COVID-19 Emergency Power Supply Response

STRATEGY NOTE -- DRAFT FOR CONSULTATION

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Contents

Electricity for health care facilities in the COVID19 pandemic

COVID19 presents unique and severe challenges to health care systems in World Bank client countries and around the world. The World Bank and UN are committing billions of dollars in emergency support to governments to prepare for the ongoing spread of the pandemic, including the purchase of ventilators and oxygen supplies, and ramping up staff where possible, and to manage the economic impact of the crisis. A reliable electricity supply is among one of the many requirements that must be in place for a country's health care system to address the crisis. The purpose of this note is to explore how the electricity sector can contribute to the COVID-19 response especially in the initial phase. (The note does not cover the impacts of the crisis on the energy sector, nor the role of the energy sector in the recovery phase).

Peak cases for COVID-19 are expected to occur in countries at different points in time in coming weeks and even months. The current initial wave may be followed by a second wave in the latter half of 2020. The World Bank can play a critical role in addressing the urgent electricity needs for hospitals and clinics during the COVID-19 crisis. Given the urgency to act, available funding in existing operations and/or the emergency operations should be pursued where feasible. In the future, new operations can be used to build on the fast response investments carried out now. While this note outlines some key areas of attention needed, the actual investment program needs to be designed at the country level to respond to the country needs and should be carried out through a close coordination between the energy and the health teams. In the first phase, because of the urgency, all options should be on the table and bureaucratic hurdles minimized so that any appropriate resources can be mobilized.

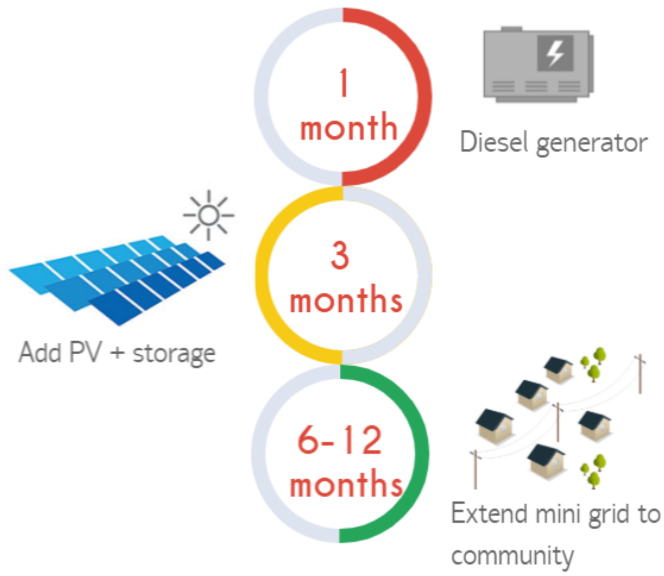
Solutions can be distinguished according to the site's power demands and supply options, taking into account unique needs for COVID-19 response. Power demands range from large urban hospitals served by unreliable grids to unelectrified rural clinics with few resources, and include non-clinic needs such as testing labs and cooling for warehouses. A range of medical countermeasures with different power requirements will be appropriate for different contexts based on available medical equipment, human resources and other resources. Power supply options include some combination of diesel generators (subject to fuel supply), batteries and inverters, and solar PV. Pre-packed “box solutions” of solar+storage of various sizes can ship immediately. This note provides an overview of key considerations for World Bank teams and their clients on these issues, and provides resources including user-friendly tools for system design, possible providers, as well as template terms of reference (TOR).

Urgency, resilience and sustainability

We are competing against an exponential curve, and it is important to implement the first round of solutions in weeks, not months, otherwise the opportunity to help meaningfully will have passed. For every health care facility, For many clinics, the urgent need for reliable electricity can be most quickly met by diesel generators. However, speed should not be the only consideration: electricity supply solutions, because they support life-saving apparatuses and processes, need to carefully consider resilience to supply disruption risks, and redundancy in this case may be beneficial. Diesel fuel supply is already a significant risk in many of our client countries and will likely be more so during this global crisis which could last over a year.[1] Fuel normally comes out of health care facility operational budgets, which will likely be heavily constrained under COVID19. In some cases, fuel costs for diesel-powered clinics can constitute up to 20% of their operating expenses.

Whatever is installed will remain after the crisis, so it is important to think of sustainability in the design process, particularly for those systems that will be installed on permanent facilities. Diesel electricity is very expensive in the long run, and it is important not to leave hospitals with systems that they will not be able to afford to operate, or will have to make decisions that compromise health care because the high cost of diesel or lack of diesel availability means that power is only available several hours per day.

[1] Other measures to mitigate fuel supply risk such as large fuel storage depots create their own problem with risk of theft and fire hazard.



In many cases, an optimal solution will be to rapidly procure solar-diesel hybrid systems with battery storage, with the diesel generator portion of the system installed first, if necessary, to take up urgent load. The solar + storage components installed can be in subsequent days or weeks. This provides urgent electricity to the clinic in the short term, while removing the medium- and long-term fuel supply risk from the clinic's healthcare delivery supply chain. Installed as part of an optimized solar electric system, the diesel generator serves an emergency need and is also a building block in a system that provides 24/7 electricity at the lowest cost. This, in turn, can form the backbone for a community mini grid when the COVID crisis is over.

Electricity needs will vary significantly depending on the size of the clinic and whether the facility has grid power. While the situation may vary across countries, for the purpose of this note, we divide health facilities into four groups: (i) hospitals, which are typically in urban areas and likely to have grid power (though often intermittent); and (ii) rural clinics, primary health centers, small rural hospitals mostly in secondary towns and rural areas, often with poor or no grid power; and (iii) emergency temporary COVID19 facilities, often with unreliable or no grid electricity; and (iv) non-clinic needs such as warehouses and testing facilities.

Hospitals (on-grid, but often with intermittent supply)

It is expected that select hospitals (especially larger ones with at least 200 beds) in urban areas will be designated to treat COVID19 patients. In many cases these will have electricity supplies from the national grid and already have diesel backup generators. In others, there is no grid electricity, and the hospital has long used generators. Designing interventions to ensure reliability of supply requires a quick energy audit (see Box below) for each site, with contracting for this supported by a [Technical Assistance template TOR for medical facility electricity audits].

Box: Electricity audit

Key considerations for the energy audit include:

1. What is the facility's current source of electricity and how is it perceived in terms of reliability, cost and service quality?
2. What are the expected "regular" and "priority" electricity needs in the facility? Create a table of the total quantity, the "priority" quantity (that quantity that is necessary to keep running even in a power outage), the power consumption of the appliance, and hours per day each medical and non-medical appliance is used. Cross-check the aggregate total of monthly kWh

against utility bills, if they exist. Determine if high priority loads should be isolated on a separate circuit from low-priority loads.

Table 1: Appliance power consumption and usage hours data for electricity audit, with examples.

Equipment	**Total quantity of each**	**Priority quantity in power outage**	**Power (watts)**	**Daytime hours (7:00 to 17:59)**	**Evening hours (18:00 to 21:59)**	**Night hours (22:00 to 06:59)**
Vital monitor (GE-Dinamap V-100)	20	20	12	12	4	8
LED lighting	15	10	5	0	4	9

3. What are needed related electrical services such as water pumping and basic electricity for medical staff housing that could be addressed with auxiliary installations?
4. What is the reliability of electricity supply from the grid? How many hours per day is electricity not available on average? How many blackouts per day? How many hours per day is the generator run, if applicable?
5. Does the facility have a backup power supply? If diesel generator, what is capacity (kVA). If battery / inverter or solar PV, what is the battery kWh and inverter kVA and solar array kWp?
6. If diesel generators are used, what is the reliability of diesel fuel supply? How many liters of diesel fuel is stored onsite? What is the assessment of the availability of diesel as the infections and economic impacts of COVID19 spread? Is the diesel in working order? If not, what cost estimate to repair it?
7. What are the hospital facility staff or auditor's assessments of the electric power-related gaps that need to be filled?
8. To help determine if a solar array could be considered, what space is available to deploy a solar array? Measure area and distance from electricity mains panel, take photos of available area. Provide latitude and longitude and Google maps satellite image.

In urban areas with grid electricity that experiences interruptions, diesel backup generators, battery/inverter solutions, or hybrid PV/battery/diesel are all viable and much depends on what can be installed in advance of the surge of cases. In battery/inverter systems the battery charges up when electricity is available, and automatically switches over to inverted battery power when there is an outage. If suitable space is available for solar panels (on rooftops, carports, surrounding fields) these should be considered as an integral part of the system to lower risks from diesel fuel supply shortages, protect against power outages, and lower hospital energy bills.

At the level of individual crucial medical devices, a solution may also include individual Uninterruptible Power Supply (UPS) units, if available. This may be particularly crucial for ventilators. For facilities that have air conditioning, air conditioning will be a very significant load. Solar electricity is coincident with daytime peak air conditioning load and can substantially reduce costs including diesel costs when the air conditioning is otherwise powered by diesel generators.

Rural Clinics, Primary Health Centers, Small Hospitals (off-grid or on-grid with unreliable supply)

Rural clinics, primary health centers and small rural hospitals that are not assigned treating COVID19 patients should be included in the emergency response where possible. These clinics and health centers are still in the frontline of the fight against the pandemic as they are often the only place that sick patients can access in rural areas. As major hospitals focus on COVID19, these facilities will also need to treat other patients, including those that would typically be referred to hospitals. They are likely to provide palliative care, and possibly serve as referral clinics for more severe cases. Moreover, these clinics and health centers will gain more prominence if the pandemic spreads to rural communities; hence it is essential that they are also well-equipped.

These are more likely to be in areas with no national grid, or if grid electricity is available it is likely to be less reliable than in more urban areas. Many have no electricity of any kind. If electricity can be made available, the main COVID19 loads are likely to be ventilators, bedside monitors, lighting, and bedside oxygen concentrators. Power supply requirements are considerably lower than for large hospitals. At these sites it is more likely there will be adequate space for solar arrays. Diesel fuel supply chains will likely be more fragile and grid extension would be unviable. For all these reasons, standalone (off-grid) solar electric systems will likely be an appropriate solution, if they can be installed relatively quickly.

Electricity requirements for these can be estimated via filling out data in table 1, or (considerably less accurate but faster) can be estimated on a per-square meter basis. As a very rough estimate or reference, assume 10 to 16 watts per square meter of clinic space for a basic clinic with triage, suspect wards and isolation wards. For a clinic with the above plus some lab ability and limited ICU beds assume 25 to 40 watts per square meter. As another reference point, many Sub-Saharan countries are planning health centers of 5 kW and health posts of around 2.5-3 kW. For more, see Sample bidding documents and technical specifications for solar electric systems for medical facilities in client countries.

Communication to and from these rural clinics will be important. We suggest providing solar home system (SHS) kits (that can power lighting, phone charging and small appliances) together with a laptop to all field doctors and nurses, so that they can be at least appropriately connected with the health authorities and hospitals and benefit from emerging best practice in fighting the virus. These could be quickly sourced from off-grid solar companies operating in the country, ideally equitably to support all of them, but depending also on their available supply, how quickly they can deliver.

Also, cost and time permitting, remote monitoring systems should be considered to enable off-grid companies to track performance of the standalone units and SHSs and troubleshoot issues remotely. Remote monitoring would significantly contribute to resilience in responding to O&M issues and sustainability of the systems in the long-term. Companies such as Schneider and Victron are appropriate reference points in the industry. Where sufficient supply is available, we recommend limiting these products to those that are quality assured through Lighting Global to ensure quality and sustainability. Lastly, when customer feedback mechanisms (e.g. call centers) have been established under the ongoing off-grid programs, these can be used for conveying preventive information on Covid 19 and advice for emergency response. In some cases, it may also be possible to use the established logistics channels of off-grid companies to ship goods (e.g. sanitizers, protective equipment etc.) to rural areas.

Temporary Emergency COVID19 Facilities

Temporary emergency facilities for processing COVID19 patients are expected to be set up in many client countries. These will serve as isolation wards for suspected cases and for confirmed cases, with facilities for treatment of acute cases. These will often be built adjacent to existing hospitals, with screening facilities to separate COVID-suspected patients from non-COVID cases. Because of the urgent and temporary nature of these facilities, electricity supply from diesel generators is expected to generally be the appropriate choice if adequate grid power is not available.

Non-clinic Facilities: cold chain, testing labs, and other critical facilities

Certain promising drugs for COVID19 treatment and any eventual vaccine will need cold-chain facilities that keep them chilled in all stages from production to final delivery in village clinics. This will require reliable 24/7 electricity to power cooled warehouses and refrigeration down to the level of clinics and dispensaries. Where the grid is not available, cooled warehouses will be most cost-effectively served by 24/7 electricity from hybrid solar/diesel systems. Where grid electricity is available but not reliable, battery/inverter systems or backup generators will be needed. At the level of clinics and dispensaries, highly reliable direct-drive solar vaccine refrigerators can keep vaccines and medicines cool without the need for batteries. Testing is proving to be essential in the fight against COVID19, and laboratories will require electricity to process test samples and communicate results. Masks and other personal protective equipment – essential for healthcare workers encountering COVID19 patients – is in limited supply worldwide. As a result, local workshops and factories will need to produce additional supplies. These factories will need electricity to operate sewing machines and other equipment. Finally, government buildings coordinating COVID-19 response (including facilities outside the capital coordinating sub-nationally) would also be candidates for priority support in terms of guaranteeing 24/7 electricity.

Medical clinic system design tools

Data collected from appliance usage surveys (Table 1 above), together with solar resource information can be used to quickly design optimized hybrid solar/diesel/battery systems using the tools referenced below.

USAID Powering Health online HOMER design tool for clinics (note: HOMER is in the process of updating this tool to include likely COVID19 appliances, including in consultation with WB staff and other experts).

Spreadsheet design tool for clinics developed by Humboldt State University

A slide deck on *template modular PV mini-grid system design as emergency response for rural communities* is available here.

Ensuring quality for solar electric systems and battery/inverter systems

In addition to being properly sized, a system needs to be built to reasonable quality standards to ensure it works properly and does not present electrical hazards. This medical clinic PV system quality assurance document[2] covers equipment quality for medical clinic electricity supply systems. HSU is working to adapt the current version to a "triage" version.

Box solutions vs. component-based systems

A number of companies provide pre-packaged solar electric systems and microgrids that can ship quickly and once on site can be deployed in several days or less. Our team is developing a large and growing list of pre-packaged solar and storage as well as microgrid suppliers in countries around the world. Many of these companies have significant inventory and are ready to ship. These generally have higher quality assurance and lower need for troubleshooting than component-based system. As such, these will be an excellent resource, especially deploying in areas where COVID19 presents logistical challenges to on-site construction.

Table 2: A sample of pre-packaged solar plus storage solutions, from a list of over 20. Note: listing does not connote endorsement.

Company	PV Size	Product specifications	Country of origin	Inventory as of 4/7/2020	Website	Notes	Company Contact
Tesla	L	PowerPack Skid: Solar PV: 250 kWp Battery storage: 1MWh Mobile Powerwall: Solar PV: 10kWp Battery storage: 27 kWh	USA	20 packs (10 kWh – 40 kWh) and 5 skids (250 kWh – 1 MWh) could ship immediately. 500 within a month.	www.tesla.com/energy	20 ft containers	sbordenave@tesla.com
Aggreko	L	Solar PV: from 1MWp Battery storage: Diesel generator:	UK		www.aggreko.com	Available for rent, strong logistics	
General Electric	M	30 kW PV or 15 kW PV, battery 53 to 96 kWh	USA		www.ge.com		
Schneider Electric (Villaya Emergency)	M	Solar PV: 7 kWp to 65 kWp Battery storage: 10 kWh to 120 kWh	France		www.se.com	10 or 20 ft containers	Jean-Francois.Riutort@se.com
PowerGen	M	Solar PV: up to 100's of kW	Kenya, Sierra Leone, Tanzania, Nigeria		www.powergen-renewable-energy.com		
BoxPower	M	Solar PV: up to 528 kWp (units of 3.5 kW to 22kW)	USA		https://boxpower.io	20 ft container	
We Care Solar	S	Solar PV: 0.065 to 0.125 kW	USA	100 in Uganda, 100+ in Colorado.	https://wecaresolar.org	Suitcase that fits in aircraft carry-on luggage bin.	Dr Laura Stachel MD laura@wecaresolar.org

With component-based systems, wiring is done on-site. While field-based time is longer, wait time may be lower, especially if there is inventory in-country. Firms with inventory in client countries are encouraged to complete this survey questionnaire (tiny.cc/COVID19PVinventory).

[2] Developed by Humboldt State University (HSU) for the World Bank's Regional Off-Grid Electrification Project (ROGEP).

To mitigate against the risk of import and delivery delays, project teams may want to consider immediately procuring some of the equipment that they know will be needed, even if all facilities requiring urgent intervention have not yet been identified. Equipment to consider procuring immediately includes solar panels, batteries, inverters, diesel gensets, and pre-packaged box systems described above. While procurement from national suppliers can be prioritized if their equipment is of adequate quality, in-country inventories for these products may be quite limited, so the idea is to get supplies into the country while other preparatory activities happen in parallel. Our team is preparing bid documents for both pre-packaged box systems and individual components that project teams can adapt to their specific needs.

Fast Tracking Procurement

Considering the urgency of this pandemic, efficiency gains from a full competitive bidding process are not worth the added weeks and months that they require, in addition to the inflexibility of standard contracting requirements. We recommend that teams engage with their procurement specialist to explore emergency procurement options that can be carried out quickly, virtually and with increased involvement of the WB team.[3] These may include the following options:

- Identifying a national register of authorized or licensed suppliers/bidders to limit the procurement to only well-established firms;
- Preparing a Request for Bids (RFB) that is sent to prospective bidders by email with a short turn-around time (could be a week or so), ideally preceded by a virtual consultation meeting (if there is time) to forewarn them and get their feedback on any outstanding issues;
- RFP could be issued with an up-front per-unit cost, allowing the selection of firms to focus entirely on their experience, capacity to deliver, and other issues that can be assessed via a short desk-based evaluation;
- If market costs cannot be easily estimated in advance then teams could opt for a two-envelope bidding process based on a 'sample project' (e.g. an indicative facility or requirement), perhaps combined with a price cap to guard against collusion. The desk-based evaluation would take place first, and then a live bid opening could be held by videoconference;
- Multiple firms could be awarded contracts by splitting up the work, thereby helping to overcome capacity constraints, accelerating implementation, reducing the risk of non-delivery from any single firm, and spreading the economic benefits across the industry;
- Firms could be made wholly responsible for site surveying, design, installation and a set number of years of O&M (most likely kept within the project's duration). Depending on the capacity of the client or PMU a supervision engineer may be required (refer to the template TOR available), but this could also be procured via direct selection and could come in later on;
- Teams could explore using the WB's 'direct payments' facility if there is a risk that clients will not be able to pay invoices quickly due to lockdown conditions. This may require a revision to the threshold for direct payments as specified in the Financial Agreement.

[3] Our understanding is that WB teams are allowed to be involved in bid evaluation, bid meetings, and other such steps, which can be used to reduce the number of steps and review required. See also the Health Nutrition and Population GP's market analysis for COVID-19 response suppliers here.

We recommend a number of different options for structuring the bid cost and contracts, which will depend on the project's requirements, as follows:

- For relatively simple or standardized projects it may be possible to specify a cost according to different pre-defined packages or kits, with a simplified disbursement schedule according to key milestones;
- For more complex projects developers could be paid according to a formula based on up to four variables: kWp of the PV array, the kWh of battery, the kVA of diesel genset, and the kVA of inverter, perhaps including geographic factors to take into account logistical expenses of more remote sites.

Template TOR

To facilitate rapid deployment of resources, three draft template TOR have been developed, which can be adapted to each country's specific needs:

The Installation of Electric Power Systems for Healthcare Facilities at the Front Lines of [COUNTRY's] COVID-19 Response TOR addresses the rapid installation of electric power systems for healthcare facilities which are expected to be on the front lines of supporting COVID-19 patients and which have inadequate or non-existent electricity supply.

Installation activities are supported by a Preparation and Management TOR for consulting activities to help a World Bank project team with the preparation and oversight of activities under the first TOR.

TOR for hiring of a Supervision Engineer to support the client in procuring and supervising any installations.

Further Resources

The link below provides sample technical specifications/documents for standalone and mini grid solar projects in some countries.

Technical Specifications and Documents

The following brief published by the Kigali Cooling Efficiency Program (KCEP), an ESMAP donor, describes carbon footprints and potential energy savings that can be achieved in healthcare facilities:

Global Climate Pollution from Hospital Cooling

ESMAP is available to support project teams with the design and implementation of energy-related activities in response to COVID-19. The financial and human resources that ESMAP can provide to World Bank TTLs working on these issues is under discussion. The key contacts in this regard are Dana Rysankova, Senior Energy Specialist and Energy Access Global Lead, contact for ESMAP's off-grid program (drysankova@worldbank.org), Jon Exel, Senior Energy Specialist and Program Lead for the ESMAP Global Mini Grid Facility (jexel@worldbank.org), Zuzana Dobrotkova, Senior Energy Specialist and lead for ESMAP's grid-connected solar program (zdobrotkova@worldbank.org), Lighting Africa's off-grid solar electrification of public institutions specialist Rahul Srinivasan (rsrinivasan11@worldbank.org), leads for ESMAP's Efficient Clean Cooling Program Martina Bosi (mbosi@worldbank.org) and Daron

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