STRENGTHENING HEALTHCARE DELIVERY SYSTEMS IN LOW- INCOME COUNTRIES

Zerin Osho and Jagjeet Sareen

Introduction

As more and more African countries report spikes in their respective COVID-19 counts, there is a substantial increase in the number of reported cases from areas beyond capital cities (WHO, April 2020b). With over 8,500 new cases between 6 and 7 December 2020, Africa has a cumulative COVID-19 patient count of more than 1.5 million to date (WHO, December 2020c). The World Health Organization (WHO) estimates that if containment measures fail, over 190,000 people could die of coronavirus in Africa (WHO, May 2020a). Access to a reliable electricity supply and a cold chain infrastructure in healthcare centres is critical for marshalling an effective response to tackle COVID-19. However, roughly 70% of SSA health facilities do not have access to reliable electricity, and one in four health facilities have no electricity at all (Adair-Rohani, Heather *et al.*, 2013). On the other hand, 1.5 million children are lost to vaccine-preventable diseases each year due to lack of a reliable vaccine cold chain network (SEforAll, 2020a).

The deployment of off-grid solar energy projects to power primary healthcare centres (PHCs) and the use of solar-powered cold chains for safe vaccine storage and last-mile distribution can help in building an effective healthcare delivery mechanism across low-income countries. At the International Solar Alliance (ISA), global efforts are being galvanised through the ISA Cares Initiative to provide financial and technical support to low-income countries for solarising PHCs and for the development of solar-powered cold chains. This would scale up the capacity of PHCs in LDCs to respond to the pandemic effectively. This chapter will:

1. Examine the current state of healthcare infrastructure across low-income countries.
2. Explore how healthcare delivery in these countries can be strengthened despite having no access to reliable electricity.
3. Consider the solarisation of health centres to significantly reduce COVID-19 fatalities and ease the patient load on provincial health centres.

Current state of healthcare infrastructure across low-income countries

Reliable electricity ensures that basic sustenance measures like fresh water, air conditioning, vaccine and blood refrigerators, lights and cell phone chargers are available, and that first responders to COVID-19 have adequate lighting to see patients and to safely use personal protective equipment such as masks, gloves and gowns. Despite significant steps, approximately 600 million people lack access to electricity in sub-Saharan Africa alone (SEforAll, 2019). On average, one in four health facilities in the SSA region has no access to electricity (World Bank and WHO, 2015). A study suggests that only 28% of health facilities and 34% of hospitals had access to “reliable” electricity (reliable in this context meaning without prolonged interruption in any given week) (*ibid.*). In the absence of grid connectivity, or a reliable source of electricity, the use of diesel generators to meet energy demands in PHCs is a common practice (World Bank, 2020). Combustion of diesel causes $PM_{2.5}$ emissions that cause public health crises such as cardiovascular diseases, cancers, respiratory illnesses and even premature deaths (CARB, 2015). Research has confirmed that $PM_{2.5}$ emissions increase the rate of mortality in COVID-19 patients (Pozzer *et al.*, 2020). Estimates suggest that operating and maintaining diesel generators can cost up to 20% of the operating expense of PHCs that are already cash-crunched due to COVID-19 (World Bank, 2020). Diesel is also a source of black carbon emissions that are categorised as Short-Lived Climate Pollutants (SLCPs) (WHO, 2015a). Increased reliance on diesel may put PHCs in the difficult situation of having to decide between continuous electricity service and purchases of necessary medical supplies. Mitigation of SLCP emissions can reduce global warming by 0.4–0.5°C by 2040–2050 (World Bank, 2013). WHO estimates that SLCP emissions have significantly contributed to more than 7 million premature air pollution-linked deaths annually (WHO, 2015a).

Without reliable energy, even the most fundamental medical services cannot be provided. For instance, in Tanzania, only 28% of immunisation health facilities have access to grid electricity (WHO and UNICEF, 2017). Desperate attempts to use fossil fuels to power health centres and vaccine refrigerators for a prolonged period cause localised air pollution, and increases fatality in COVID-19 patients (Pozzer *et al.*, 2020). Each year, approximately 31 million children suffer from vaccine-preventable diseases, and more than a half million die due to lack of access to vaccines in the SSA region (WHO, 2019). Most vaccines need to be transported and stored between 2 and 8°C (WHO, 2015b). Cold chain disruptions cause the wastage of approximately 50% of freeze-dried, and 25% of liquid vaccines annually (SEforALL, 2020a). Lack of a reliable energy supply and access to cooling has historically forced health providers in SSA countries to use “absorption refrigerators” (Path and WHO, 2013). Powered by kerosene or

gas, absorption refrigerators cause high localised pollution, are expensive to operate and maintain, and run the high risk of exposing vaccines to freezing temperatures (WHO and UNICEF, 2017). Accidental freezing of vaccines can be fatal. In 2017, improper storage of measles vaccines in South Sudan claimed the lives of 15 children (Rao, 2020). According to a study in 2014, GAVI reported that roughly 90% of health facilities lacked adequate cold chain equipment in GAVI-eligible countries (GAVI, 2020).

As pharmaceutical giants such as Pfizer, Moderna and University of Oxford/Astra Zeneca applied for emergency use authorisation of their COVID-19 vaccines, national governments and global health organizations prepared to develop an extensive vaccine delivery network. Though some of the vaccines required ultra-low temperatures, most could be stored, transported and administered at 2–8°C between 5 and 10 days (SEforALL, 2020b). The success of immunisation efforts depends in large part on maintaining cold chains.

Solar energy as a force multiplier for an effective COVID-19 response

Access to reliable energy cannot remedy the structural weaknesses of health-care systems in low-income countries alone, but it is a key component in the overall delivery of healthcare. The use of off-grid solar energy to power PHCs and vaccine refrigerators can help in marshalling an effective response to the COVID-19 pandemic whilst achieving other developmental co-benefits.

Solar energy is reliable and affordable. With technological progress, the overall costs of solar off-grid solutions have reduced significantly (IRENA, 2016). Distributed solar power projects have been the backbone of electrification initiatives in low-income countries over the past decade (GOGLA and World Bank, 2020). The off-grid solar market currently serves 420 million people, most of whom reside in the SSA region (*ibid.*). Use of distributed solar, as a stand-alone solution in smaller health facilities, or as a hybrid solution for larger hospitals, can deliver more reliable, sustainable and affordable power for health facilities (Box 3.1). For small and medium-sized PHCs, a hybrid solar-diesel system can achieve lifetime savings on an order of 75–80% while ensuring a reliable power supply (World Bank and WHO, 2015). Solar energy as a reliable and affordable source of power is gaining traction. In Uganda, for example, approximately 15% of hospitals and 2% of other health facilities use the solar and grid hybrid model.

Off-grid solar can power PHCs to deliver life-saving healthcare while achieving Sustainable Development Goals. Off-grid solar solutions offer a clean, cost-effective, and reliable option for the electrification of PHCs while achieving the following Sustainable Development Goals (SDGs) – SDG 1: No poverty; SDG 3: Good health and well-being; SDG 5: Gender equality; SDG 6: Clean water and Sanitation; SDG 7: Affordable and clean

Box 3.1 Case study

Solar energy powers hospitals in Afghanistan to save lives of COVID-19 patients

Prolonged power outages in Herat, Afghanistan, risked the lives of COVID-19 patients that were dependent on medical appliances such as electric ventilators and other respiratory devices for breathing. Herat recorded the second-highest number of COVID-19 cases after the state capital, Kabul. As the pandemic hit the province, Afghanistan's national power utility company Da Afghanistan Breshna Sherkat (DABS) installed solar panels across ten hospitals in Herat to provide emergency power. The project was financed by the Herat Electrification Project in June 2020 and was capable of generating 75 kW of reliable energy to power operation theatres, critical COVID-19 equipment such as ventilators, defibrillators, and other patient monitoring devices. In Herat's Shaidayi Children's hospital, 36 solar panels were installed to generate 10 kW of energy to power the Intensive Care Unit (ICU) and 14 ventilators and lights to manage critical patients suffering from coronavirus. Similarly, 34 solar panels were installed in Obei Hospital that provide 10 kW of energy to power all the departments of the hospital.

Source: World Bank (2020)

energy; SDG 10: Reduced inequalities; SDG 11: Sustainable cities and communities; and SDG 13: Climate action.

Solar-powered cold chains can help develop an equitable COVID-19 vaccine delivery mechanism. Access to reliable energy is critical for the elimination of vaccine-preventable diseases and to combat COVID-19. For protection against COVID-19, approximately 4.7–5.5 billion people, which represent 60–70% of the global population, would have to be inoculated through a vaccine to achieve herd immunity (WHO, 2020d). Currently, due to the lack of access to reliable energy at PHCs in low-income countries, vaccine refrigerators are powered through kerosene-based absorption refrigerators (WHO and UNICEF, 2017). Absorption refrigerators often expose vaccines to freezing temperatures, making them unstable and fatal for use (Rao, 2020). Furthermore, supplies of kerosene to power these refrigerators is subject to disruptions, making them unreliable for delivery of COVID-19 vaccines. The adoption of solar-powered direct drive (SDD) refrigerators can help build an effective vaccine delivery mechanism while mitigating greenhouse gas (GHG) emissions (Box 3.2). Even in terms of the overall annualised cost of ownership, SDDs are cheaper than kerosene-based vaccine refrigerators (WHO and UNICEF, 2017).

Box 3.2 Case study

Senegal uses solar powered vaccine refrigerators

Prolonged power outages and failures of backup generators in Senegal have risked the safety and stability of vaccines. 15 SunDanzer solar refrigerators were installed at PHCs in Podor, Pete, and Richard Toll districts in the northern part of the country. It was observed that SunDanzer designed a unique solar installation – with the two solar panels facing East and West, respectively. This design helped the facility generate power earlier than other comparable facilities, which did not generate power until late in the evening. It was reported that all refrigerators performed reliably for over a year with no serious technical glitches. The remote temperature monitoring data revealed that all refrigerators cooled consistently even when they were in regular use and being opened frequently for vaccine storage and removal. On analysis of the combined data, it was found that the refrigerators maintained their target temperature range of 2–8°C nearly 99% of the time.

Source: WHO, PATH and Optimize (2013)

ISA Cares Initiative proposes to solarise primary healthcare centres in Africa to enable round the clock quality healthcare services. The International Solar Alliance (ISA) launched its ISA Cares Initiative at the Third ISA Assembly in response to the humanitarian crisis caused by COVID-19. Through this initiative, ISA aims to solarise one PHC in every district of 42 Least Developed Countries (LDCs) and Small-Island Developing States (SIDS) member countries from the African region. This initiative will solarise in total, 1,260¹ PHCs across the targeted member countries of ISA. The initiative will help PHCs to deliver basic medical procedures to reduce patient load on provincial health centres while expanding diagnostic and testing facilities. Access to energy and lighting by solarisation of PHCs will allow for longer operational hours in a day and help health facilities run sterilisation and refrigeration appliances for better prevention. To implement this initiative and expand its coverage, ISA will raise USD 150 million jointly with UNAIDS and Health Innovation Exchange (HIX). To further reduce the overall cost of the initiative, maintain quality standards and build localised capacity, ISA will aggregate the overall demand from LDC and SIDS countries, empanel experts and enterprises to ensure quality control, and host regular training programmes to build local capacity for adequate operation and maintenance.

Key takeaways

- Recovery from COVID-19 has given the world an unprecedented opportunity to build back better.
- Improvement in energy infrastructure to better serve health facilities can strengthen the global response to COVID-19 while achieving developmental co-benefits.
- The elimination of coronavirus is a mammoth task for which access to energy is a quintessential requirement.
- Solarisation of health centres can significantly reduce COVID-19 fatalities and ease the patient load on provincial health centres. Similarly, solar-powered cold chains are adept at delivering vaccines safely to rural communities in remote areas.
- The implementation and expansion of multilateral efforts such as ISA Cares initiative can help in building climate-resilient energy infrastructure to serve PHCs in low-income countries while achieving SDG 7.

Note

- 1 Assuming each LDC and SIDS country has 30 districts on average.

References

- Adair-Rohani, H., Zukor, K., Bonjour, S., Wilburn, S., Kuesel, A.C., & Hebert, R., Fletcher, E.R. (2013). Limited electricity access in health facilities of sub-Saharan Africa: a systematic review of data on electricity access, sources, and reliability. *Global Health Science and Practice*, 14;1(2):249–261. doi: 10.9745/GHSP-D-13-00037. PMID: 25276537; PMCID: PMC4168575.
- CARB. (2015). Summary: Diesel particulate matter health impacts. *California Air Resources Board*. <https://ww2.arb.ca.gov/resources/summary-diesel-particulate-matter-health-impacts>
- GAVI. (2020). Cold chain equipment optimisation platform. *Gavi the Vaccine Alliance*. <https://www.gavi.org/sites/default/files/publications/Cold-chain-equipment-technology-guide.pdf>
- GOGLA and World Bank. (2020). Off-grid solar market trends report 2020. *Lighting Global, World Bank Group*. https://africa-energy-portal.org/sites/default/files/2020-02/14005VIV_OFF-GRID-SOLAR-REPORT-V13-Exec-Sum-AW4vis.pdf
- IRENA. (2016). Solar PV in Africa: Costs and markets. *International Renewable Energy Agency*. <https://www.irena.org/publications/2016/Sep/Solar-PV-in-Africa-Costs-and-Markets>
- PATH and WHO. (2013). Direct-drive solar vaccine refrigerators – A new choice for vaccine storage. *Optimise Evidence Brief*. https://www.who.int/immunization/programmes_systems/supply_chain/optimize/direct_drive_solar_vaccine_refrigerator.pdf
- Pozzer, A., Dominici, F., Haines, A., Witt, C., Münzel, T., Lelieveld, J. (2020). Regional and global contributions of air pollution to risk of death from COVID-19. *Cardiovascular Research*, 116(14), 2247–2253. doi: 10.1093/cvr/cvaa288

- Rao, R. (2020, April 21). Why a strong cold chain is more critical than ever to defeat COVID-19. *Devex Global Views*. <https://www.devex.com/news/sponsored/opinion-why-a-strong-cold-chain-is-more-critical-than-ever-to-defeat-covid-19-97026>
- Sustainable Energy for All (SEforALL). (2019). Electricity for All in Africa. *SEforALL*.
- Sustainable Energy for All (SEforALL). (2020a). Chilling prospects: Providing Sustainable Energy for All. *SEforAll*. https://www.seforall.org/sites/default/files/SEforALL_CoolingForAll-Report.pdf
- Sustainable Energy for All (SEforALL). (2020b). Cooling for all: The role of cold chain in delivering a COVID-19 vaccine. *SEforALL, University of Birmingham, Nexleaf Analytics, the International Institute for Energy Conservation, and the Basel Agency for Sustainable Energy*. <https://www.seforall.org/system/files/2020-11/Medical-Cold-Chains-Briefing-Note-SEforALL.pdf>
- WHO. (2015a). Reducing global health risks through mitigation of short-lived climate pollutants: Scoping report for policy makers. *World Health Organisation*. <https://apps.who.int/iris/handle/10665/189524>
- WHO. (2015b). The vaccine cold chain. *WHO*. https://www.who.int/immunization/documents/IIP2015_Module2.pdf
- WHO. (2019). Experts caution against stagnation of immunisation coverage in Africa. *WHO Regional Office for Africa*. <https://www.afro.who.int/news/experts-caution-against-stagnation-immunization-coverage-africa>
- WHO. (2020a, May). New WHO estimate: Up to 190,000 people could die of COVID-19 in Africa if not controlled. *WHO Regional Office for Africa*. <https://www.afro.who.int/news/new-who-estimates-190-000-people-could-die-covid-19-africa-if-not-controlled>
- WHO. (2020b, April). COVID-19 pandemic expands reach in Africa. *WHO Regional Office for Africa*. <https://www.afro.who.int/news/covid-19-pandemic-expands-reach-africa>
- WHO. (2020c, December). WHO Coronavirus COVID-19 Dashboard. *WHO Health Emergency Dashboard*. <https://covid19.who.int/>
- WHO. (2020d). Science in 5, Episode #1: Herd immunity: A conversation with Dr. Soumya Swaminathan. *WHO Media Resources*. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/media-resources/science-in-5/episode-1>
- WHO and UNICEF. (2017). Solar direct drive vaccine refrigerators and freezers. *WHO and UNICEF Evidence Brief*. <https://apps.who.int/iris/bitstream/handle/10665/254715/WHO-IVB-17.01-eng.pdf;sequence=1>
- World Bank. (2013). Integration of short-lived climate pollutants in World Bank activities. *The World Bank*. <https://documents1.worldbank.org/curated/en/972571468326204977/pdf/804810WP0G80Re00Box0379805B00OUO090.pdf>
- World Bank. (2020). COVID-19 emergency power supply response. *World Bank Strategy Note – Draft for Consultation*. <https://www.seforall.org/system/files/2020-04/COVID19-emergency%20power-supply%20strategy-note.pdf>
- World Bank and WHO. (2015). Access to modern energy services for health facilities in resource-constrained settings: A review of status, significance, challenges and measurement. *World Health Organisation*.