacity to undertake O&M activities in the solar sector more broadly. Flexible, long-term financing structures, such as a multi-partner trust fund, should be explored for application to this challenge.

Establish a Global Task Force: The current pace of health facility electrification in humanitarian settings is too slow in part because projects are usually developed in an ad-hoc and decentralised manner. Decentralised implementation is essential for navigating in-country complexities and building the capacity of the local solar and health sectors. However, centralized monitoring and bundling of assessments, fundraising, and procurement can pool resources and reduce costs through economies of scale. A Global Task Force, supported by an existing Coordination Platform, should be established to track the electricity access status of humanitarian healthcare facilities and help countries identify the most efficient pathway for solarising facilities in a given location.

Data Collection Partnerships: Better quality data on in-country solar installation costs for humanitarian health facilities in different contexts is essential to more accurately communicate investment needs and potential savings to humanitarian organisations, donors, and financiers. Opportunities to improve on-the-ground pricing and supplier data, via existing mechanisms, such as the WREC Coalition's supply chain mapping activities, should be explored. The results of this work can then be fed back into the aforementioned Global Task Force for broader dissemination and use.

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Annex A – Detailed Methodology and Limitations

1. Data Collection

Health facility electricity needs were identified based on data inputs from field-based technical staff who had visited the sites and/or conducted recent needs assessments via complementary programmes. Partners consulted included NORCAP energy experts deployed to UNHCR and WHO offices across multiple countries, and IOM staff managing health facilities in several countries.

2. Facility Energy Demand and Investment Cost Estimations

The energy needs of the identified health facilities were categorised based on standardised profiles of public health facilities developed by WHO et al. The report provides daily energy consumption ranges for different facilities based on the number and type of services delivered, which were used as a benchmark for appropriately sizing solar systems. More details regarding the expected load and peak demand of each facility level are provided in **Annex B.**

Facility Type/Level	Estimated Daily Electricity Consumption
Health Post (L1)	1.9 kWh – 4.5 kWh
Primary Health Centre (L2)	10 kWh – 18.4 kWh
Small Hospital (L3)	39.6 kWh – 54 kWh

Cost estimates for the systems needed for the power demand of each facility type were based on the UNICEF supply catalogue,[5] which provides full costs for five integrated solar PV solutions including panels, batteries, and inverters. The inverter capacities range from 1.5 kW to 10 kW.

The CAPEX and OPEX estimates are based on figures provided by UNICEF's supply division from experience installing solar systems at 2,000 comparable facilities across sub-Saharan Africa via the Cold Chain Equipment Optimisation Platform jointly implemented by Gavi, UNICEF, and WHO, with technical support from SELCO Foundation. Capital expenditures considered include the cost of the equipment as per UNICEF's supply catalogue, the cost of installation, international and in-country logistics and transportation costs, the cost of the complete re-wiring of the facility, and the provision of lighting at the facility level. Operational expenditures considered include the cost of the communication for remote

[5] UNICEF empanels multiple Long-Term Agreement (LTA) holders for solar systems in different regions. It shares the indicated pricing of products which is based on a median and hence actual pricing is confirmed only at time of ordering. The indicated price is based on a ground-mounted structure. UNICEF accounts for more than 20%of all UN global procurement, the largest share of any entity. Nearly 80% of UNICEF's supplies are procured in collaboration with other UN agencies and other humanitarian and development partners.

monitoring of installed systems and the cost of battery replacement including the physical battery and related installation works.

Limitations and Opportunities for Further Research

First, the final investment cost estimate encompasses system purchase, on-site installation, transport, re-wiring and remote monitoring. It may not reflect important additional costs that would be incurred in practice, including additional transport and logistics costs and country-specific costs. Additionally, while the estimates used are based on UNICEF's experience from a large sample size of 2,000 facilities electrified by UNICEF, Gavi, and WHO across four countries (Zambia, Ethiopia, Pakistan and Uganda), actual costs may still vary significantly across countries and regions, particularly given the specific characteristics of different fragile and hard-to-reach humanitarian settings. Thus, actual CAPEX and OPEX investment costs for a given system may be higher and depend on the individual country and site context.

Second, for the sake of simplicity, it was assumed in the calculations that all 176 facilities identified would require first-time solarisation or full replacement of an existing system. However, 75 of the facilities have limited access to solar energy from systems that are either inadequately sized or poorly maintained. The cost of expanding or refurbishing existing facilities was not considered. In particular, the costs of solarising these facilities may be lower than estimated if existing systems can be refurbished or existing parts reused.

Annex B – Example Healthcare Facility Types

Level	Facility Type	Example Healthcare Services Offered	Load Sources / Equipment	Maximum Load (kW)	Daily Demand (kWh)
L1	**Health Post**	Out Patient Departments/ Examination room + minimal utility and administrative areas	Basic loads like lights, fans, laptop, wi-fi	0.67 - 1.38	1.9 - 4.5
L2	**Primary Health Centres**	Out Patient Departments/ Examination room +	Basic loads + Phototherapy, radiant warmer, suction, microscope, centrifuge, nebulizer, needle	4.62 - 7.87	10 - 18.4

		labour room, laboratory, minor operation room, cold chain, pharmacy, immunization room, emergency room, male and female wards, nurses room + utility and administrative areas	cutter, ice lined refrigerator, deep freezer, oxygen concentrator, ECG machine, spotlight		
L3	**Small Hospitals**	OPD, examination room + laboratory, operating theatre (including deliveries, newborn care), prenatal care, immunization room, emergency room, prenatal care, blood storage room, NCD room, dental care + utility and administrative areas	Basic loads + Phototherapy, radiant warmer, suction, microscope, centrifuge, nebulizer, needle cutter, ice lined refrigerator, deep freezer, oxygen concentrator, ECG machine, spotlight + Cardiac monitor, ultrasound, phototherapy, blood bank refrigerator, CBC machine, TSH machine, digital centrifuge, biochemistry machine, dental chair with equipment, rapid molecular tests machine	13.7 - 19	39.6 - 54