Ministry of Health and Family Welfare
Government of India

Guidelines for Solar Powering Healthcare Facilities

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National Health Mission
राष्ट्रीय स्वास्थ्य मिशन

National Programme on Climate Change and Human Health

National Centre for Disease Control
Government of India

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ABBREVIATIONS

HWC	**Health & Wellness Center**
PHC	**Primary Health Center**
CHC	**Community Health Center**
SDH	**Sub Division Hospital**
DH	**District Hospital**
FRU	**First Referral Units**
EE	**Energy Efficient**
IPHS	**Indian Public Health Standards**
SDG	**Sustainable Development Goals**
AMC	**Annual Maintenance Contract**
O&M	**Operations & Maintenance**
kWh	**Kilowatt hour**
Ah	**Ampere Hours**
DRE	**Decentralized Renewable Energy**
PV	**Photovoltaic**
MMR	**Maternal Mortality Rate**

ACKNOWLEDGEMENT

These Guidelines for Solar Powering Healthcare Facilities have been prepared to support energy transition of the healthcare facilities of India from fossil fuel dependent to renewable sources under National Programme on Climate Change and Human Health (NPCCHH). This document is focused mainly on technical aspects of solar powering health facilities. By guiding efforts on energy conservation and transition, it is envisioned to contribute towards India's greenhouse gas reduction goals, air pollution reduction and towards resilient health service delivery especially during extreme weather events.

We would like to extend our gratitude towards Public Health Foundation of India and SELCO, India teams in preparing the guidelines. We would also like to thank all the members of Technical Expert Group (TEG) on Green and Climate Resilient Health Facilities who provided valuable inputs and suggestions.

We hope that these guidelines will be useful for health administrators, and medical and public health professionals in supporting assessment of energy needs and determining appropriate solar application for their health facilities. Implementation of this environmentally friendly and sustainable measure is expected to lead health facilities towards partial or complete energy independence strengthening them to withstand impacts of climate change, dynamic population and align with the 100-year vision for the country to avail best facilities both in the villages and the cities.

About National Programme on Climate Change and Human Health

National Programme on Climate Change and Human Health (NPCCHH) is a flagship programme of the Ministry of Health and Family Welfare (MoHFW), strengthening health system response to climate change in the country. The goal of the programme is to reduce morbidity, mortality, injuries, and health vulnerability to climate variability and extreme weather events. The actions being taken under the programme include increasing general awareness, building capacity of health care workforce, and strengthening the health systems structurally and functionally. These will strengthen our health system's adaptive capacity to increasing and compounding impacts of various climate-sensitive diseases and health impacts ranging from increased vector and water borne diseases, food insecurity, heatwaves, flooding, and other extreme weather events.

This guideline addresses one of the key components of green and climate resilient health facilities under the aegis of NPCCHH for which funds are being allocated through National Health Mission's Programme Implementation Planning (PIP) process. These green (Environmentally friendly and sustainable) measures to be implemented at health care facilities include;

a. Energy audit
b. Installation of LED lighting
c. Installation of solar panels
d. Water conservation measures, mainly rain water harvesting

Chapter

1

INTRODUCTION

1. INTRODUCTION

1.1. Background and Context

The vision of the National Health Mission (NHM) is the "Attainment of Universal Access to Equitable, Affordable and Quality health care services, accountable and responsive to people's needs, with effective inter-sectoral convergent action to address the wider social determinants of health". While similarly, the World Health Organization (WHO) defines Primary health care as "a whole-of-society approach to health and well-being centered on the needs and preferences of individuals, families and communities. It addresses the broader determinants of health and focuses on the comprehensive and interrelated aspects of physical, mental and social health and wellbeing".

Public health care system in India can be broadly envisaged as a three-tier structure comprising primary, secondary, and tertiary healthcare facilities. The primary tier largely consists of two types of facilities. They ensure last-mile delivery of essential primary healthcare services such as immunization, maternal & antenatal care, emergency referral, laboratory services, out-patient and in-patient services at the village level and other remote areas. Stronger primary health care systems are essential to achieving Sustainable Development Goal 3 (SDG3) which aims to ensure healthy lives and promote wellbeing for all of all ages, including through universal health coverage.

Access to electricity is not only imperative for the functioning of healthcare facilities but also a vital determinant of effective delivery of health services. It is important to note that energy access in this context means that healthcare facilities have efficient, reliable, affordable, and secure energy services for delivery of healthcare services. In this regard, the Indian Public Health Standards (IPHS) emphasize uninterrupted power supply for health care facilities.

Nevertheless, rural health centers are largely vulnerable to irregular power supply and frequent interruptions adversely impacting the delivery of essential healthcare services. Despite having diesel generators for power backup, their operations are restricted due to inadequacy of funds for diesel. Sometimes in remote locations, the supply of diesel is interrupted during monsoons or bad weather. As per the World Health Organization (WHO), unreliable electricity access leads to vaccine spoilage, interruptions in the use of essential medical and diagnostic devices, and lack of even the most basic lighting and communications for maternal delivery and emergency procedures.

Decentralized Renewable Energy (DRE) (stand-alone solar PV solutions) have successfully emerged as a solution to this issue- replacing the conventional power supply (rather lack of it) and enabling uninterrupted provision of health services in weak grid settings. Rooftop Solar PV systems can meet the needs of lighting, fans, maternal services, operation services, labs, refrigeration for immunization, water pumping, and, in many cases, enable the use of critical medical and laboratory equipment in healthcare facilities. Moreover, integrating energy efficiency in the design of healthcare facility infrastructure and medical equipment can optimize the capacity of DRE systems (viz. PV array, battery and inverter) or free up the installed capacity for serving other critical loads and make them more affordable for healthcare facilities. Some states, including Meghalaya, Karnataka, Manipur, Odisha, Chhattisgarh, Maharashtra, and Tripura, have already deployed solar PV systems to power Health & Wellness Centers, PHCs, sub-divisional and district hospitals.

Thus, DRE solutions empower healthcare centers in effectively delivering healthcare services. Each of the different tiers of healthcare systems would require need-based solar system designs, and operational and ownership frameworks for them to be complementing the day-to-day requirements of the facilities. This guideline document seeks to provide recommendations for the technical designs for Solar solutions across the various levels of healthcare infrastructure in India. Considering the reference of standards from the IPHS guidelines, designs for each of the tiers provide directions via fairly standardized (however, customized for each level of Health & Wellness Centers, PHCs, CHCs, DHs) system designs to solar power facilities across the county.

1.2. Need and Impact of Solar Energy for Public Health Centers

Access to basic healthcare in remote rural areas can be challenging for multiple reasons - one of the critical reasons being lack of energy access at the center. Health personnel and the communities in last-mile clinics face unexpected challenges from the lack of reliable energy access. Selecting an appropriate source of reliable and sustainable energy can help mitigate some of the challenges inherent in operating a health facility in vulnerable areas. Thus, access to reliable electricity acts as a further barrier for the delivery of basic services for the poor.

With improved energy reliability and access, the interventions will help reduce out-of-pocket expenses for end-users, improve staff retention levels especially in remote and vulnerable contexts, change end-user perceptions on the value of public health facilities, increasing footfalls and usage. The program could be developed with a collaboration between Government agencies, Health facilities and staff and Health sector NGOs to ensure better delivery of health care.

The potential impact of building reliable energy access via decentralized solar energy for the healthcare facilities go beyond access to electricity to run the services more effectively.

- **Improved quality and quantity of health services:** Studies, including the analysis of data from the District Household and Facility Survey (DHLS), reveal the effect of electricity access on health service delivery with some services such as deliveries, diagnostics being more dependent on electricity than others[1]. For example, the average number of deliveries conducted by PHCs without electricity access was 50% lower than those with electricity. This could also be on account of a lack of equipment and trained personnel, which are also a consequence of the lack of electricity[2].
  With appropriately designed solutions for electricity provision, not only do the quality of existing services improve but also the number of critical and relevant

[1] Ramji et. al (2017), Powering Primary Healthcare through Solar in India: Lessons from Chattisgarh', CEEW and Oxfam India;
[2] Shastry, Vivek and Rai, Varun, How Energy Access Impacts Primary Healthcare: Evidence from India (June 4, 2021). PLOS ONE 16 (6): e0252705.,

services that are needed for local communities can be increased. With Solar energy solutions, existing services at the health centers can be made more reliable. Evaluation studies, albeit with a limited sample size, found that 90% of facilities reported an ease of operations owing to the introduction of sustainable energy solutions[3]. Patients would not need to be denied a service for otherwise unavailability of electricity.

- **Financial savings for the health facility and the local governments:** Unlike grid powered or diesel generator powered energy sources, decentralized solar solutions do not have high recurring costs for the healthcare facilities, thus saving significant financial resources for the local governments. An evaluation of sustainable energy provision in 70 health facilities across India found that facilities saw a 40-50% reduction in monthly electricity bills with the introduction of solar energy and efficient appliances[4]. Previous studies have also shown that 90% of solar powered PHCs reported cost savings from use of solar PV systems (for back-up power), compared to traditionally used diesel generators[5].

- **Reduced wastage of vaccines and other temperature sensitive commodities:** With the appropriate cold-chain solutions powered by solar energy, the reliability of cooling solutions gets improved, and thus the reduction in the wastage of vaccines, which are even more critical in remote areas. Power deficit PHCs in Chhattisgarh with back-up energy sources were seen to rely exclusively on solar energy to power cold chain equipment, indicating that the availability of solar energy can enhance the vaccine storage capacities of the health facility[6]. Additionally, based on initial studies done on solar electrification programs across southern and eastern states with a sample set of health facilities, 83% reported a reduction in vaccine wastage on account of poor refrigeration[7].

- **Reduction in health appliance damages:** With the reduced voltage fluctuations from well-designed solar solutions (which is common from the grid powered sources, especially in remote areas), there will be no damage of critical appliances which in turn decreases the cost and improves the reliability of services. An evaluation of solar powering across 70 health facilities found that all of the facilities reported no voltage fluctuations and associated damages to equipment, compared to pre-intervention levels (where more than 50% reported voltage fluctuation related challenges).

[3] SELCO Foundation (2020)
[4] SELCO Foundation (2021), Evaluation of Sustainable Energy based interventions
[5] Ramji et. al (2017), Powering Primary Healthcare through Solar in India: Lessons from Chattisgarh', CEEW and Oxfam India
[6] Ramji et. al (2017), Powering Primary Healthcare through Solar in India: Lessons from Chattisgarh', CEEW and Oxfam India
[7] SELCO Foundation (2020)

- **Improved wellbeing and productivity of health staff**: With the conditions improving at the facilities, not only the retention of the staff is higher because of the improvement in their well-being but also the productivity is positively impacted due to the improved efficiency and reliability of the services along with appropriate training on operating the solutions. According to one study, 96% of health staff across 70 health facilities reported being able to provide better treatment on account of uninterrupted supply of lighting, fans and cooling[8]. Evidence from solar energy programmes across the world corroborate that electricity access is a key factor in retaining and attracting qualified health workers and reducing absenteeism[9].

- **Increased access to health services:** Improving energy access can ensure that health facilities are able to provide care in a more reliable manner. Depending on the level of healthcare facility intervention, access to services (basic to secondary, tertiary) for the communities increases with more efficient, appropriately designed and reliably powered solutions. Research has found that energy can enhance patient comfort and increase their willingness to be admitted (when essential) if the health facility has functional lights, and fans.[10] Another study found that patients' experience in terms of waiting time and referral services improved significantly with the addition of the solar energy solution[11].

- **Decrease in transactional costs for patients:** Communities, especially those who stay in remote areas with lack of access to basic healthcare services due to the gaps in energy access and skills of the personnel, spend time and resources traveling long distances to access the facilities. The health-energy nexus interventions with the ecosystem approach helps in reducing the transaction costs by bringing essential healthcare services at the last-mile facilities such as Health & Wellness Centers.

1.3. Solar Energy Application and Conservation for Health Services

Decentralized, renewable energy solutions, coupled with energy efficiency measures, have great potential to expand health facility access to cost-effective, reliable electricity in many low-income settings where the grid is unreliable or nonexistent. Today there are more efficient options for each appliance required at the level of Primary healthcare- be it basic energy, cold chain and refrigeration or maternal and newborn care.

The differences in appliance efficiency significantly change the sizing of the decentralized solar energy system- both PV panel and battery capacities which in turn change the cost of powering the system and the future cost of maintenance. Sometimes, the cost of powering a center with inefficient appliances is 3 times more than the cost of powering one with efficient appliances. Including the cost of appliances would still mean the inefficient appliance center is 35% more expensive than the one with efficient appliances.

[8] SELCO Foundation (2021), Evaluation of Sustainable Energy based interventions

[9] UN Foundation and SEforALL. 2019. Lasting impact: Sustainable off-grid solar delivery models to power health and education.

[10] Shastry, Vivek and Rai, Varun, How Energy Access Impacts Primary Healthcare: Evidence from India (June 4, 2021). PLOS ONE 16 (6): e0252705.,

[11] SELCO Foundation (2020)

Installing more efficient equipment is an important component of energy conservation, but good management practices are equally important. These include maintaining equipment properly, insulating any areas that are heated or cooled, turning off unused lighting or equipment where possible, and monitoring energy consumption. All health center staff should be knowledgeable of the measures it takes to meet the center's energy needs and encouraged to help conserve energy.

The following are examples of some of the main energy intervention points, which play a critical role in ensuring quality delivery of services at the health facility:

- **Disease treatment & Prevention (immunization):** In health centers, access to reliable electricity is essential for ensuring the cold chain to safely preserve and store vaccines, blood, and other critical medicines requiring refrigeration.
- **Maternal care and obstetrics services**: During pregnancy and childbirth, adequate and continuous lighting along with medical equipment such as a fetal heart rate monitor or an ultrasound can be a life-saving measure for many women and children. A number of services would require energy to run effectively, such as Family Planning and Immunization: Antenatal Care, Intra-natal care: (24-hour delivery services both normal and assisted), Postnatal Care, Newborn Care, Nutrition and immunization services, Medical Termination of Pregnancies, etc. Of the ones mentioned above, there are some things that could be critically strengthened by Solar. Maternal and child health care needs such as baby warmers, suction machines for deliveries, phototherapy, lighting & fans are the examples that could be powered by solar energy.
- **Communication, training and outreach:** ICT is a critical enabler of wider "telemedicine" strategies, which have been extremely effective in supporting activities such as remote health worker consultations and ongoing training and education. Additionally, communication is a critical enabler of access to public health education and information in an era of rapid global and regional disease transmission, pandemic alerts, and extreme weather. Solar powered solutions would strengthen the basic communication and other remote consultation requirements via powering computer, mobile and internet services.
- **Facility operations, admin, and staff facilities:** Efficient management of patient records and referrals, as well as collection and reporting of health statistics, is greatly facilitated when computer-based services, software, and solutions are enabled by electricity access. The basic day to day operations of the facilities such as offices, store rooms, admin areas, reception and registration areas, pharmacies, toilets, and other supportive departments could get basic access to lights and fans via solar powered facilities. Outdoor lighting of the PHC also makes them accessible and positive landmarks in the community energy access also enables expanded operating hours, increased night-time health provision, and increased opportunity for health clinic visits. Another critical piece that enables improved operation within the health centers is retainment of quality staff who stay closer to the facilities. Solar powered solutions can power the staff quarters as well, complementing the

healthcare center related interventions - which enables attracting and retaining qualified health workers and reducing employee absenteeism in health facilities.

- **Access to water (normal and hot) for the facilities:** With the ability to power water pumps via efficient solar powered water pumps, and further, to provide hot-water for the facility operations via solar water heater options, DRE can facilitate an uninterrupted water supply for the healthcare centers.

Chapter

2

METHODOLOGY FOR SYSTEM DESIGN AND COSTING

2. METHODOLOGY FOR SYSTEM DESIGN AND COSTING

This section provides an overview of the steps and factors involved in determining the system design and thereby the cost implications for different levels of healthcare facilities.

Broadly, the steps include the following:
Step 1: Energy needs are determined based on:

- Type of health facility and expected service provision (based on IPHS guidelines)
- Loads considered (whether critical or non-critical from energy reliability perspective)
- Typical operational hours for specific loads and rooms within the facility

Step 2: System designs are determined based on:

- Availability of the grid which includes autonomy requirements
- Peak Sun hours/ Sunshine hours which also impacts autonomy requirements
- Equipment-level efficiency or inefficiency

Step 3: System costs are arrived at based on 2.1 and 2.2.

- For the purposes of this document, Installed costs alone have been considered. This includes the first year of maintenance and servicing. However, the costs for 5 year servicing and maintenance are separately mentioned as well.
- All Indicative costs are inclusive of solar energy system components, transportation and installation
- It is good practice to ensure that allocations are made for Annual Maintenance costs for a 5 year period.
- Batteries come with a warranty of 5 years; depending on usage and maintenance, the life of the lead acid battery could be extended to 7-8 years;
  At current costs, the battery replacement would cost approximately 35% of the total system cost. This would need to be planned for and allocated.

The detailed system designs and load calculations for each facility type are provided in the Annexes.
An overview of solar energy system components for health facilities are provided in Annex 1.

2.1 Factors for Determining Energy needs

The energy needs have been established based on the type of health facility, the services being provided at the center, and the patient load. To elaborate on the same, the following 3 steps have been followed for understanding the energy needs.

2.1.1 Type of Health Facility

The guidelines provided by IPHS outline the essential services and infrastructure requirements at each health facility level. For the Health and Wellness Centers and PHCs,, there may be 2 typologies based on the number of beds, the number of patients being catered to or the extent of service provision. The guidelines for each type combined with field insights of service provision at different levels of health facility help in determining the energy needs. These are developed as templates to aid the design of decentralized solar energy solutions.

2.1.2 Load Considerations

The loads considered for solar system design are based on the equipment requirements for each room (as per layouts in IPHS Guideline, 2012) or services being delivered (as per IPHS guidelines, 2012). For Health and Wellness Centres and Primary Health Centers, the loads are based on layouts and each room. For Community Health Centers, Sub Divisional Hospitals and District hospitals, the loads considered for specific services have been detailed in each section and in the associated Annexes.

While the load assumptions made for the purpose of this document have been detailed in the following sections (and Annexes), customized designs are encouraged for specific geographical areas, based on needs. For example,

- If a certain health facility has a specific disease burden, certain assumptions or usage hours under this document may not hold true and may need to be reworked as per the need.
- Similarly, it is encouraged that the loads are further assessed to identify critical and non-critical loads. It is suggested that the solar system design for each critical load is done separately to the non-critical loads. Here the criticality is defined as per reliability and criticality of the service availability. For example, lights, fans, mobile charging points, laptops and printers are considered as non-critical and consumptive loads. Whereas, baby warmers, oxygen concentrators, refrigerators, etc are considered as critical loads. Usage patterns of one should not disrupt the functioning of the other- ie overuse of lights and fans (non-critical loads), should not drain the power required for refrigerators and baby warmers (critical loads) when required. Hence, they should be designed and connected separately.

2.1.3. Typical Operational Hours for Specific Loads and Rooms within the Facility

The primary results of a load inventory are quantified estimates of the facility's electrical loads and consumption. Solar system design requires a detailed inventory of all loads and their consumption. The load assessment includes a listing of the quantity of appliances, power consumption, and daily hours of operation of the appliance.

In the following recommendations for system design, these assumptions have been established for each type of facility as per the IPHS guidelines. It is to be noted that the decision making authority should also consider the increase in total daily load which can be expected in the future. This can be done in a strategic manner to arrive at a system design specification higher than the currently determined daily load. The detailed load calculations assumed for the system design in the document have been expanded upon in the Annexes.

The operational hours of each type of load in different rooms are considered for a typical day's usage based on the services being provided and Loads Considered in that particular room in that center. For instance, in a Health & Wellness Center, the lights and fans in the waiting area may be used for 4 hours in a day, which is considered as the operational hours of usage for that equipment.

At the CHC, Sub Divisional Hospital and District hospital levels, average hours of usage for each equipment are indicated in the associated Annexes. The specific hours may vary between rooms: for example, certain rooms where lights may be used for 2 hours per day while in others where they may be used for 4 hours per day. In this case, the operation hours for lights has been calculated at an average of 3 hours per day for all lights in the facility.

It is important to note that while the above assumptions have been made for the purpose of this document, customized designs are encouraged based on requirement, disease burden and patient load. For example, if a certain health facility has a specific disease burden, certain assumptions under this document may not hold true and may need to be reworked as per the need.

2.2 Factors for Determining System Design:

The following key information points have been used for determining the system design, detailed in the following sections:

2.2.1 Sunshine hours/Peak sun hours:

The term "peak sun hours[12]" refers to the solar insolation which a particular location would receive if the sun were shining at its maximum value for a certain number of hours. Since the peak solar radiation is 1 kW/m2, the number of peak sun hours is numerically identical to the average daily solar insolation. For example, a location that receives 5 kWh/m2 per day can be said to have received 5 hours of sun per day at 1 kW/m2. Being able to calculate the peak sun hours is useful because PV modules are often rated at an input rating of 1kW/m2. This refers to sunshine which a particular location would receive if the sun were shining at its maximum value for a certain number of hours in a day. It will vary in different geographical locations & climatic conditions.

For the purpose of this document, the geographical map of India has been bifurcated into 2 zones (3 hours sunshine and 5 hours sunshine) as detailed in Figure 1.

[12] Definition of standard sunshine hours

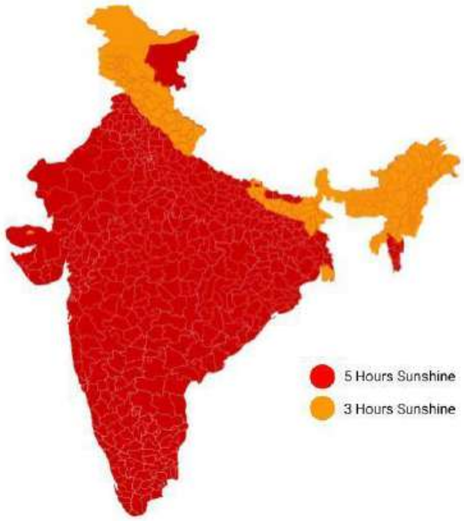

Figure 1: The map shows the district division as per sunshine hours. The document recommends 2 zones particularly and all system designs have been done keeping these in mind. Compiled from the NREL Source.

2.2.2 Days of Autonomy:

The days of autonomy is the number of days the load can operate without any charging from the sun. This is an important number because despite bad weather on a particular day, the system should still have enough reserve charge to be able to run the system.[13]

- For Health & Wellness Centers and PHCs, a 3-day autonomy has been considered (due to the higher probability of being in areas with very poor or no access to electricity)
- For CHCs, Sub Division Hospitals, and District Hospitals, a 2-day autonomy has been considered (as often these areas have more reliable electricity access)

While the above assumptions have been made for the purpose of this document, customized designs are encouraged for specific geographical areas, based on requirement.

2.2.3 Depth of Discharge (DOD):

It indicates the charging capacity of the battery DoD indicates the percentage of the battery that has been discharged relative to the overall capacity of the battery[14]. In the case of lead acid batteries the recommended DoD is 50%. i.e. the battery should not be discharged by more than half of available battery capacity to avoid any damage or premature system degradation. For lithium-ion batteries, it is 80%. All system designs in this document consider lead-acid batteries as per MNRE guidelines.

2.2.4 Equipment Level Efficiency:

[13] https://pveducation.com/
[14] https://federalbatteries.com.au/news/what-depth-discharge-and-why-it-so-important

- **Powering Existing Loads:** Powering currently existing loads in the centers like lights, fans, medical equipment; without consideration of an energy efficiency drive.
- **Powering Efficient Equipment:** Complementing the solar energy powering with an energy efficiency drive. This would include replacing all the existing high power consuming loads with less power consuming (more efficient) loads. For example, replacing all CFL and incandescent bulbs with LED bulbs, efficient fans and medical equipment etc. It is to be noted that the indicative costing does not include the cost of the energy efficient equipment. The difference in power consumption has been detailed in Table 1.

Table 1: Comparison of Existing (as per experience on the field) and Efficient Appliances

Appliance	Typical Existing Load (W)	Suggested Efficient Load (W)
Tube Lights*	40	20
Light Bulbs*	18	5 - 9
Ceiling Fans	75 - 80	28 - 32
Wall-mounted Fans	75	55
Baby Warmer/ Radiant warmer)	800	650
Suction Apparatus	200	132
Spotlight	100	20
Phototherapy	100	20

**The efficient load considers LED lights. It is assumed that typical lights seen at the health facility are CFL bulbs or incandescent or fluorescent tube lights.*

2.3 Aspects of System Costing:

The indicative costing in the following sections includes:

- Installed cost: Cost of system components (including solar panels, batteries, inverter, charge regulator, wiring, mounting structure etc) Transportation, installation and commissioning cost
- Maintenance cost for 5 years: It is to be noted that this maintenance cost does not include replacement of any spare parts. Please see section 9.4.2 for more details.
- GST of 12% on the installed cost

The indicative costing in this document do not include:

- Battery replacement: Lead acid batteries (considered for designs in this document) come with a warranty of 5 years; depending on usage and maintenance, the life of the lead acid battery could be extended to 7-8 years. At current costs, the battery replacement would cost approximately 35% of the total system cost. This would need to be planned for and allocated.

- Electrical and Medical Equipment: It is to be noted that the costs indicated do not include the cost of electrical and medical equipment.

It is also to be noted that the indicative costing mentioned in this document for each of the designs is an estimation for the present day and average scenario - depending on the transaction costs and geographies, the cost might vary from 10 to 20%.

The states are encouraged to allocate funds for universalization of solar energy in public health facilities across the States. Annex 7 details out some of the fund sources which can be unlocked, depending on the fund availability and local mandate.

Chapter

3

INTRO SOLAR SYSTEM DESIGN AND COSTING SUMMARY DUCTION

3. SOLAR SYSTEM DESIGN AND COSTING SUMMARY

SNo	Health Center Type	Type of Loads	Average total load (W)	Total Units/Day (Wh)	Average Sunshine Hours 3h (for states or regions like Meghalaya, Uttarakhand, etc)			Cost		Average Sunshine Hours 5h (for states or regions like Rajasthan, Madhya Pradesh, Karnataka etc)			Cost	
								Min	Max				Min	Max
					Panel KW	Battery Ah	Inverter	INR Lakhs	INR Lakhs	Panel KW	Battery Ah	Inverter	INR Lakhs	INR Lakhs
1	Health and Wellness Center - Type A	Existing	1,380	4,500	2.8	1800	4 kVA	**4.4**	**6.6**	1.95	1800	2.5 kVA	**3.3**	**5.5**
2		Efficient	678	1,900	1.2	620	2.5 kVA	**1.9**	**2.9**	0.68	620	1.4 kVA	**1.7**	**2.2**
3	Health and Wellness Center - Type B	Existing Loads	5,585	12,300	7.3	4100	10 kVA	**9.5**	**11.0**	4.4	4100	7.5 kVA	**6.8**	**7.7**
4		Efficient	3,766	5,800	3.5	1900	5 kVA	**5.5**	**6.1**	2.1	1900	5 kVA	**3.5**	**4.4**
5	Primary Health Center	Existing Loads	7,870	18,400	10.11	6100	20 kVA	**13.2**	**15.4**	6.6	6100	12.5 kVA	**9.7**	**10.8**
6		Efficient	4,620	10,000	6	3300	7.5 kVA	**9.7**	**10.3**	3.6	3300	7.5 kVA	**5.5**	**6.1**
7	Community Health Center	Existing Loads	19,000	54,000	32	18000	60 kVA	**38.5**	**41.8**	19.2	18000	60 kVA	**25.3**	**27.5**
8		Efficient	13,700	39,600	23.5	13000	40 kVA	**27.5**	**30.8**	14.1	13000	40 kVA	**18.2**	**20.4**
9	Sub-Division Hospital	Existing Loads	27,000	98,000	58.1	32100	80 kVA	**70.4**	**75.9**	35	32100	80 kVA	**41.8**	**45.1**
10		Efficient	22,800	83,000	50	27200	60 kVA	**66.0**	**70.4**	30	27200	60 kVA	**38.5**	**41.8**
11	District Hospital	Efficient	43,000	196,500	116	64300	175 kVA	**143.0**	**154.0**	70	64300	120 kVA	**83.6**	**90.2**
12	Grid-tie system (District Hospital and Medical Colleges)	8-10 watts per sqft of available roof space Installed cost: INR 40 - 60 per watt (States to follow the most up to date MNRE benchmark costing)												

Chapters

4-10

HEALTH FACILITY: DESIGNS AND COSTING

4. HEALTH AND WELLNESS CENTERS (HWCs): DESIGNS AND COSTING

4.1. Overview:

In the public sector, a Health & Wellness Center (HWC) is the most peripheral and first point of contact between the primary health care system and the community. In order to provide quality care in these HWCs, Indian Public Health Standards (IPHS) are being prescribed to provide basic primary health care services to the community and achieve and maintain an acceptable standard of quality of care. Currently, HWCs have been categorized into 2 Types (Types A and B) taking into consideration various factors namely catchment area, health seeking behavior, case load, location of other facilities like PHCs, CHCs, SDHs, District Hospitals in the vicinity of the HWC.[15]

- Type A HWC provides all recommended services except that the facilities for conducting delivery which will not be available here. If the requirement for delivery services goes up, Indian Public Health Standards (IPHS) Guidelines for HWCs the Health & Wellness Center may be considered for upgradation to Type B.
- Type B HWC provides all recommended services including facilities for conducting deliveries at the HWC itself. Although the main focus shall be to promote institutional deliveries, the facilities for attending to home deliveries shall remain available at both types of HWCs.

The following sections provide detailed designs for both types of Health & Wellness Centers with different types of loads. The detailed load calculations for each of these typologies and options under HWCs are provided under Annex 2.

4.2. TYPE A: Loads considered, System design and Costing

HWCs Type A provide health prevention and promotion services.

4.2.1. TYPE A: Loads considered for each room

Loads considered for each room are based on the services being provided as per IPHS guidelines and are listed in the table below. Details on the operational hours, number of appliances and wattage of each appliance are provided in Annex 2 (a) and Annex 2 (b).

Type Of Room	Loads Considered
OPD/Clinic	Lights, fans, Laptop*, Printer*
Examination Room	Lights, fans, WIFI*

[15] IPHS Guidelines for SCs

Waiting Area	Lights, fans
Staff Residence (incl. Kitchen, Bathroom/ toilet)	Lights
Outdoor	Light
Store room	Light

** Equipment not mentioned in the detailed equipment list under IPHS guidelines, but deemed necessary to provide recommended services in the health facilities.*

4.2.2. TYPE A: Designs and Costing

The solar system for Health & Wellness Center Type A is designed considering all of the above loads for an AC system with 3 days autonomy (based on assumption laid out in Section 2.2.2). The system designs provided below consider:

(a) Lower and higher sunshine hours i.e., 3 hours and 5 hours (refer section 2.2.1)
(b) Powering of existing inefficient vs. efficient equipment (refer Section 2.2.4)

The system designs (i.e. panel, battery and inverter capacity) and indicative costs are outlined in the table below. For load calculations refer to Annex 2 (a) and Annex 2 (b).

Parameters	*Powering Existing*		*Powering Efficient Equipment*	
Max Load connected (Watts)	**1380 W**		**678 W**	
Max Units that can be utilized per day (KiloWatt Hour)	**4.5 kWh**		**1.9 kWh**	
Peak Sun Hours per day (Hrs)	**Lower Sunshine Hours**	**Higher Sunshine Hours**	**Lower Sunshine Hours**	**Higher Sunshine Hours**
Solar Panel capacity (kW)	**2.8 kW**	**1.95 kW**	**1.2 kW**	**0.68 kW**
** Battery Capacity (Ah)*	**1800 Ah**	**1800 Ah**	***620 Ah***	***620 Ah***
Inverter capacity equivalent to	**4kVA**	**2.5 kVA**	**2.5 kVA**	**1.4 kVA**
Indicative Costing (Capital Cost including Solar and 5year service & maintenance) As of Feb 2022 (in lacs)	**4.4 - 6.6**	**3.3 - 5.5**	**1.9 - 2.9**	**1.7 - 2.2**

**Designs have been developed considering Lead Acid Batteries. If they are to be replaced with Gel Batteries, the costing would increase by 10-12%. (The Gel Batteries would be considered based on the approval of MNRE). Batteries in this design are rated at 12 V and c10.*

4.3. TYPE B: Loads considered, System design and Costing

HWCs Type B provide Health Prevention and Promotion Services as well as normal deliveries.

4.3.1. TYPE B: Loads considered for each room

Loads considered for each room are based on the services being provided as per IPHS guidelines and are listed in the table below. Details on the operational hours, number of appliances and wattage of each appliance are provided in Annex 2 (c) and Annex 2 (d). Best practices and customisation as outlined in Section 2.1.2 is encouraged.

Type Of Room	Loads Considered
Consultation/ OPD Room	Lights, Fans, Laptops*, Printers*
Sterilizer Room	Lights, Sterilizer/Autoclave**
Labor room	Lights, Fan, Radiant Warmer, Suction Machine, Spot Light
Examination room	Lights & Fan
Wards	Lights & fan
Nurse station	Lights & fan
Immunization Room	Lights & fan
Clinic	Lights & fan
Emergency Room	LED lighting, fan, mobile light, oxygen concentrator
Waiting Area	Lights & fan
Store	Lights
Bath/ Wash/ Toilet	Lights
Veranda	Lights and fan
Outdoor	Light

Table: Equipment considered are adequate to provide all the assured services in the Health & Wellness Centers Type B. This also includes all the equipment necessary for conducting safe deliveries at HWC.
** Equipment not mentioned in the detailed equipment list under IPHS guidelines, but deemed necessary to provide recommended services in the health facilities.*
*** It is advisable to use the Autoclave/ Sterilizer once in a day and preferably day time*

4.3.2. TYPE B: Designs and Costing

The solar system for Health & Wellness Center Type B is designed considering all of the above loads for an AC system with 3 days autonomy (based on assumption laid out under 2.2.2). The system designs provided below consider:

(a) Lower and higher sunshine hours i.e., 3 hours and 5 hours (refer section 2.2.1)
(b) Powering of existing inefficient vs. efficient equipment (refer Section 2.2.4)

The system designs (i.e. panel, battery and inverter capacity) and indicative costs are outlined in the table below. For load calculations refer to Annex 2 (c) and Annex 2 (d).

Parameters	*Powering Existing*		**Powering Efficient Equipment**	
Max Load that can be connected (Watts)	**5585 W**		**3766 W**	
Max Units that can be utilized per day (KiloWatt Hour)	**12.3 kWh**		**5.8 kWh**	
Peak Sun Hours per day (Hrs)	**Lower Sunshine Hours**	**Higher Sunshine Hours**	**Lower Sunshine Hours**	**Higher Sunshine Hours**
Solar System Capacity	**7.3 kW**	**4.4 kW**	**3.5 kW**	**2.1 kW**
** Battery Capacity*	**4100 Ah**	**4100 Ah**	***1900 Ah***	***1900 Ah***
Inverter Capacity Equivalent to	**10 kVA**	**7.5 kVA**	**5 kVA**	**5kVA**
Indicative Costing (Capital Cost including Solar and 5year service & maintenance) As of Feb 2022 (INR in lacs)	**9.5 - 11**	**6.8 - 7.7**	**5.5 - 6.1**	**3.5 - 4.4**

** Designs have been developed considering Lead Acid Batteries. If they are to be replaced with Gel Batteries, the costing would increase by 10-12%. (The Gel Batteries would be considered based on the approval of MNRE). Batteries in this design are rated at 12 V and c10.*

5. PRIMARY HEALTH CENTERS (PHCs): DESIGN AND COSTING

5.1. Overview

Primary Health Center is the cornerstone of rural health services- a first port of call to a qualified doctor of the public sector in rural areas for the sick and those who directly report or are referred from HWCs for curative, preventive and promotive health care. A typical Primary Health Centre covers a population of 20,000 in hilly, tribal, or difficult areas and 30,000 populations in plain areas with 6 indoor/observation beds. It acts as a referral unit for 6 HWCs and refers out cases to CHC (30 bedded hospital) and higher order public hospitals located at sub-district and district level.

The overall objective of IPHS is to provide health care that is quality oriented and sensitive to the needs of the community. The objectives of IPHS for PHCs are:

- To provide comprehensive primary health care to the community through the Primary Health Centers.
- To achieve and maintain an acceptable standard of quality of care.
- To make the services more responsive and sensitive to the needs of the community.[16]

From a Service delivery angle, PHCs may be of two types, depending upon the delivery case load: Type A and Type B.

- Type A PHC: PHC with delivery load of less than 20 deliveries in a month
- Type B PHC: PHC with delivery load of 20 or more deliveries in a month

The design provided in the following section caters to both Type A and Type B PHCs, considering a maximum of 35 deliveries per month.
The detailed load calculations for all options under PHCs are provided in Annex 3.

5.1.1: PHCs: Load considerations

Loads considered for each room are based on the services being provided as per IPHS guidelines and are listed in the table below. Details on the operational hours, number of appliances and wattage of each appliance are provided in Annex 3 (a) and Annex 3 (b). Best practices and customisation as outlined in Section 2.1.2 is encouraged.

Type of Room	Loads Considered
Office	Lights, Fans, Laptop & printer
Registration	Lights, Fans, Laptop & printer
Labor Room	Lights, Fan, Phototherapy, Radiant Warmer, Suction Machine, Spot Light, Phototherapy
Ladies & Gents Ward	Lights, Fans

[16] IPHS Guidelines for PHCs

Nurse Room	Lights, Fans
Laboratory	Lights, Fans, Microscope and Centrifuge
Minor OT	Lights, Fans, Nebulizer, Needle cutter
OPD	Lights, Fan
Cold Chain room & Pharmacy	Lights, Fan
Immunization room	Lights, Fan,
Dressing room	Lights, Fan
Cold chain equipment in cold chain room, pharmacy, immunization rooms	Cold Chain room and Pharmacy- ILR, Deep Freezer Immunization- Refrigerator
Emergency Room	Lights, Fan, Mobile Light, Oxygen Concentrator, ECG machine
Store room	Light
Waiting area	Lights, Fan
Wash/Bath/Toilet	Light
Entrance	Light
Corridor	Lights, Fan

Notes: Equipment considered are adequate to provide all the assured services in the Primary Health Center. This also includes all the equipment necessary for conducting safe deliveries at the PHC.

5.2. PHCs: Energy system design and costing

The solar system for Primary Health Center is designed considering all of the above loads for an AC system with 3 days autonomy (based on assumption laid out under 2.2.2). The system designs provided below consider:

(a) Lower and higher sunshine hours i.e., 3 hours and 5 hours (refer section 2.2.1)
(b) Powering of existing inefficient vs. efficient equipment (as mentioned in Section 2.2.4)

The system designs (i.e. panel, battery and inverter capacity) and indicative costs are outlined in the table below. For load calculations refer to Annex 3 (a) and Annex 3 (b).

Parameters	*Powering Existing*	Powering Efficient Equipment
Max Load that can be connected (Watts)	**7870 W**	**4620 W**
Max Units that can be utilized per day (KiloWatt Hour)	**18.4 kWh**	**10 kWh**

Peak Sun Hours per day (Hrs)	**Lower Sunshine Hours**	**Higher Sunshine Hours**	**Lower Sunshine Hours**	**Higher Sunshine Hours**
Solar System Capacity Required (kW)	**10.11 kW**	**6.6 kW**	**6 kW**	**3.6 kW**
** Battery capacity*	***6100 Ah***	***6100 Ah***	***3300 Ah***	***3300 Ah***
Inverter Capacity Equivalent to	**20 kVA**	**12.5 kVA**	**7.5 kVA**	**7.5 kVA**
Indicative Costing (Capital Cost including Solar and 5 year service & maintenance) As of Feb 2022 (INR in lacs)	**13.2 - 15.4**	**9.7 - 10.8**	**10 - 12**	**5.5 - 6.1**

** Designs have been developed considering Lead Acid Batteries. If they are to be replaced with Gel Batteries, the costing would increase by 10-12%. (The Gel Batteries would be considered based on the approval of MNRE). Batteries in this design are rated at 12 V and c10.*

6. COMMUNITY HEALTH CENTERS (CHC): DESIGN AND COSTING

6.1. Overview:

The CHCs are designed to provide referral health care for cases from the Primary Health Centers level and for cases in need of specialist care approaching the center directly. CHC is a 30-bedded hospital providing specialist care in Medicine, Obstetrics and Gynecology, Surgery, Pediatrics, Dental and AYUSH[17].

- Unlike HWCs and PHCs, CHCs have been envisaged as only one type and will act both as Block level health administrative units and gatekeeper for referrals to higher level of Facilities.
- The revised IPHS Guidelines (2012) for CHC considers the services, infrastructure, manpower, equipment and drugs in two categories of Essential (minimum assured services) and Desirable (the ideal level services which the states and UT shall try to achieve).
- All essential services as envisaged in the CHC should be made available, which includes routine and emergency care in Surgery, Medicine, Obstetrics and Gynecology, Pediatrics, Dental and AYUSH in addition to all the national health programs.
- Standards of services under existing programs were updated and standards added for newly developed non communicable disease programs based on the inputs from various program divisions.
- Standards for Newborn stabilization units, MTP facilities for second trimester pregnancy (desirable), The Integrated Counseling and Testing Center (ICTC), Blood storage and link Antiretroviral Therapy center have been added.[18]

6.1.1: Loads considered and other assumptions:

The operational hours for each of the loads in a CHC are based on a typical daily usage. Details on the loads considered, number of units of each appliance, wattage of each appliance and average operational hours are provided in Annex 4. Best practices and customisation as outlined in Section 2.1.2 is encouraged for optimal system design.

For CHCs, the design complements electricity from the grid with 4-5 hours of backup for the entire center. It considers loads mentioned in the table below. Since CHCs are located in areas with grid connectivity, the solar system is designed for back-up, considering 4-5 hours of power

[17] As per IPHS guidelines for CHCs
[18] IPHS Guidelines for CHCs

cut per day. Even in the case of reliable electricity, CHCs are encouraged to off-set some of their power consumption from the grid by generating power locally. This will impact the burden of recurring electricity bills over a period of time. Further, it would reduce the damage to equipment typically caused by voltage fluctuations in grid-based electricity.

Critical equipment such as Vaccine Storage, however, are considered with a full 8 hours of back up (time required for the compressor to run to keep the vaccine storage running).

The solar system design considered different loads spread across services as defined by IPHS guidelines (2012). The decision on whether or not to power specific equipment are outlined below:

- Equipment such as sterilizers in operation theaters, dental OPD, X-ray machines, Air Conditioners, Autoclaves are not considered for design due to their high power consumption and surge loads.
- Desirable services (as per IPHS guidelines, 2012) such as Tobacco control services, Ultrasonography under Radiology, Medical Termination of Pregnancy services (MTP), etc are not considered under the solar system design.

Type of services	Loads Considered
Administration	Printer, Photocopier, Computer
Emergency	Cardiac Monitor, Needle cutter, Oxygen concentrator
Operation Theater (including deliveries, newborn care)	Lights (ceiling and portable), Nebulizer, Suction apparatus, Radiant warmers, Phototherapy, Oxygen Concentrator, Cardiac Monitor, Refrigerator, Spotlight, Examination light, Needle Cutter
Prenatal care	Ultrasound
Blood transfusion (materials kit)	Centrifuge, Microscope
Immunization	ILR, Deep Freezer
Blood storage	Blood bank refrigerators, Deep freezers, Microscope and Centrifuge
Laboratory	Refrigerator, Needle Cutter, Microscope and Centrifuge, CDC machine*, TSH machine*, Digital Lab Centrifuge, Truant machine*, Biochemistry Machine
NPCDCS	ECG, Cardiac Monitor
Dental care	Dental chair with equipment, Needle cutter
General	Lights and Fans for all rooms; Refrigerators (3 units), Laptops for doctors' room, Microscope, Water dispenser*, Computers and Printers in specific rooms, TV

Table: Equipments under IPHS guidelines (2012) considered for the solar back-up.
** Equipment not mentioned in the detailed equipment list under IPHS guidelines, but deemed necessary for service provision in the health facilities based on field experience.*

6.2. CHCs: Energy System Designs and Indicative Costing:

The solar system for the CHC is designed considering the following aspects, in addition to what has been detailed under Sections 5.1.1:

- Lower and higher sunshine hours i.e., 3 hours and 5 hours (Refer to Section 2.2.1)
- Powering of existing inefficient vs. efficient equipment (Refer to Section 2.2.4)
- 2-day autonomy has been considered (as the CHC and upper tiers of healthcare provision are likely to be in areas with relatively more reliable electricity access. Refer to Section 2.2.2)

The system designs (i.e. panel, battery and inverter capacity) and indicative costs are outlined in the table below. For load calculations refer to Annex 4 (a) and Annex 4 (b).

Parameters	Powering Existing (Excluding AC & X-Ray)		Powering Efficient Equipment (Excluding AC & X-Ray)	
Max Load that can be connected (kilo Watts)	**19 kW**		**13.7 kW**	
Max Units that can be utilized per day (KiloWatt Hour)	**54 kWh**		**39.6 kWh**	
Peak Sun Hours per day (Hrs) - Considered as an average from all the loads	**Lower Sunshine Hours**	**Higher Sunshine Hours**	**Lower Sunshine Hours**	**Higher Sunshine Hours**
Solar System capacity required (kW)	**32 kW**	**19.2 kW**	**23.5 kW**	**14.1 kW**
** Battery Capacity*	**18000 Ah**	**18000 Ah**	**13000 Ah**	**13000Ah**
Inverter Capacity Equivalent to	**60 kVA**	**60 kVA**	**40 kVA**	**40 kVA**
Indicative Costing (Capital Cost including Solar and 5 year service & maintenance) As of Feb 2022 (INR in lacs)	**38.5 - 41.8**	**25.3 - 27.5**	**27.5 - 30.8**	**18.2 - 20.4**

** Designs have been developed considering Lead Acid Batteries. If they are to be replaced with Gel Batteries, the costing would increase by 10-12%. (The Gel Batteries would be considered based on the approval of MNRE). Batteries in this design are rated at 12 V and c10.*

7. SUB DIVISIONAL HOSPITALS: DESIGN AND COSTING

7.1: Overview:

Sub-divisional/ Sub District hospitals (SDHs) are below the district and above the block level (CHC) hospitals and act as First Referral Units for the Tehsil/Taluk/block population in which they are geographically located. They have an important role to play as First Referral Units in providing emergency obstetrics care and neonatal care and help in bringing down the Maternal Mortality and Infant Mortality. They form an important link between HWC, PHC and CHC on one end and District Hospitals on the other end. It also saves the travel time for the cases needing emergency care and reduces the workload of the district hospital. A subdivision hospital caters to about 5-6 lakh people.

The Sub Divisional Hospitals are divided into two categories. Category I being 31-50 beds and the category II being 51 - 100 beds. It is presumed that above 100 bed strength, healthcare facilities would constitute District Hospital groups.[19]

7.1.1: Loads considered and other assumptions:

The operational hours for each of the loads in the facility are based on a typical daily usage. Details on the loads considered, number of units of each appliance, wattage of each appliance and average operational hours are provided in Annex 5. Best practices and customisation as outlined in Section 2.1.2 is encouraged for optimal system design.

Typically, Sub Divisional Hospitals are located at Taluk level or below district level with relatively better access in terms of roads, grids and other amenities. The design, therefore, complements electricity from the grid with 4-5 hours of backup for the entire center. It considers loads mentioned in the table below. Since SDHs are located in areas with grid connectivity, the solar system is designed for back-up, considering 4-5 hours of power cut per day. Even in the case of reliable electricity, health facilities are encouraged to off-set some of its power consumption from the grid by generating power locally. This will impact the burden of recurring electricity bills over a period of time. Further, it would reduce the damage to equipment typically caused by voltage fluctuations in grid-based electricity.
Critical equipment such as for vaccine storage, however, are considered with a full 8 hours of back up (time required for the compressor to run to keep the vaccine storage running).

The solar system design considered different loads spread across services as defined by IPHS guidelines (2012). The decision on whether or not to power specific equipment are outlined

[19] IPHS guideline for Sub Division Hospitals

below:

- The design considers all the basic loads (lights, fans, computers, printers, microscopes, etc) across different service areas to cover the needs of these rooms. The rooms considered for the design are Labor room, Triage room, Staff Nurse rooms, Waiting rooms, Post delivery wards, Pharmacy, Male and female wards, Operation theater, Labs, all the rooms in the Blood bank, all the key rooms in admin block, and Outpatient Department (OPD)
- Large imaging equipment such as 100-300 mA X-Ray machines, Ultra Sonograms, etc are not considered under due to their high power consumption.
- Loads and hospital fittings such as Air conditioners, coolers, heaters, sterilizers, Hot air ovens, Vacuum cleaners, Steam laundry machines, etc are not considered under the design with the assumption that they are not critical to be powered during the power cuts.
- Solutions associated with bio-medical waste management such as plastic shredder, incinerators, autoclaves are not considered under the solar design as they could be run with the availability of grid, and are also high power consuming.

Services	Loads Considered
General	Lights, Fans, Laptops, Water Dispenser*, Printer
Emergency room	Lights and fans, Oxygen concentrator, Needle cutter
Cardiopulmonary Equipment	Cardiac Monitor,
Labor ward & NeoNatal care	Cardio Toco Graph (CTG) Monitor, Baby incubators, Nebulizer, Fetal Doppler,Phototherapy, Oxygen Concentrator, Spotlight, Refrigerator
Eye Equipment	Operating Microscope, Auto refractometer, Slit Lamp
Dental care	Dental chair, Needle Cutter
Operation Theater	Autoclave, OT light
ICU	Ventilator, Defibrillator, High end monitor
Laboratory	Refrigerator, Needle Cutter, Microscope, electrolyte machine, cell counter machine, centrifuge, Fans, Lights, Biochemistry Machine, Printer, Computers, Lab Incubator,Fridge*
Immunization	ILR, Deep Freezer
Blood Bank	Blood Bank Refrigerator, ILR, Deep Freezer, Refrigerator, Blood Bag Sealer, Water Bath Serological, Lisa Wash*, Lisa scan EM*, Microscope and Centrifuge

Table: Equipments under IPHS guidelines (2012) considered for the solar back-up.
** Equipment not mentioned in the detailed equipment list under IPHS guidelines, but deemed necessary for service provision in the health facilities based on field experience.*

7.2. Sub Divisional Hospitals: Energy System Designs and Indicative Costing:

The solar system for the Sub Divisional Hospital is designed considering the following aspects, in addition to what has been detailed under Sections 6.1.1:

- Lower and higher sunshine hours i.e., 3 hours and 5 hours (Refer to Section 2.2.1)
- Powering of existing inefficient vs. efficient equipment (Refer to Section 2.2.4)
- 2-day autonomy has been considered (as the SDH and upper tiers of healthcare provision are likely to be in areas with relatively more reliable electricity access. Refer to Section 2.2.2)

The system designs (i.e. panel, battery and inverter capacity) and indicative costs are outlined in the table below. For load calculations refer to Annex 5 (a) and Annex 5 (b).

Parameters	Powering Existing		Powering Efficient Equipment	
Max Load that can be connected (kilo Watts)	**27 kW**		**22.8 kW**	
Max Units that can be utilized per day (KiloWatt Hour)	**98 kWh**		**83 kWh**	
Peak Sun Hours per day (Hrs) - Considered as an average from all the loads	**Lower Sunshine Hours**	**Higher Sunshine Hours**	**Lower Sunshine Hours**	**Higher Sunshine Hours**
Solar System capacity required (kW)	**58.1 kW**	**35 kW**	**50 kW**	**30 kW**
**Battery Capacity*	**32100 Ah**	**32100 Ah**	**27200 Ah**	**27200 Ah**
Inverter Capacity Equivalent to	**80 kVA**	**80 kVA**	**60 kVA**	**60 kVA**
Indicative Costing (Capital Cost including Solar and 5 year service & maintenance) As of Feb 2022 (INR in lacs)	**70.4 - 75.9**	**41.8 - 45.1**	**66 - 70.4**	**38.5 - 41.8**

** Designs have been developed considering Lead Acid Batteries. If they are to be replaced with Gel Batteries, the costing would increase by 10-12%. (The Gel Batteries would be considered based on the approval of MNRE). Batteries in this design are rated at 12 V and c10.*

8. DISTRICT HOSPITALS: DESIGN AND COSTING

8.1 Overview:

District Hospital is a hospital at the secondary referral level responsible for a district of a defined geographical area containing a defined population. Its objective is to provide comprehensive secondary health care services to the people in the district at an acceptable level of quality and being responsive and sensitive to the needs of people and referring centers. Every district is expected to have a district hospital. As the population of a district is variable, the bed strength also varies from 75 to 500 beds depending on the size, terrain and population of the district.

The overall objective of IPHS is to provide health care that is quality oriented and sensitive to the needs of the people of the district. The specific objectives of IPHS for District Hospitals are:

1. To provide comprehensive secondary health care (specialist and referral services) to the community through the District Hospital.
2. To achieve and maintain an acceptable standard of quality of care.
3. To make the services more responsive and sensitive to the needs of the people of the district and the hospitals/centers from where the cases are referred to the district hospitals.[20]

Services that a District Hospital is expected to provide can be grouped as Essential (Minimum Assured Services) and Desirable (which we should aspire to achieve). Following are the major services at the District Hospital as per Indian Public Health Standards (IPHS) guideline.

- Grade I: District hospitals norms for 500 beds
- Grade II: District Hospital Norms for 400 beds
- Grade III: District hospitals norms for 300 beds
- Grade IV: District hospitals norms for 200 beds
- Grade V: District hospitals norms for 100 beds.

8.1.1: Loads Considered and other assumptions

The design templates that are mentioned below are done for the DHs with 100 beds - considering loads across different types including some of the key loads such as maternal & childcare, laboratory, operation theater, blood bank, admin among other critical rooms.

Since the District Hospitals are located at the headquarters of the district with relatively more reliable electricity access, the solar design complements the connected grid with 4 hours of backup for the different key services. It considers loads mentioned in the table below.

[20] IPHS Guidelines (2012) for DHs

Since DHs are located in areas with grid connectivity, the solar system is designed for back-up, considering 4-5 hours of power cut per day. Even in the case of reliable electricity, DHs are encouraged to off-set some of its power consumption from the grid by generating power locally. This will impact the burden of recurring electricity bills over a period of time. Further, it would reduce the damage to equipment typically caused by voltage fluctuations in grid-based electricity. Critical equipment such as Vaccine Storage, however, are considered with a full 8 hours of back up (time required for the compressor to run to keep the vaccine storage running).

The solar system design considered different loads spread across services as defined by IPHS guidelines (2012). The decision on whether or not to power specific equipment are outlined below:

- Large imaging equipment such as 500mA and 300mA X-Ray machines, Ultra Sonograms, etc are not considered under the solar design due to their high power consumption. However, medium range machines such as 100mA X-Ray machines are considered for the design.
- Loads and equipment related to equipment for disinfection of Special Newborn Care Unit such as heaters/ boilers, washing machines with dryers, vacuum cleaners, electronic fumigators, disinfectant sprayers, etc are not considered for the design.
- Loads and hospital fittings such as Air conditioners, coolers, heaters, sterilizers, Hot air ovens, Vacuum cleaners, Steam laundry machines, borewell motors etc are not considered under the design with the assumption that they are not critical to be powered during the power cuts.
- Solutions associated with bio-medical waste management such as plastic shredder, incinerators, autoclaves are not considered under the solar design as they could be run with the availability of grid, and are also high power consuming.
- Specialized equipment related to Oncology and Radiotherapy such as Radiotherapy simulator, Energy Linear Accelerator, High Dose Linear Accelerator are not considered under the design due to their high power consumption.
- The design considers all the basic loads (lights, fans, computers, printers, microscopes, etc) across different service areas to cover the needs of these rooms. The rooms considered for the design are Labor room, Triage room, Staff Nurse rooms, Waiting rooms, Post delivery wards, Pharmacy, Male and female wards, Operation theater, Labs, all the rooms in the Blood bank, all the key rooms in admin block, and Outpatient Department (OPD)[21]

[21] Mapping of loads with IPHS guidelines (2012)

Services	Loads Considered
OPD, Wards, Corridors, Registration Counters, Administrative Block, National Health Programs (Rooms), Laundry, Kitchen, Store room, Pharmacy, Nursing room	Lights, Fans, Desktop, Printer, Refrigerator, AC
ICU	Lights and fans, Ventilator, Suction Apparatus, Cardiac Monitor, ABG Machine, Oxygen concentrator, Refrigerator, Needle cutter
Operation Theater	OT Table, Cautery Machine, Suction Apparatus, Radiant Warmer, Laparoscopic Set, Anesthesia Unit, Oxygen Concentrator
Maternal and Child Health (Labour Room, Female Ward, Maternity Ward, Maternity OT)	Lights, Fans, Radiant Warmer, Suction Apparatus, Spotlight, Refrigerator
Dental care	Dental Chair, Dental Chair Compressor
Immunization and Cold Chain	ILR, Deep Freezer, Lights and Fans
Blood Bank and Laboratory	Blood Bank Tube Sealer, Blood Collection Monitor, Blood Storage Refrigerator, Centrifuge, Cryobath, Deep Freezer, Microplate Reader, Microplate Washer, Hematology Analyser, Lisa scan, Microscope, Microscope Water System, Microscope Printer, Biochemistry Analyser Cuvettes, Mini Rotary Shaker, Needle Destroyer, Needle Cutter, Plasma Thawing Bath, Platelet Agitator and Incubator, Printer, Refrigerators, Serology Water Bath, Tube Sealer

Table: Equipments under IPHS guidelines (2012) considered for the solar back-up.

8.2. District Hospitals: Energy System Designs and Indicative Costing:

The solar system for the District Hospital is designed considering the following aspects, in addition to what has been detailed under Sections 7.1.1:

- Lower and higher sunshine hours i.e., 3 hours and 5 hours (Refer to Section 2.2.1)
- Indicative powering of efficient equipment only
- 2-day autonomy has been considered (as the DH and upper tiers of healthcare provision are likely to be in areas with relatively more reliable electricity access. Refer to Section 2.2.2)

The system designs (i.e. panel, battery and inverter capacity) and indicative costs are outlined in the table below. This system For load calculations refer to Annex 6

Parameters	Powering Energy Efficient Equipment	
Summary of services considered	Maternity-care, Child-care, ICU, Operation Theater, Immunization, Blood Bank, Laboratory and Admin	
Max Load that can be connected (kilo Watts)	43 kW	
Max Units that can be utilized per day (KiloWatt Hour)	196,500 kWh	
Peak Sun Hours per day (Hrs) - Considered as an average from all the loads	**Lower Sunshine Hours**	**Higher Sunshine Hours**
Solar System capacity required (kW)	**116 kW**	**70 kW**
**Battery Capacity*	**64300 Ah**	**64300 Ah**
Inverter Capacity Equivalent to	**175 kVA**	**120 kVA**
Indicative Costing (Capital Cost including Solar and 5 year service & maintenance) As of Feb 2022 (INR in lacs)	**143 - 154**	**83.6 - 90.2**

** Designs have been developed considering Lead Acid Batteries. If they are to be replaced with Gel Batteries, the costing would increase by 10-12%. (The Gel Batteries would be considered based on the approval of MNRE). Batteries in this design are rated at 12 V and c10*

9. OTHER LOADS IN HEALTHCARE FACILITIES

9.1 Water Pumping

Water is a critical element in facilitating different key services in the health center such as deliveries and basic as well basic washing and cleaning purposes. An increase of PV capacity for water pumping can also reduce the use of diesel, since additional pumping is often performed during the day. Following are the designs for solar water pumps that could be installed at the health facilities across different tiers. Since the system doesn't include the batteries, the solar system can be designed and installed separately.

Capacity of pump	1 HP	2HP	3HP
Solar System	1.2 kWp	1.8 kWp	3 kWp
Indicative Costing (Including Transportation & GST) (INR in lacs)	1.3 - 1.5	1.6 - 1.8	2.5 - 2.8

9.2 Water Heating

Hot water is a key necessity for the healthcare facilities, especially for maternal care, laboratories and other key activities, and is economically viable. Following are the key designs and indicative costing for solar water heating solutions.

Capacity	200 LPD (Ltr per day)	300 LPD	500 LPD
Indicative Costing (Including Transportation & GST) (INR)	27,000	38,000	61,000

10. ROOF-TOP GRID-TIED SYSTEM

In some cases, where power reliability is very high, grid-tied roof top solar systems could also be looked at as an option. For states with robust buy-back policies that could be economically attractive, it might make sense for health institutions like district hospitals and medical colleges to opt for grid-tied systems.

The grid tied systems are designed on the basis of roof space availability. The normal benchmark is approximately 8-10 watts per square foot of available roof space. These systems directly interact with the grid, and have no provisions for batteries.

Depending on the incentives and per unit costs offered by the local government and electricity board, the individual institutions could save considerable in terms of electricity bills. The states are advised to refer to the MNRE guidelines on grid connected solar roof-top systems for more details. The absence of batteries reduces the capital cost considerably. The selected institutions need to make sure they allocate dedicated personnel to liaison with the respective utilities for power purchase agreements (PPA) and timely payments.

There are some primary disadvantages of a roof-top system that need to be considered by the relevant stakeholders while designing and selecting the energy model for the health facility. For example, in a grid-tied system, it is important to note that the solar power will not be usable during power outages. Thus, depending on the criticality of the services, reliability of power and back-up requirements would need to be assessed. Additional separate standalone solar energy systems will have to be installed for those identified critical services.

Chapter 11

INSTALLATION OF DRE SOLUTIONS FOR PUBLIC HEALTH FACILITIES

11. INSTALLATION OF DRE SOLUTIONS FOR PUBLIC HEALTH FACILITIES

11.1 Key aspects of Pre-Installation

11.1.1 Trainings required at pre-installation stage:

Training and skilling across different stakeholders (especially the vendors, healthcare staff) would be critical in the effective installation process and utilization of solutions in the facility. The section looks at various training programs that need to be conducted across the timeline of the program

Key training and awareness programs required pre-installation include:

11.2.1a For the on-site assessments to prepare site-readiness for each of the facilities, a thorough on-site assessment would have to be conducted. This would include different stakeholders, where the training and capacity building would be required. The training components include basic understanding of importance of site assessment, step by step details of how to document the site-specific nuances, and the key considerations in terms of different healthcare levels.

11.2.1b A specific training program with local working healthcare staff regarding the awareness and key knowledge on the management of assets along with the operation and maintenance of PV systems is required. The training program can be launched in parallel with the installation of the PV systems. In addition, training of local staff on management of energy stored in batteries is necessary, including the operation of critical, important and unimportant loads. A user manual should be delivered to end-users of health facilities and technicians. For instance, a user manual should illustrate battery water level measurement and should show a caution of misusing batteries. This will help technicians in remote monitoring or reporting a problem might occur.

- Along with that the installation training to be provided on the Standard Operating Procedure for the local solar enterprises. This is to include introduction to installation, creating pre-installation check-list, on the installation procedure, bringing out the best practices, common errors that occur, and other key components for the local enterprises. The training is also to be provided to the local enterprises on creating the checklist and handover documents for staff at health centers on proper usage of the energy system and appliances
- Along with the above, it is critical to conduct awareness programs for the local community, in collaboration with the local NGOs, or civil society organizations, about the infrastructure upgrade at the health facility - showcase significance of decentralized energy solutions for effective at last mile healthcare delivery. It is critical to undertake outreach and popularize the availability of services (through upgradation and energy access) to increase usage of health facilities by the community in the future.

11.2 Key Aspects of Post-Installation

11.2.1 Operation and maintenance of the solar systems

After the installations are complete, regular & annual maintenance are essentially required for the sustenance of the systems. Lack of periodic maintenance hampers the regular operations of the systems and appliances which will ultimately hinder the continuous service delivery in health centers. After the system installation, the health center staff and community members must be trained on the basic technicalities, operations & maintenance of the systems by the technician. The concerned team will be responsible for day-to-day supervision and monitoring of the systems as well as solar powered equipment and appliance for its smooth functioning

Most PV systems are designed by independent consultants either State Project management Unit (PMU) in liaison with State Renewable Development Agency or private agencies having expertise in installation of the PV systems in PPP model. The task includes system design, field survey, and preparing the technical specifications of PV systems.

A dedicated Operation and Maintenance (O&M) Cell is recommended at every district, which can regularly monitor the performance of all the systems installed and provide repair and maintenance services as and when required in their area of responsibility. Further, the system being maintenance intensive would require AMC support for 5 years with option of battery replacement as and when found dysfunctional. The main PV systems components, lifetime and maintenance recommendation are as follows:

System Components	Lifetime (Years)	Maintenance	Suggested Responsibility	
			Health Center Staff	Local Energy Vendor
Solar panels	20	Clean dust on modules regularly (once a month)	X	
		Check PV array output current, voltage and connections (once a Year)		X
Batteries (Lead-Acid Type)	5 - 10	• Clean battery terminals regularly (once a month) • Check Electrolyte level of battery cells (once a month) • Check level of electrolyte of cells (once a month) • Check the voltage of the battery (twice a month) e.g., at noon it should be 14V for a 12V battery • Fill distilled water when required.	X	

Charge Controllers	10	• Inspect connection of wiring to and from charge controllers (once a year) • Check charging current and voltage		X
Inverters	10	• Inspect connection of wiring to and from inverters (once a year) • Check output current and voltage		X
Wiring, Connection s, etc.	20	Check fuse, connections between system components regularly (once a year)		X

11.2.2 Annual Maintenance Contracts

It is recommended that the regular upkeep of the solar system should be done by having Annual Maintenance Contracts (AMCs) with the supplier or any other technically qualified vendor. The AMCs are aimed at creating a long term supporting structure for the servicing and maintenance of solar powered systems installed at the health center. It is recommended that AMC for 5 years is included as part of the procurement process.

The following are the key components of an AMC, which should be considered during procurement:

- The AMC is to include 2 scheduled free visits to the health facilities every year. An acknowledgment form, available with the enterprise, should be signed and kept under records by the health facility after completion of every servicing visit.
- In addition to the two scheduled visits, the AMC should include one unscheduled visit. This would be to attend for any emergency failure or fault complaint received from the customer. Any additional calls for service would be billed by the local vendor separately. It is recommended that untied funds are used for the same.
- The following activities should be considered under the AMC:
    - Checking for proper connections at Solar modules, Charge Regulators, Battery and Luminaries;
    - Cleaning all dusty components of the solar system;
    - Checking for electrolyte level in the battery, if required the topping up would be done;
    - Checking state of battery charge;
    - Applying petroleum jelly to battery terminals;
    - Checking the cable conditions to make sure that the wiring is safe and stable.
- The AMC includes cost of servicing only, and does not include replacement of spares. However, the vendor will ensure that if the system component is under warranty (as per section 10.4.1), the component is replaced without any costs.
- Typically, damage to the system due to any force majeure event are not covered under the warranty or by the vendor. For facilities in high disaster-prone areas, health facilities may be encouraged to insure the solar energy systems.

The efficiency of the solar energy systems, the savings from the expenditure towards conventional energy source & generator which eventually reaches the patient in terms of improved healthcare facility and protection of the environment through reducing carbon emissions will encourage the state and central governments in promoting incentives & adoption of solar energy solutions in healthcare policy & guidelines. The community participation in O&M of the systems & appliances requires rigorous propaganda for widespread adoption in national & international forums. Development and promotion of such sustainable & renewable energy solutions will be a significant step towards transforming the bigger healthcare system into energy efficient and environmentally sustainable.

Annex 1. HEALTH & WELLNESS CENTER LOAD CALCULATIONS:

Annex 1 (a): TYPE A HWC- Powering Existing Equipment

Room Type	Load Type	Power Consumption (W)	Quantity	Hours of Usage (hrs)
Consultation/OPD Room	Lights - CFL/ Incandescent	60	1	5
	Fan - Ceiling/ Wall/ Pedestal	80	1	5
	Mobile Charging	15	2	3
	Laptop/ Desktop/ TV	120	1	4
	Printer	250	1	0.5
	Dongle - Internet Facility	20	1	12
Examination Room	Lights - CFL/ Incandescent	60	1	3
toilet	Lights - CFL/ Incandescent	60	1	3
Store room	Lights - CFL/ Incandescent	60	1	3
room 1	Lights - CFL/ Incandescent	60	1	3
	Fan - Ceiling/ Wall/ Pedestal	80	1	3
Bath/Washroom	Lights - CFL/ Incandescent	60	2	1
room 2	Lights - CFL/ Incandescent	60	2	3
	Fan - Ceiling/ Wall/ Pedestal	80	1	3
Kitchen	Lights - CFL/ Incandescent	60	2	4
Outdoor	Outdoor light	60	1	12

Annex 1 (b) TYPE A HWC - Powering Energy Efficient equipment

Room Type	Load Type	Power Consumption (W)	Quantity	Hours of Usage (hrs)
Consultation/OPD Room	LED tube light	20	1	5
	Ceiling Fan	32	1	5
	Mobile Charging	15	2	3
	Laptop/ Desktop/ TV	120	1	4
	Printer	250	1	0.5
	Dongle - Internet Facility	20	1	12
Examination Room	LED tube light	20	1	3
Toilet	LED Bulb	5	1	3
Store room	LED Bulb	9	1	3
Room 1	LED tube light	20	1	3
	Ceiling Fan	32	1	3
Bath/Washroom	LED Bulb	5	2	1
Room 2	LED tube light	20	2	3
	Ceiling Fan	32	1	3
Kitchen	LED Bulb	9	2	4
Outdoor	Outdoor light	20	1	12

Annex 1 (c): HWC- Type B: Powering existing equipment

Room Type	Load Type	Power Consumption (W)	Quantity	Hours of Usage (hrs.)
Consultation/ OPD Room	Lights - CFL/ Incandescent	40	1	5
	Fan - Ceiling/ Wall/ Pedestal	80	1	5
	Mobile Charging	15	2	3
	Laptop/ Desktop/ TV	120	1	4
	Printer	250	1	0.5
	Dongle - Internet Facility	20	1	12
Sterilizer Room	Lights - CFL/ Incandescent	60	1	2
	Autoclave/Sterilizer	1500	1	0.5
Labor room	Lights - CFL/ Incandescent	40	1	3
	Fan - Ceiling/ Wall/ Pedestal	80	1	3
	Radiant Warmer	800	1	1
	Suction Apparatus	250	1	1
	Spot Light	100	1	1
Toilet	Lights - CFL/ Incandescent	60	1	1
Examination room	Lights - CFL/ Incandescent	60	1	2
Wards	Lights - CFL/ Incandescent	40	2	4
	Fan - Ceiling/ Wall/ Pedestal	80	2	5
	Mobile Charging	15	1	2
Nurse station	Lights - CFL/ Incandescent	40	2	4
	Fan - Ceiling/ Wall/ Pedestal	80	1	5
Washroom/ Bath	Lights - CFL/ Incandescent	60	2	4
Waiting Area	Lights - CFL/ Incandescent	40	2	4
	Fan - Ceiling/ Wall/ Pedestal	80	1	5
Immunization	Lights - CFL/ Incandescent	40	2	4

	Fan - Ceiling/ Wall/ Pedestal	80	1	5
Clinic	Lights - CFL/ Incandescent	40	2	4
	Fan - Ceiling/ Wall/ Pedestal	80	1	5
Store	Lights - CFL/ Incandescent	40	2	4
	Fan - Ceiling/ Wall/ Pedestal	80	1	2
Toilet	Lights - CFL/ Incandescent	60	2	4
Veranda	Lights - CFL/ Incandescent	60	2	4
Outdoor	Outdoor Light	60	2	12
Emergency Room	Lights - CFL/ Incandescent	40	2	4
	Fan - Ceiling/ Wall/ Pedestal	80	1	2
	Oxygen concentrator(10L)	400	1	1

Annex 1 (d) HWCs - Type B - Powering Energy Efficient Equipment

Room Type	Load Type	Power Consumption (W)	Quantity	Hours of Usage (hrs.)
Consultation/OPD Room	LED	20	1	5
	Fan - Ceiling	32	1	5
	Mobile Charging	15	2	3
	Laptop/ Desktop/ TV	120	1	4
	Printer	250	1	0.5
	Dongle - Internet Facility	20	1	12
Sterilizer Room	LED	9	1	2
	Autoclave/Sterilizer	1500	1	0.5
Labor room	LED	20	1	3
	Fan - Ceiling	32	1	3
	Radiant Warmer	600	1	1
	Suction Apparatus	132	1	1
	Spot Light	20	1	1
Toilet	LED	20	1	1
Examination room	LED	9	1	2
Wards	LED	20	2	4
	Fan - Ceiling	32	2	5
	Mobile Charging	10	1	2
Nurse station	LED	20	2	4
	Fan - Ceiling	32	1	5
Wash room/ bath	LED	5	2	4
Waiting Area	LED	10	2	4
	Fan - Ceiling	32	1	5
Immunization	LED	20	2	4
	Fan - Ceiling	32	1	5
Clinic	LED	20	2	4
	Fan - Ceiling	32	1	5

Store	LED	9	2	4
	Fan - Ceiling	32	1	2
Toilet	LED	5	2	4
Veranda	LED	5	2	4
Outdoor	Outdoor Light	20	2	12
Emergency Room	LED	9	2	4
	Fan - Ceiling	32	1	2
	Oxygen Concentrator	400	1	1

Annex 2: PRIMARY HEALTH CENTERS LOAD CALCULATIONS

Annex 2 (a): PHC - Powering Existing Equipment

Room	Load Type	Wattage(W)	Quantity	Hours of usage (Hrs)
Labor Room	Lights - CFL/ Incandescent	40	2	3
	Ceiling Fan	80	2	3
	Mobile Charging Point	15	2	3
	Suction machine	200	1	1
	Baby warmer	800	1	1
	Spot light	100	1	1
	Phototherapy	100	1	1
Labor room Toilet	Lights - CFL/ Incandescent	40	1	1
Ladies Ward	Ceiling Fan	80	2	6
	Lights - CFL/ Incandescent	40	2	6
	Mobile Charging Point	15	2	3
Ladies Ward Toilet	Lights - CFL/ Incandescent	40	1	1
Gents Ward	Ceiling Fan	80	2	6
	Lights - CFL/ Incandescent	40	2	6
	Mobile Charging Point	15	2	3
Gents Ward Toilet	Lights - CFL/ Incandescent	40	1	1
Nurse Room	Lights - CFL/ Incandescent	40	1	4
	Ceiling Fan	80	1	4
	Mobile Charging Point	15	1	3
Laboratory	Lights - CFL/ Incandescent	40	1	4
	Ceiling Fan	80	1	4
	Mobile Charging Point	15	1	3
	Microscope	30	1	2
	Centrifuge	180	1	2

Minor OT	Lights - CFL/ Incandescent	40	2	3
	Ceiling Fan	80	1	3
	Nebulizer	60	1	1
	Needle Cutter	60	1	0.25
Doctor rooms 1	Lights - CFL/ Incandescent	40	2	3
	Ceiling Fan	80	1	3
	Mobile Charging Point	15	1	3
	Laptop	40	1	4
	Printer	250	1	0.5
Doctor rooms 2	Lights - CFL/ Incandescent	40	2	3
	Ceiling Fan	80	1	3
	Mobile Charging Point	15	1	3
	Laptop	40	1	4
	Printer	250	1	0.5
Registration	Lights - CFL/ Incandescent	40	1	4
	Ceiling Fan	80	1	4
	Mobile Charging Point	15	1	3
	Laptop	40	1	4
	Printer	250	1	0.5
Dressing room	Lights - CFL/ Incandescent	40	1	2
	Ceiling Fan	80	1	2
Office	Lights - CFL/ Incandescent	40	1	4
	Ceiling Fan	80	1	4
	Mobile Charging Point	15	1	3
	Laptop	40	1	4
	Printer	250	1	0.5
Store room	Lights - CFL/ Incandescent	40	1	2
Ladies Toilet	Lights - CFL/ Incandescent	40	1	2
Gents Toilet	Lights - CFL/ Incandescent	40	1	2
Cold Chain room & Pharmacy	Lights - CFL/ Incandescent	40	1	1
	Refrigerator	200	1	8

	Autoclave/Sterilizer	1500	1	0.5
Immunization room	Lights - CFL/ Incandescent	40	1	2
	Ceiling Fan	80	1	2
	ILR	140	1	8
	Deep Freezer	120	1	10
Emergency room	Lights - CFL/ Incandescent	40	1	2
	Ceiling Fan	80	1	2
	Oxygen Concentrator	400	1	1
Waiting area	Lights - CFL/ Incandescent	40	1	4
Entrance	Lights - CFL/ Incandescent	40	1	6
Corridor	Lights - CFL/ Incandescent	40	6	6

Annex 2 (b) PHC - Powering Energy Efficient Equipment

Room	Load Type	Wattage(W)	Quantity	Hours of Usage (Hrs)
Labor Room	LED Tube Light	20	2	3
	Ceiling Fan	20	2	3
	Mobile Charging Point	10	2	3
	Suction machine	132	1	1
	Baby warmer	600	1	1
	Spot light	20	1	1
	Phototherapy	20	1	4
Labor room Toilet	LED Bulb	5	1	1
Ladies Ward	Ceiling Fan	32	2	6
	LED Tube Light	20	2	6
	Mobile Charging Point	10	2	3
Ladies Ward Toilet	LED Bulb	5	1	1
Gents Ward	Ceiling Fan	32	2	6
	LED Tube Light	20	2	6
	Mobile Charging Point	10	2	3
Gents Ward Toilet	LED Bulb	5	1	1

Nurse Room	LED Tube Light	20	1	4
	Ceiling Fan	32	1	4
	Mobile Charging Point	10	1	3
LAB	LED Tube Light	20	1	4
	Ceiling Fan	32	1	4
	Mobile Charging Point	10	1	3
	Microscope	30	1	2
	Centrifuge	180	1	2
Minor OT	LED Tube Light	20	2	3
	Ceiling Fan	32	1	3
	Nebulizer	60	1	1
	Needle Cutter	60	1	0.25
Doctor rooms 1	LED Tube Light	20	2	3
	Ceiling Fan	32	1	3
	Mobile Charging Point	10	1	3
	Laptop	20	1	4
	Printer	13	1	0.5
Doctor rooms 2	LED Tube Light	20	2	3
	Ceiling Fan	32	1	3
	Mobile Charging Point	10	1	3
	Laptop	20	1	4
	Printer	13	1	0.5
Registration	LED Tube Light	20	1	4
	Ceiling Fan	32	1	4
	Mobile Charging Point	10	1	3
	Laptop	20	1	4
	Printer	13	1	0.5
Dressing room	LED Tube Light	20	1	2
	Ceiling Fan	32	1	2
Office	LED Tube Light	20	1	4
	Ceiling Fan	32	1	4

	Mobile Charging Point	10	1	3
	Laptop	20	1	4
	Printer	13	1	0.5
Store room	LED bulb	20	1	2
Ladies Toilet	LED bulb	5	1	1
Gents Toilet	LED bulb	5	1	1
Cold Chain room & Pharmacy	LED bulb	20	1	1
	Refrigerator	100	1	8
	Autoclave/Sterilizer	1500	1	0.5
Immunization room	LED Tube Light	20	1	2
	Ceiling Fan	32	1	2
	ILR	120	1	8
	Deep Freezer	140	1	10
Emergency room	LED Tube Light	20	1	2
	Ceiling Fan	32	1	2
	Oxygen Concentrator	400	1	1
Waiting area	LED Tube Light	10	1	4
Entrance	LED bulb	9	1	5
Corridor	LED bulb	9	6	5

Annex 3: COMMUNITY HEALTH CENTERS

Annex 3 (a): CHC- Powering Existing Equipment

Load Type	Wattage(W)	Quantity	Average Hours of Usage per Day (Hrs)
Fluorescent Tube light	40	94	3.22
CFL/ Incandescent	60	12	1.45
CFL/ Incandescent	18	49	2.8
Fan	75	43	3
Refrigerator (Type 1)	150	2	8
Refrigerator (Type 2)	230	1	8
Baby Warmers	650	5	1.5
Blood storage unit	650	1	8
Cardiac monitor	150	3	2
CBC Machine	70	1	1
Computer	200	5	3
Deep freezer	140	2	9
Dental chair	1000	1	2
Digital Lab Centrifuge	400	1	1
Filter Drinking water	40	2	3
ILR	210	1	8
Microscope	30	2	2
Needle Cutter	60	5	1.2
Oxygen Concentrator (5 lts)	350	1	2
Oxygen Concentrator (10 lts)	550	1	1
Printer	100	1	0.5
Spotlight	20	1	2
Suction Apparatus	132	2	1
Television	95	1	2

Truant Machine	45	1	1
Truant Extractor	45	1	1
TSH Machine	65	1	2
Ultrasound Machine	400	1	2

Annex 3 (b): CHC- Powering Energy Efficient Equipment

Load Type	Wattage(W)	Quantity	Average Hours of Usage per Day (Hrs)
LED Tube light	20	94	3.22
LED Bulb	7	12	1.45
LED Bulb	9	49	2.8
Fan	32	43	3
Refrigerator (Type 1)	150	2	8
Refrigerator (Type 2)	230	1	8
Baby Warmers	650	5	1.5
Blood storage unit	650	1	8
Cardiac monitor	150	3	2
CBC Machine	70	1	1
Computer	200	5	3
Deep freezer	140	2	9
Dental chair	1000	1	2
Digital Lab Centrifuge	133	1	1
Filter Drinking water	40	2	3
ILR	210	1	8
Microscope	30	2	2
Needle Cutter	60	5	1.2
Oxygen Concentrator (5 lts)	350	1	2
Oxygen Concentrator (10 lts)	550	1	1

Printer	100	1	0.5
Spotlight	20	1	2
suction Apparatus	132	2	1
Television	95	1	2
Truant Machine	45	1	1
Truant Extractor	45	1	1
TSH Machine	65	1	2
Ultrasound Machine	400	1	2

Annex 4: SUB DIVISIONAL HOSPITAL

Annex 4 (a): Sub Divisional Hospitals: Powering Existing Equipment

Load Type	Wattage(W)	Quantity	Average Hours of Usage per Day (Hrs)
Ceiling Fans	75	87	4
AC	1250	1	1
Water Purifier	75	1	4
Autoclave	1200	2	1
Baby Warmer	650	5	2.5
Bio Chemistry Analyzer	70	1	2
Blood Bag sealer	100	1	1
Blood Bank Refrigerator	1000	3	8
Blood Collection Monitor	50	1	2
Cell Counter	100	1	2
Centrifuge	345	2	1
Computers/ Desktop	120	7	5
ECG	80	1	2
Electrolyte Analyzer	100	1	2
Foetal Monitor	30	1	1
Refrigerator	120	5	8
Bacteriological Incubator	450	1	2
Bulbs	9	13	2
Microscope	30	1	2
Erba Lisa Washer	80	1	2
Erba Lisa Scan	100	1	2
Oxygen Concentrator	450	2	2
OT Machine	120	1	2
OT Light	80	1	3

Outdoor Lights	15	4	9
Phototherapy	50	2	4
Printer (Type 1)	280	4	1.5
Printer (Type 2)	400	2	1
Spotlight	80	5	2
Suction Apparatus	180	1	2
Tubelights	32	85	6
Wall Fan	55	2	2
Weighing Scale	20	1	1
Serological Water Bath	300	1	1

Annex 4 (b) Sub Division Hospitals: Powering Energy Efficient Equipment

Load Type	Wattage(W)	Quantity	Average hours of Usage per day (Hrs)
Ceiling Fans	35	87	4
AC	1250	1	1
Water Purifier	35	1	4
Autoclave	1200	2	1
Baby Warmer	650	5	2.5
Bio Chemistry Analyzer	70	1	2
Blood Bag sealer	100	1	1
Blood Bank Refrigerator	1000	3	8
Blood collection monitor	50	1	2
Cell Counter	100	1	2
Centrifuge	300	2	1
Computers	120	7	5
ECG	80	1	2
Electrolyte Analyzer	100	1	2
Foetal Monitor	30	1	1

Fridges	120	5	8
Bacteriological Incubator	450	1	2
Bulbs	9	13	2
Microscope	30	1	2
Erba Lisa Washer	80	1	2
Erba Lisa Scan	100	1	2
Oxygen Concentrator	450	1	2
OT Machine	120	1	2
OT Light	80	1	3
Outdoor Lights	15	4	9
Phototherapy	50	2	4
Printer (Type 1)	280	4	1.5
Printer (Type 2)	400	2	0.75
Spotlight	80	5	2
Suction Apparatus	180	1	2
Tubelights	32	85	6
Wall Fan	55	2	2
Weighing Scale	20	1	1
Serological Water Bath	300	1	1

Annex 5: DISTRICT HOSPITAL

Annex 5 (a): District Hospitals: Powering Efficient Equipment

Load Type	Wattage(W)	Quantity	Average hours of Usage per day (Hrs)
Tube Light	10	30	5
Ceiling Fan	32	86	4
Desktop	150	2	4
LED Bulb	12	610	4
LED Bulb	9	23	2.3
LED Bulb	7	11	2.5
Needle destroyer (Type 1)	60	2	1
Needle destroyer (Type 1)	100	3	4
Needle Cutter	60	1	1
Printer	50	2	0.5
Radiant Warmer	600	10	2
Suction Apparatus	180	3	3.5
Refrigerator	120	2	8
Spotlight	20	1	4
Ceiling Fan	32	176	4
Computer/Desktop	110	6	4
Printer	60	6	0.5
Ventilator	720	2	1
Cardiac Monitor	200	4	4
ABG Machine	180	1	1
Oxygen Concentrator	330	1	2
OT Table	250	2	4
Cautery Machine	400	2	2
Laparoscopic Display TV	108	1	2
Anesthesia Workstation	100	2	6
ILR	140	1	10

Deep Freezer (Immunization Room)	120	1	8
Dental Chair Compressor	750	1	3
Dental Chair	1000	2	1
Blood bag tube sealer	20	1	4
Blood Collection Monitor	220	2	6
Blood Storage Refrigerator	920	3	12
Centrifuge	345	1	6
Cryobath	115	1	6
Deep freezer - 40	650	1	10
Deep freezer - 80	80	1	10
Desktop	100	7	8
Microplate reader	120	2	4
Microplate washer	80	2	4
Hematology analyser	100	1	8
Hydraulic chair	120	3	6
Lab Centrifuge (Type 1)	180	1	12
Lab Centrifuge (Type 2)	135	1	4
LED Bulb	12	67	8
Lisa Scan	45	1	4
Micropore water system	25	1	12
Microscope	30	4	7
Microscope printer	60	1	6
Biochemistry Analyser Cuvetts	50	1	12
Mini rotary shaker	12	1	4
Needle Destroyer	100	3	4
Plasma thawing bath	200	1	6
Platelet agitator & incubator	28	1	12
Printer (Type 1)	315	3	0.5
Printer (Type 2)	100	2	0.5
Printer (Type 3)	13	2	0.5

Microbiology cubicle room - Refrigerator - 10ltr	105	1	12
Blood storage room- Refrigerated centrifuge	180	1	12
Record store room- Refrigerator	105	1	8
Refrigerator	340	1	8
Blood storage room- Refrigerator	780	1	8
Biochemistry- Small Refrigerator	350	1	8
Biochemistry- Large Refrigerator 789	789	1	8
Serology water bath	500	1	6
Tube Light	20	32	7
Tube sealer	170	1	6
Ultrasound machine	65	1	6

ANNEX 6: POTENTIAL FUNDING SOURCES FOR HEALTH - ENERGY PROGRAMS

Health and Energy sector funds (National and State levels)
These funds are applicable across states through National and State level departments of the Ministry. They focus on the core sectors of energy and healthcare.

1. National Health Mission (Central and State level resources)
   State NHM Program Implementation Plans
2. Finance Commission Grants
   https://fincomindia.nic.in/; Overview of grants in aid
3. State Nodal Agencies of Ministry of New and Renewable Energy (MNRE)
   https://mnre.gov.in/
4. Indian Renewable Energy Development Agency (IREDA)
   https://www.ireda.in/background

Special area development funds:
These funds are available for the development of specific communities and regions that have faced developmental challenges. They may be accessible at the national, state and district levels

5. Ministry of Tribal Affairs
   https://tribal.nic.in/
6. Ministry of Minorities Affairs
   https://minorityaffairs.gov.in/
7. Ministry for Development of North Eastern Region (DONER)
   https://mdoner.gov.in/
   - North East Special Infrastructure Development Scheme (NESIDS)
   - Non Lapsable Central Pool of Resources (NLCPR) Scheme
   - Special Package for Bodoland Territorial Council (BTC), Assam
   - Special Package for Dima Hasao Autonomous Territorial Council (DHATC),Assam
   - Special Package for Karbi Anglong Autonomous Territorial Council (KAATC), Assam

8. Border Area Development Programme (BADP)
   https://www.mha.gov.in/departments-of-mha

9. Aspirational District Programme (ADP)
   https://www.niti.gov.in/aspirational-districts-programme

10. District Mineral Foundation (DMF)
    https://www.mines.gov.in/writereaddata/UploadFile/Orderdated12thJuly2021.pdf

District and local area development funds:
These are funds accessible through local representatives at the district level, block and village levels, including MPs and MLAs for the region.

11. Member of Parliament Local Area Development Scheme (MPLAD)
    https://www.mplads.gov.in/mplads/Default.aspx

12. Member of Legislative Assembly Constituency Development Scheme (MLADCDS)
    https://tnrd.gov.in/schemes/st_mlacds.html

13. District Innovation Fund (DIF), Department of Expenditure
    https://doe.gov.in/financecommission/guidelines-district-innovation-fund

14. Gram, Taluk, Zilla Panchayat Funds
    https://gpdp.nic.in/getSelection.html

Health facility level funds:
These are funds accessible at the health facility level, allocated annually through the local health facility management committees, known as the Rogi Kalyan Samiti/ Arogya Raksha Samiti. These are particularly important for opex: to unlock funds for annual maintenance or replacements of spare parts.

15. Rogi Kalyan Samiti (RKS) Fund
    https://nhm.gov.in/New_Updates_2018/communization/RKS/Guidelines_for_Rogi_Kalyan_Samities_in_Public_Health_Facilities.pdf

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National Programme
on Climate Change
and Human Health

National Centre
for Disease Control
Government of India