

Table 3. Indicative power requirements of electrical devices for health services^{vii}

Health services	Electrical devices (features and characteristics)	Indicative power rating [W] operation mode	AC power supply	DC power supply or battery port	
INFRASTRUCTURE	Basic amenities	Basic lighting requirements for health clinics are estimated at: ~162 lux (lumens/m ²), which may be achieved by various types of lamps:			
	<ul style="list-style-type: none"> ✱ Incandescent lamp (~10–15 lm/W) ✱ Halogen lamp (~15–20 lm/W) ✱ CFL^{viii} (~45–65 lm/W) ✱ LED lamp (~70–90 lm/W) 	40–100 W	110/220 V AC	–	
	Security lighting, outdoors (LED)	10–100 W ⁴	110/220 V AC	10–30 V DC	
	Mobile phone battery (charging)	5–20 W ⁵	110/220 V AC	5–16.5 V DC	
	Desktop computer ^k	15 ⁶ –200 W ^{7,8}	110/220 V AC	8–20 V DC ⁹	
	Laptop computer	20–60 W	110/220 V AC	12–20 V DC ¹⁰	
	Internet (V-Sat connection)	85–500 W ¹¹	110/220 V AC	15–24 V DC ¹²	
	Printer, ink jet	65 ¹³ –100 W ¹⁴	110/220 V AC	12–20 V DC ¹⁵	
	Printer, laser	150–1100 W ¹⁶	110/220 V AC		
	VHF radio receiver: Stand-by	2 W ¹⁷	110/220 V AC	12 V DC	
	Transmitting	30 W ¹⁸			
	Ceiling fan (AC)	30–100 W ^{19,19a}	110/220 V AC	–	
	Ceiling fan (DC)	28 W ^{20,21,22}		12 V DC	
	Refrigerator, 165 L (for food & water)	(AC) 150–200 W ^{23,x} (DC) 40–80 W ^{24,xi}	110/220 V AC	–	
	Portable electric space heater	1392–1500 W ²⁵	110/220 V AC	48 V DC	
	Portable air conditioner (AC & DC variants)	1000–1500 W	110/220 V AC ²⁶	48 V DC ²⁷	
	Processing of equipment for reuse	Countertop autoclave (steam sterilizer) (19–45 L)	1200–2850 W ^{28,29}	110/220 V AC	–
		Dry heat sterilizer	500 W ³⁰ –1.56 kW ³¹	110/220 V AC	–
	Health-care waste management	Small waste autoclave (35–178 L)	2–6 kW ³²	220 V AC ⁱⁱⁱ	–
		Autoclave grinder	1400 W	–	–
	Small water pump – clinic	50–200 W ³³	–	15–30 V DC	
	Water pump – district health centre	400–1000 W ³⁴	110/220 V AC	–	
	UV water purifier	10–40 W ^{35,36}	–	12 V DC	
	Reverse osmosis/other water purifier	264 W ³⁷ –570 W ³⁸	110/220 V AC	–	
SPECIFIC SERVICES	General outpatient services	Micro-nebulizer	2.5 ³⁹ –36 W ⁴⁰	100–240 V AC	9–12 V DC
		Nebulizer	80–90 W ⁴¹	110/220 V AC	–
		Oxygen concentrator ⁴²	270–310 W	110/220 V AC	12–18 V DC
		Pulse oximeter	70 W		
		Pulse oximeter (AA battery-operated)	50 W ⁴³ 2–3 W ⁴⁴	110/220 V AC	1.5–3 V DC

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^{vii} Note: This table does not consider electricity demands for dentistry services, which also are important to primary health-care, and deserve further consideration in the energy context. All values are calculated for use in the “active” mode unless otherwise stated. Total daily power consumption (Wh/day) would normally be a function of watt hours of active use plus any standby power requirement. Wherever possible, indicative power requirements have been compiled from data contained in reports and supply catalogues offered by recognized UN or national health and energy research agencies, including: (UNICEF, 2014; World Health Organization, 2013c; United States Agency for International Development, 2012; African Renewable Energy Access Program, 2010; National Renewable Energy Laboratory, 1998). References to other indicative values are noted individually in Annex 4. Reference to performance specifications of specific products or manufacturers does not imply any endorsement or recommendation by the World Bank or WHO, or that they are preferred to others of a similar nature not mentioned.

^{viii} Note: Regarding lighting options: Incandescent bulbs are very inefficient and generate a lot of heat. Such lamps are progressively being banned in some countries. CFLs contain volatile mercury and should be avoided when a strong recycling service is not in place. In addition, CFLs produce electromagnetic and UV emissions. Thus whenever possible, LED is preferred. Linear fluorescent tubes, common in developed-country health facilities, have an additional problem insofar as they break easily in settings with electrical perturbations that occur frequently in the unstable grids of developing countries. As an alternative to fluorescent tubes, LED tubelights (9–18 W) with dimming option and running with both AC and DC power are now available in the market.

^{ix} Note: Power varies widely for desktop computers, from 15 W for very efficient, new models, plus another 15 W for the monitor display, and up to 200 W for older ones.

^x Daily electricity requirement for AC refrigerator: 600 Wh–1.44 kWh at ambient temperature of 21.1–32.2 °C

^{xi} Daily electricity requirement for DC refrigerator: 77–168 Wh at ambient temperature of 21.1–32.2 °C

^{xii} Larger models or models with faster cycles often require 440 VAC.

Health services	Electrical devices (features and characteristics)	Indicative power rating [W] operation mode	AC power supply	DC power supply or battery port
Antenatal, child and adolescent health	Vaccine refrigerator (polio, measles, DPT-Hib+HepB, BCG & tetanus toxoid) ^{xiii} designed to perform at 43° C:			
	<i>Vestfrost VLS200</i> AC (electric mains) refrigerator, 100 litres (WHO/PQS: E003/031)	115 W ^{xiv}	110/220 V AC	N/A
	<i>Dometic TCW 3000</i> DC (solar-charged, battery-driven) vaccine refrigerator, 110 litres (WHO/PQS-E003/008)	250 W solar array ^{xv}	N/A	12/24 V DC
	<i>Sure Chill BLF100</i> DC (solar direct-drive) vaccine refrigerator, 99 litres (WHO/PQS: E003/019) ^{xv}	370 W +/- solar array ^{xv}	N/A	12/24 V DC
Obstetric and newborn	LED light for phototherapy treatment of neo-natal jaundice ^{xvi}	440 W	110/220 V AC	–
	Suction apparatus ^{xvii}	90–200 W 33 W	110/220 V AC	± 12 V DC
	Vacuum aspirator or D&C kit ^{xviii}	36–96 W	110/220 V AC	± 3–6 V DC
	Neo-natal incubator	800–1035 W ^{xix}	110/220 V AC	–
	Neo-natal infant warmer ^{xix}	125/550 W ^{xix}	110/230 V AC	–
	Fetal heart monitor (Doppler)	1.5–3 W (AA battery) ^{xix}	–	1.5–3 V DC
	Ultrasound	800–1000 W ^{xix}	110/220 V AC	–
	Portable ultrasound	6 W (idle) – 22–28 W (active-charging) ^{xix}	100–240 V AC ^{xi}	11–15 V DC ^{xii}
General diagnostics, blood analysis and laboratory equipment	Laboratory refrigerator	60–160 W ^{xix} 40–80 W (165 L) ^{xix}	110/220 V AC	12/24 V DC
	Centrifuge	250 – 400 W (low-medium speeds) ^{xix}	110/220 V AC	–
	Mini-centrifuge	25 W ^{xix}	–	12 V DC
	Haematology analyser	230–400 W ^{xix}	–	–
	Blood chemistry analyser	45–88 W ^{xix}	–	–
	Blood chemistry analyser (hand-held) ^{xix}	–	–	18 V DC battery ^{xix}
	CD4 counter	200 W ^{xix}	110/220 V AC	12 V DC
	Brightfield white light microscope (with LED light)	20–30 W ^{xix}	110/220 V AC	3–6 V DC
	LED microscope (for fluorescence smear microscopy (halogen or LED light)) ^{xix}	70 W ^{xix}	110/220 V AC	12 V DC
	Mercury/xenon fluorescence microscope ^{xix}	75–200 W	220–240 V AC	–
	X-ray machine ^{xix}	15–20 kW	120 V AC	–
		30–40 kW	1Φ/108–230 V AC	–
		50–80 kW	3Φ/400–480 V AC	–
	Portable X-ray machine	3–4 kW ^{xix}	90–264 V AC	–
	Laboratory incubator	200 W ^{xix}	110/220 V AC	12 V DC
Vortex mixer	18 W ^{xix} 70–90 W ^{xix}	90/220 V AC 120/230 VAC	6 V DC –	
TB diagnosis	Sputum-smear microscopy (LED microscope w/fluorescent smear) ^{xix}	30 W (+ 6 W LED bulb) ^{xix} 20–30 W ^{xix} (+6 W LED bulbs)	110/230 V AC –	– 6 V DC
	GeneXpert MTB/RIF diagnostic	190 W ^{xix}	110/220 V AC	12/24 V DC
HIV diagnosis	ELISA test reader	500–650 W ^{xix}	110/220 V AC	48 V DC
Cardiovascular diagnosis/treatment	Portable electrocardiograph (ECG)	1.2 W ^{xix} –45/70 W ^{xix}	100/240 V AC	3–12 V DC
	Defibrillator with ECG	130–200 W ^{xix} 100–130 W ^{xix}	110/220 V AC –	14–15 V DC 11.1 V DC
Diabetes	Blood glucose monitor	<1 W	–	3.3–5 V DC ^{xix}
Basic surgical services^{xix}	Suction apparatus (AC)	90–200 W	110/220 V AC	–
	Suction apparatus (DC)	33 W	–	± 12 V DC
	Anaesthesia machine	1440 W ^{xix}	110/220 V AC	–
	Low-energy anaesthesia machine with DC monitor backup ^{xix}	480 W – oxygen concentrator 20 W – monitor ^{xix}	220 V	12 V DC backup (for monitor)

^{xiii} Note: Vaccine refrigerators are designed to keep vaccines in a stable +2° C – +8° C range; vaccine cold packs require freezers.

^{xiv} Note: In a well-designed refrigerator, the cooling compressor only operates intermittently so total daily demand would be estimated at about 710 Wh/day

^{xv} At solar radiation reference period average = 3.5 kWh/m²/day – (approximating average solar radiation in less-than-optimal sunlight, e.g. cloudy, rainy and cool-weather days).

^{xvi} These values refer to the power supply for the x-ray generator; 150 kVp is the maximum voltage across the x-ray tube itself.

^{xvii} Including basic procedures such as: tracheotomy, tubal ligation, vasectomy, dilatation and curettage, obstetric fistula repair, episiotomy, appendectomy, neonatal surgery, skin grafting, open treatment of fracture, amputation, cataract surgery. Note: Dental surgery procedures can impose significant load requirements including: dental compressor (~750 W-2.2 kW); dental sterilizer (~850 W); and dental chair & exam light (200 W); as well as x-ray and other specialized devices.