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POWERING HEALTH:
LOAD CALCULATION EXAMPLES

An off-grid health facility's load calculations vary depending on its size, which is determined by the number of patient beds and health services provided.

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POWERING HEALTH

This document is provided as part of USAID's Powering Health toolkit. Health-care facilities require electricity to maintain perishable supplies and power life-saving technologies. Energy is essential for preventing child and maternal deaths, controlling the HIV/AIDS epidemic, and combating infectious diseases and pandemics.

Reliable electricity can mean life or death for patients in developing country health-care facilities. However, many of these facilities have little or no access to reliable electricity. USAID supports partner countries in understanding the energy needs of their health-care facilities over the long term. This challenge requires local capacity for careful planning, a commitment to maintenance, and dedicated funding.

USAID uses its experience at the nexus of the health and energy sectors to help international development practitioners and health-care administrators design programs that meet the energy needs of health-care facilities. By applying international best practices and lessons learned, stakeholders can help ensure that health-care facilities are able to power standard appliances, such as lights, life-saving equipment, blood and medicine refrigerators, ventilators, laboratory diagnostic tools, and technology that monitors patients' vital signs.

INTRODUCTION

An initial load and energy analysis of an off-grid health facility is critical to facilitate the design and operation of energy supply systems. When properly executed, a load analysis can yield valuable insights into facility energy usage that can help reduce energy costs, increase productivity, and protect critical assets.

Off-grid health clinics are key to providing health-care services to people in surrounding villages. To provide effective health care, it is necessary to have a power infrastructure that is adequate for the types of health services provided. For example, in a small off-grid health clinic, limited health services are offered, such as outdoor-patient (OPD) consultations, vaccinations, and simple surgical procedures such as suturing. In medium off-grid health clinics, additional health services, such as childbirth, neonatal, and dental care, may be offered. Different equipment (centrifuge, vaccine refrigerator, microscope, dental chair, etc.) is required, and its energy consumption and source of power must be considered in the planning process.

SMALL RURAL HEALTH CLINIC

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A small health clinic typically has a capacity of 0 to 60 beds and a daily energy requirement up to 10 kilowatt-hours (kWh).

CHARACTERISTICS

A small health facility may have the following characteristics:

- A remote location with limited services and a small staff
- Lights during evening hours to support limited surgical procedures (*e.g.*, suturing)
- One or two refrigerators to maintain the cold chain for vaccines, blood, and other medical supplies
- Basic lab equipment, such as a centrifuge, hematology mixer, microscope, incubator, and hand-powered aspirator.

LOAD INVENTORY

An example load inventory for a small rural health clinic is provided below. Even these small loads can be difficult to support in remote settings, where access to energy is limited. Grid power is often not an option in such cases, and diesel power can be very expensive and is subject to fuel shortages; while photovoltaic (PV) systems are often a sustainable option, their upfront cost is relatively high. An example of a typical load and energy consumption for a small health facility is provided in the following table:

LOAD INVENTORY: SMALL RURAL HEALTH CLINIC

EQUIPMENT	POWER (WATTS)	HOURS USED PER DAY	ENERGY USED (WATT-HOURS)
Vaccine Refrigerator	60	8*	480
Lights (LED)	10	8	60–80
Microscope	30	1–2	30–60
Exam Light	20	1–3	20–60
Radio	10	10–12	100–120
TOTAL WATT-HOURS USED PER DAY	130		690–800

**Assumed 8 hours per day duty cycle for vaccine refrigerator*

The table above reveals that vaccine refrigeration is the most significant load and consumer at the facility. This analysis suggests that a stand-alone, solar-powered refrigerator may be a good option. Such refrigerators are commercially available specifically for situations such as this.

MEDIUM RURAL HEALTH CLINIC

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A medium rural health clinic typically has 60 to120 beds, with total daily energy consumption in the range of 10 to 20 kilowatt-hours (kWh).

CHARACTERISTICS

A medium health facility may have the following characteristics:

- Medical equipment similar to that of a small health clinic; the frequency of use and number of devices are key factors for differentiating between small and medium health clinics
- Separate refrigerators may be used for food storage and cold chain
- Communication devices, such as a radio, may be utilized
- More sophisticated diagnostic medical equipment and more complex surgical procedures than those at small clinics may be accommodated.

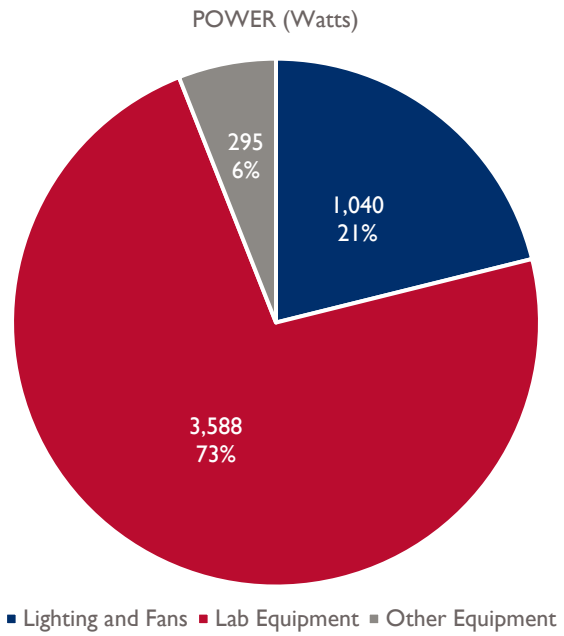
LOAD INVENTORY

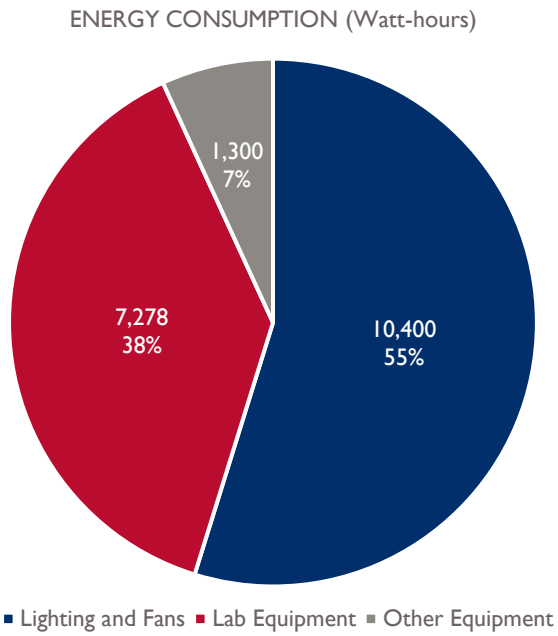
The following table is an example load inventory for a medium-sized health clinic. This inventory details equipment quantities, operational hours in a day, and total power and energy consumption.

LOAD INVENTORY: MEDIUM RURAL HEALTH CLINIC

EQUIPMENT	QTY	POWER (WATTS)	TOTAL POWER (WATTS)	HOURS USED PER DAY	ENERGY USED (WATT-HOURS)
LED Lights	40	10	400	10	4,000
Fan	8	80	640	10	6,400
Exam Light	2	20	40	2	80
Microscope	3	30	90	2	180
Solar Vaccine Refrigerator	2				
Rotator	1	60	60	1	60
AC Refrigerator	1	500	500	8	4,000
Centrifuge	1	600	600	1	600
Water Bath	1	400	400	1	400
Spectrophotometer	1	63	63	1	63
Autoclave	1	630	630	1	630
Dental Chair	1	710	710	0.5	355
Compressor	1	370	370	2	740
Jet Sonic Cleaner	1	45	45	2	90
Amalgam Filling Machine	1	80	80	1	80
Computer	2	120	240	4	960
Radio	1	30	30	8	240
Cell Phone Charger	5	5	25	4	100
GRAND TOTALS			4,868		18,638

While the majority of the connected load is laboratory equipment, its energy consumption accounts for 38 percent of the total. On the other hand, lighting load is only 21 percent but accounts for more than half of the total energy consumption of the health center. An examination of the load inventory shows that the number of operating hours for each piece of lab equipment is relatively low, while the number of operating hours for lighting is quite high.





LARGE RURAL HEALTH CLINIC

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A large rural health clinic typically has in excess of 120 beds, with total daily energy consumption of more than 20 kilowatt-hours (kWh).

CHARACTERISTICS

A large health clinic may have the following profile:

- Serves as a regional referral center and coordinates communication between several smaller facilities and hospitals in large cities
- Communicates with remote health centers and hospitals by way of telephone, fax, computer, and Internet
- Contains sophisticated diagnostic devices (x-ray machine, CD4 counters, blood-typing equipment, etc.) that require additional power.

LOAD INVENTORY

The following table is an example load inventory for a large health clinic. This inventory details equipment quantities, operational hours in a day, as well as total power and energy consumption.

LOAD INVENTORY: LARGE RURAL HEALTH CLINIC

EQUIPMENT	QTY	POWER (WATTS)	TOTAL POWER (WATTS)	HOURS USED PER DAY	ENERGY USED (WATT-HOURS)
LED Lights	120	10	1,200	10	12,000
Fan	20	80	1,600	10	16,000
Exam Light	4	20	80	2	160
Microscope	5	30	150	2	300
Solar Vaccine Refrigerator	2				
Rotator	2	60	120	1	120
AC Refrigerator	3	500	1,500	8	12,000
Centrifuge	1	600	600	1	600
Water Bath	2	400	800	1	800
Spectrophotometer	2	63	126	1	126
Autoclave	1	630	630	1	630
Dental Chair	2	710	1,420	0.5	710
Compressor	2	370	740	2	1,480
Jet Sonic Cleaner	1	45	45	2	90
Amalgam Filling Machine	1	80	80	1	80
X-Ray Machine	1	200	200	1	200
CD4 Machine	1	200	200	4	800
Hematology Analyzer	1	230	230	4	920
Blood Chemical Analyzer	1	45	45	6	270
Air-Conditioning Unit	3	1,500	4,500	8	36,000
Computer	4	120	480	4	1,920
Radio	1	30	30	8	240
Cell Phone Charger	10	5	50	4	200
GRAND TOTALS			14,746		85,206

For large off-grid health clinics, lighting, air-conditioning, and refrigeration account for around 80 percent of power and energy requirements. Air conditioners and refrigerators alone consume 56 percent of the total energy in a day. The daily facility consumption directly affects the size of the battery bank required to back up these health facilities. A battery bank sized to meet daytime consumption, connecting the air-conditioning units to backup power, will greatly increase the size and cost of the system.