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The State of Electricity Access for Primary Health Centres in India

Insights from the District Level Household and Facility Survey (DLHS-3 and DLHS-4)

Issue Brief | February 2019

SUNIL MANI, SASMITA PATNAIK, AND HEM H. DHOLAKIA

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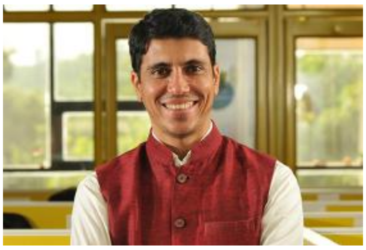
Sasmita Patnaik is a Programme Lead in the Energy Access team at The Council. She has over six years of research and consulting experience in rural development, sustainability, and social entrepreneurship. Her work in sustainability involved the assessment of sustainability policies and practices of industries around biodiversity and land use, health and safety, and carbon emissions. At The Council, she works on access to energy for healthcare, cooking and income generation. In her research, she is keen to understand the nuances of socio-economic contexts that define access to, and use of, energy. Sasmita holds an M.Sc. in Development Studies from School of Oriental and African Studies (SOAS) and a Post-Graduate Diploma in Rural Management from Xavier Institute of Management, Bhubaneswar (XIMB).



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SUNIL MANI: Conducted literature review and analysis of the data; co-authored all chapters.

SASMITA PATNAIK: Provided inputs on analysis; edited the manuscript and co-authored all chapters.

HEM H. DHOLAKIA: Provided inputs on presentation of the data; reviewed the manuscript.

Image: iStock

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Abbreviations

CAG	Comptroller and Auditor General of India
CHC	community health centre
CIA	Central Intelligence Agency
DLHS	district level household survey
GVEP	Global Village Energy Partnership
ILR	ice-lined refrigerator
IMR	infant mortality rate
IPHS	Indian Public Health Standards
kWh	kilowatt hour
LBW	low birth weight
LHV	lady health visitor
MCH	mother and child health
MMR	maternal mortality rate
MoHFW	Ministry of Health and Family Welfare
NCCMIS	National Cold Chain Management Information System
NFHS	National Family Health Survey
NHM	National Health Mission
NICU	neonatal intensive care unit
NRHM	National Rural Health Mission
PHC	primary health centre
PV	photovoltaic
RCH	reproductive and child health
RHS	rural health statistics
SARA	service availability and readiness assessment
SHC	sub health centre
SRS	Sample Registration System
TREDA	Tripura Renewable Energy Development Agency
UDHR	Universal Declaration of Human Rights
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WHO	World Health Organisation


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About the Brief

Primary healthcare facilities need regular electricity access for deliveries, storing vaccines, providing emergency services, supplying clean water, and retaining skilled staff. Despite ensuring last-mile delivery of healthcare services in rural India, one in every two primary health centres (PHCs) in India, was either un-electrified or suffered from irregular power supply in 2012-13. This brief presents a detailed picture of the duration and the quality of electricity supply in the PHCs between 2008-09 and 2012-13, drawing from one of the largest surveys on healthcare facilities in India, the District Level Household Survey (DLHS).

Electricity backup plays a very critical role in ensuring the functionality of medical equipment during irregular electricity supply in PHCs. We analyse the change in the situation of electricity backup among PHCs between the mentioned years. We find that electricity backup is installed at a much higher rate in the PHCs that already have better electricity supply from the grid, suggesting a need to ensure planning for electricity backup in primary health centres with irregular or no electricity supply.

We find that having the required infrastructure may not necessarily translate into service provision in the absence of other critical factors. For instance, around 13 per cent of the PHCs are not conducting deliveries despite having a labour room, predominantly due to the unavailability of doctors and staff, followed by the lack of equipment and electricity supply. In our analyses, we attempt to explore and highlight interlinkages between electricity access and critical aspects of the healthcare system. We find that a higher proportion of staff members (particularly medical officers and auxiliary nurse midwife) prefer to live at those PHC quarters where electricity availability is better.

Though we see a strong relationship between access to electricity and the provision of critical healthcare services, this brief argues for the need to have better availability of data on electricity access in the healthcare facilities and the mapping of critical interdependencies between electricity access and healthcare service delivery. This would help in measuring the gap (in quantitative and qualitative terms) between the actual energy requirement based on the equipment inventory and other critical requirements and the current supply of electricity. Further, to strengthen the accuracy of data on hours of electricity supply or actual consumption of electricity in healthcare facilities, the use of technology such as sensors could help in receiving real-time information. Accurate identification of gaps in electricity access could help in designing effective backups, considerate to the local needs of the healthcare centres. For instance, healthcare facilities in conflict-affected areas would need to power blood storage units and consequently have a higher electricity requirement, healthcare facilities providing 24x7 services would have the need for lighting and equipment use for a longer duration.

To summarise, the brief attempts to drive home the importance of electricity access as one of the critical components of a functional healthcare system, and aims to highlight the interdependencies between electricity access and other components of the system. We also elaborate on the existing gaps in data and design of the system to suggest some alternatives that could be considered to strengthen electricity access for healthcare facilities to meet the ever-growing need for the population.

Image: iStock

1. Introduction and Methodology

Article 25 of the Universal Declaration of Human Rights (UDHR) 1948 provides for "adequate" medical care and other necessary social services for health and well-being. Further, the constitution of the World Health Organisation (WHO) envisages the highest attainable standard of health as a fundamental right of every human being. Yet, only 36 per cent of the 191 countries guaranteed the right to medical care services by 2007 (Kurian, 2015). A rights-based approach to healthcare inevitably enhances the importance of establishing a functional healthcare system, which is equitable and affordable for all, and monitoring of the health indicators.

Worldwide more than 70 per cent of the countries perform better than India with respect to life expectancy, Maternal Mortality Rate (MMR) and Infant Mortality Rate (IMR) (CIA, 2017). IMR in India is 34 per 1000 live births. It is worse in rural India at 38 per 1000 live births (SRS, 2017). Life expectancy at age one exceeds that at age zero for both men and women in India except for the state of Kerala (Dubey, Ram, & Ram, 2015). An efficient primary healthcare system is, therefore, critical for improving these health indicators (Radwan, 2005).

Primary healthcare approach is the most efficient, fair, and cost-effective way to organise a health system (Chan, 2008). In rural India, primary healthcare is provided through a network of Sub Health Centres (SHCs) and Primary Health Centres (PHCs), and they together ensure last mile delivery of healthcare services. However, PHCs have a much more important role to play in India's Primary healthcare system, as they are the first point of contact between a patient and the doctor (DLHS-4, 2013). Further, PHCs play an important role in increasing institutional deliveries and reducing maternal mortality and infant mortality (IPHS, 2012). Despite this, as of 2017, there was a 22 per cent shortage of PHCs in India. Against the required 29,337 PHCs, only 25,650 PHCs were available. Because of this shortfall, a typical PHC which is mandated to serve a rural population of 20,000-30,000, currently serves an average population of 33,000 (RHS, 2015-16). The overburdened health facilities often fail to maintain their quality standards as they struggle to provide the required amount of time and attention needed to the patients (Bajpai, 2014).

The inadequate number of PHCs is not the only challenge for India's public healthcare system. Lack of infrastructure in these facilities put further constraints on their ability to provide timely and quality care (Global Forum for Health Research, 2004). A significant proportion of the PHCs in India, which are the key focus of this study, lack necessary functional equipment (like cold chain, delivery and newborn care equipment). For instance, over one-third of the PHCs do not have fully functional cold chain equipment (deep freezer and ice-lined refrigerators) and 50 per cent do not have the necessary infrastructure to provide newborn care services (DLHS-4, 2013).

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Conventionally, infrastructure in the health system has focused on the availability of tangible physical spaces, medicines, and equipment which are essential for delivery of healthcare services (Chauhan, Mazta, Dhadwal, & Sandhu, 2016). Even the recently developed 'Service Availability and Readiness Assessment' (SARA)[1] only partly assesses the infrastructural components

[1] The methodology was developed through a joint World Health Organization (WHO) – United States Agency for International Development (USAID) collaboration to fill critical gaps by measuring and tracking progress in health systems.

(Scholz, Ngoli, & Flessa, 2015). However, availability of utility services like electricity and water are also imperative for the functioning of a health facility and become important determinants of the effective delivery of essential health services (RHS, 2016). In this issue brief, we focus on the impact of access to electricity on the service delivery at PHCs.

1.1 Electricity Access as a Critical Enabler in Primary Healthcare

Access to electricity in the healthcare facilities is an important determinant of the efficacy of health service delivery; it is needed for deliveries, storage of vaccines, provision of emergency services, the supply of clean water, as well as retention of skilled staff. For instance, conducting deliveries in labour room requires a certain set of lighting facilities. Once the delivery is conducted, access to electricity is still necessary to ensure functionality of critical equipment like radiant warmers and incubators for neonatal care. Apart from delivery and neonatal care, electricity access is critical to run deep freezers and ILRs to maintain the requisite temperatures for storage of vaccines. Thus, it is difficult, if not impossible, to provide quality healthcare services without access to regular electricity supply (Brenneman & Kerf, 2002). The lack of electricity can significantly limit the diagnostic capabilities and treatment services, as well as may result in unavailability of staff due to lack of satisfaction.

A survey conducted by the Planning Commission of India in 2009 revealed that the states with below national average health indicators, the availability of electricity in the healthcare facilities varied between 30 per cent and 50 per cent. In the states with better than the national average health indicators, the availability of electricity was between 60 per cent and 100 per cent (Munuswamy, Nakamura, & Katta, 2011).

The data from the fourth round of the District Level Household and Facility Survey (DLHS-4) showed that among the PHCs with availability of a labour room and essential workforce (both Medical Officer and an ANM), the ones with regular supply of electricity conducted 50 per cent more child deliveries in a month as compared to the PHCs with availability of a labour room and essential workforce but irregular, or no power supply.[2] [3] Similarly, among the PHCs which are cold chain points[4] and have skilled workforce in place, the ones with regular power supply provided immunisation services[5] to around 50 per cent more children.[6] While these numbers may not adequately capture all the externalities of better healthcare delivery numbers, they indicate a strong correlation between electricity access and healthcare.

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[2] Based on access to electricity from the grid, DLHS categorises the PHCs under five categories – 'regular power supply', 'occasional power supply', 'power cut in summers', 'regular power cut', and 'no electricity connection'. For this analysis, we have collapsed 'occasional power supply',' power cut in summers', and 'regular power cut' into one single category – 'irregular power supply', while keeping the other two categories as same. Therefore, for this study, there are only three categories of power supply for the PHCs – 'regular power supply', 'irregular power supply', and 'no power supply'. For the purpose of this brief, we have referred to 'power supply' as 'electricity supply'.

[3] Median number of deliveries conducted in a month by the PHCs with labour room, essential workforce, and regular electricity supply (sample size of 2587 PHCs) is nine, which is significantly higher (P-value – 0.000) than the median number of six deliveries conducted by the PHCs with labour room, essential workforce, but no regular electricity supply (sample size of 2152 PHCs).

[4] Health facilities which have both deep freezer (DF) and Ice-lined refrigerator (ILR) are referred to as Cold Chain Points.

[5] Median number of children immunised for BCG is taken as the proxy for number of children immunised. Similar numbers are observed for all other types of immunisation for children (including Measles, Polio, and DPT).

[6] Median number of children immunised with BCG by PHCs with cold chain equipment and regular electricity supply (sample size of 3253 PHCs) is 13, which is significantly higher (P-value – 0.000) than the median number of nine children immunised with BCG by PHCs with cold chain equipment, but no regular electricity supply (sample size of 2265 PHCs).

This section elaborates the motivation for this study and the methodology adopted.

1.2 Need for the study

The need for regular electricity supply in the PHCs is pronounced as more than two-thirds of them are cold chain points (NCCMIS, 2018). To assess the significance of electricity in the delivery of healthcare services, it is essential to understand the current state of electricity access across PHCs with a focus on the quality and reliability of electricity access. However, most of the secondary data available on electricity access only captures the availability of a physical connection and not the reliability and quality of electricity supply. To cover this gap, DLHS captures additional information on availability of power backup in the health centres (including PHCs).

This brief analyses the data from DLHS to discuss the infrastructural challenges in the PHCs across India, and contextualise electricity within the domain of infrastructure and focus on the importance of electricity access in ensuring quality health service delivery.

1.3 Methodology

A key component of DLHS is the integration of health facilities (SHCs, PHCs, Community Health Centres (CHCs) and the District Hospitals) that are accessible to the sampled villages. This provides district level information on healthcare outcomes, utilisation indicators, and infrastructural situation of the health centres. This brief is based on the analysis of the data on PHCs from DLHS-3 (8619 PHCs) and DLHS-4 (8540 PHCs) to evaluate the availability and quality of electricity supply across PHCs in India. This issue brief compares the data across these two rounds of DLHS to understand the changes (if any) in electricity access at PHCs, and availability of workforce and critical equipment. Further, it also assesses the impact of electricity access on the functioning of critical cold chain, new-born care equipment, as well as on the retention of medical staff.

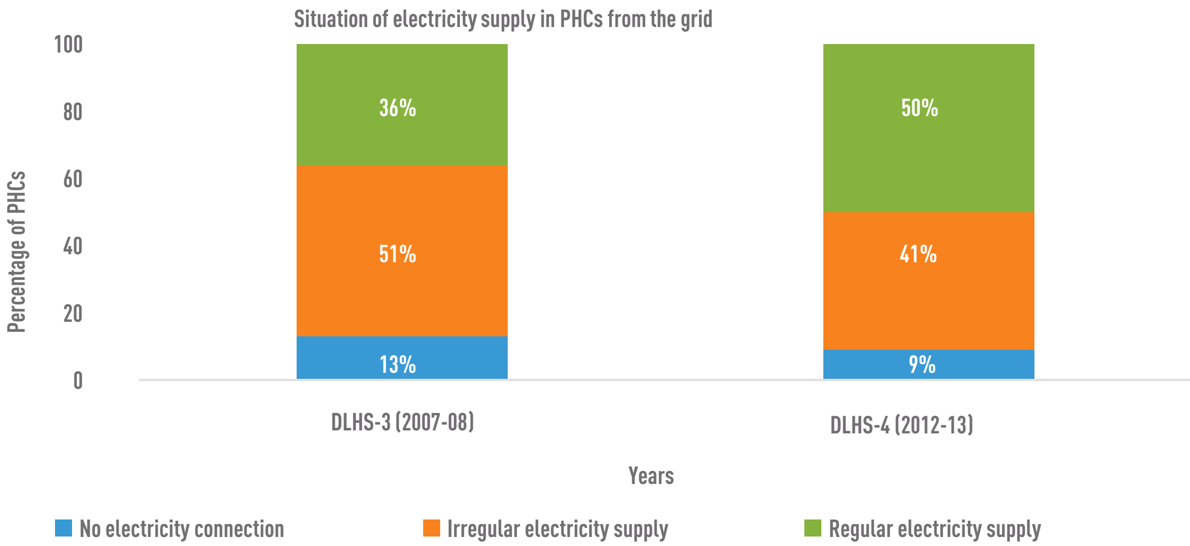
Image: iStock

2. Electricity Access in Primary Healthcare Centres across India

Figure 1 gives an overview of the electricity access across the PHCs in India for 2007-08 and 2012-13. In 2012-13, a total of 91 per cent of the PHCs had access to electricity, an improvement from 87 per cent in 2007-08. However, electricity connection does not necessarily translate into access to regular electricity. As evident from figure 1, even though 91 per cent PHCs had electricity connections in 2012-13, almost half of them had the irregular power supply. This implies that many PHCs may not have access to electricity when giving the treatment to their patients. This could impede their ability to provide quality care. It is also noteworthy that from 2007-08 to 2012-13, there is a 10 per cent improvement in the number of PHCs with regular electricity supply.

Even though 91 per cent PHCs had electricity connections in 2012-13, almost half of them had the irregular power supply

Figure 1: Access to regular electricity supply at PHCs in India has improved between 2007-08 and 2012-13[7]



Source: CEEW analysis; DLHS-3 and DLHS-4

Since electricity is a state subject in India, it is important to look at the state-wise distribution of PHC electrification. The latest round of the Rural Health Statistics (RHS) suggests that while states like Haryana, Tamil Nadu, and Maharashtra report electrification of almost all of their PHCs, more than a third of

Haryana has no un-electrified PHCs, yet only 40 per cent of all PHCs in the state have access to regular electricity supply

[7] Sample size of DLHS-3 and DLHS-4 was 8619 PHCs and 8540 PHCs, respectively.

PHCs in Jharkhand and around a fifth of them in Arunachal Pradesh have no access to electricity at all (RHS, 2015-16).

Table 1 classifies PHCs based on their electrification status. It shows a clear disparity in access to electricity by PHCs across states. While in Kerala 93 per cent of all PHCs receive regular electricity, in Manipur only eight per cent of all PHCs have access to regular electricity supply. Further, the access to reliable electricity varies even within a state. For instance, Haryana has no un-electrified PHCs, yet only 40 per cent of all PHCs in the state have access to regular electricity supply (DLHS-4, 2013).

PHCs with poor electrification rates are clustered in states either by geography (in case of north-eastern and southern states) or by demography (in case of high focus states)

As highlighted previously in Figure 1, only 50 per cent PHCs in India have access to regular supply of electricity. In as many as 11[8] of 29 states[9] the number of PHCs with access to regular electricity supply were below the national average of 50 per cent. These 11 states include five high focus states[10] (Rajasthan, Uttar Pradesh, Assam, Jharkhand and Odisha), three North-Eastern states (Manipur, Nagaland and Arunachal Pradesh), two southern states (Karnataka and Andhra Pradesh) WWand Haryana. Among the five high focus states with poor electrification, Uttar Pradesh (UP) and Jharkhand have no electricity access in almost one-third of their respective PHCs (Table 1). This shows that PHCs with poor electrification rates are clustered in states either by geography (in case of north-eastern and southern states) or by demography (in case of high focus states).

Image: Sasmita Patnaik/CEEW

[8] Names of these 11 states are in the red boxes in table 1.

[9] DLHS-4 conducted facility level survey of health institutions accessible to sampled villages in 29 Indian states and Union territories.

[10] High focus states include nine states (Uttarakhand, Rajasthan, Uttar Pradesh, Bihar, Jharkhand, Odisha, Chhattisgarh, Madhya Pradesh, and Assam), eight of which are also Empowered Action Group (EAG) states (all listed states except Assam). These nine states together account for about 48 per cent of the country's population, and have the highest fertility and mortality rates in India.

Table 1: Grid electrification of PHCs and their electricity access status across Indian states (in percentages)

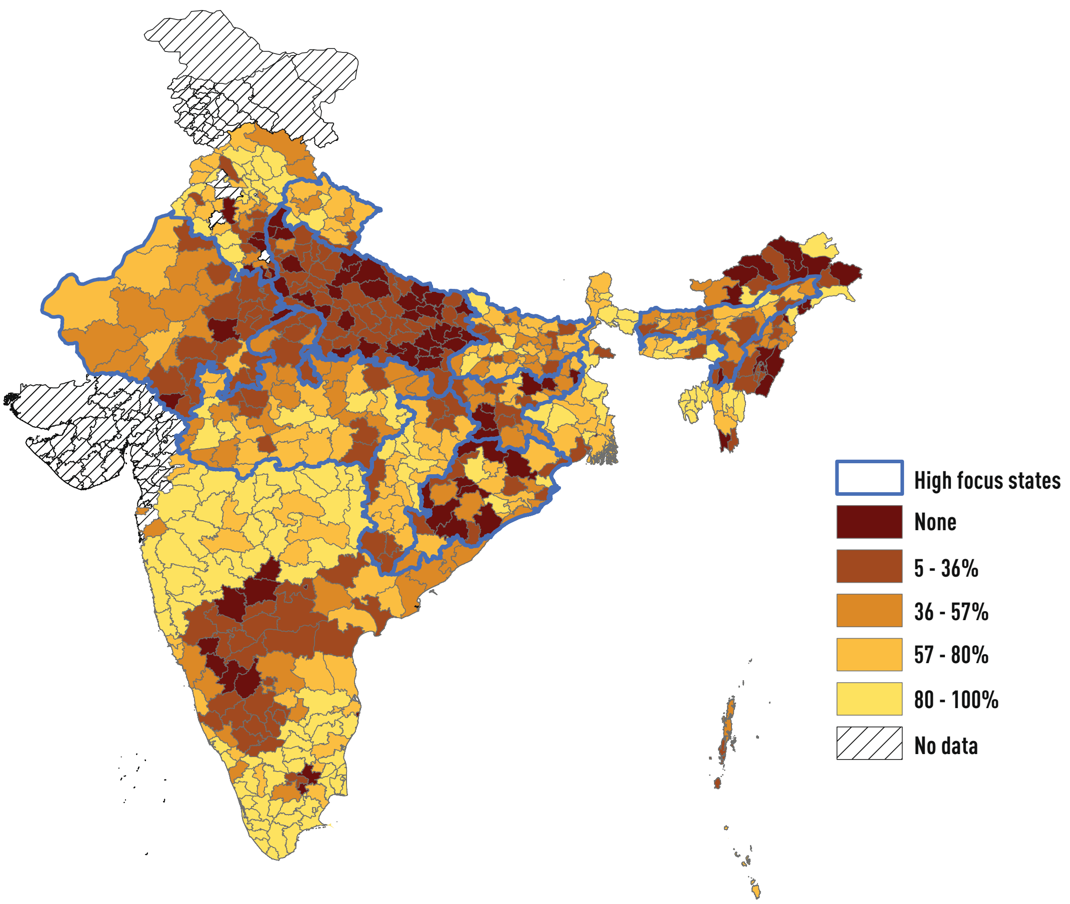
States	Regular Power Supply	Irregular Power Supply			No Electricity Connection
		Occasional Power Supply	Power Cut in Summer Only	Regular Power Cut	
India	50.00	19.00	2.00	20.00	9.00
Non-high focus states					
Kerala	93.92	2.76	0.00	0.00	3.31
Puducherry	91.30	4.35	0.00	4.35	0.00
Tripura	88.64	4.55	2.27	4.55	0.00
Maharashtra	88.05	6.17	0.77	4.24	0.77
Himachal Pradesh	85.62	12.42	0.00	0.00	1.96
Sikkim	83.33	4.17	12.5	0.00	0.00
Tamil Nadu	83.20	12.45	2.17	1.98	0.20
West Bengal	77.19	0.88	1.32	15.79	4.82
Goa	76.47	23.53	0.00	0.00	0.00
Meghalaya	74.67	18.67	0.00	6.67	0.00
Punjab	68.52	13.58	7.41	8.02	2.47
Mizoram	64.29	30.95	0.00	0.00	4.76
Telangana	57.14	3.57	4.59	34.69	0.00
A&N Island	50.00	33.33	0.00	16.67	0.00
Andhra Pradesh	49.03	9.70	3.32	36.01	1.94
Nagaland	45.45	34.09	0.00	12.50	7.95
Haryana	40.24	15.04	0.41	44.31	0.00
Arunachal Pradesh	23.46	24.69	2.47	25.93	23.46
Karnataka	17.06	21.61	1.30	58.85	1.17
Manipur	8.47	45.76	0.00	28.81	16.95
High focus states					
Chhattisgarh	66.59	26.83	0.73	1.95	3.90
Uttarakhand	58.33	38.10	2.38	0.00	1.19
Bihar	56.63	6.78	1.36	4.37	30.87
Madhya Pradesh	56.53	19.32	1.61	12.34	10.20
Assam	47.20	25.07	0.80	21.33	5.60
Jharkhand	41.82	14.55	0.00	9.09	34.55
Odisha	39.75	3.89	2.12	45.94	8.30
Rajasthan	31.72	38.50	6.23	22.16	1.39
Uttar Pradesh	10.09	39.87	1.24	18.46	30.35

Source: CEEW analysis; DLHS-4

In Figure 2, we move beyond the state, to evaluate the PHC electrification rates at the district level. The majority of the districts in 10 of the 11 poorly electrified states (identified from Table 1) have poor electricity access in their PHCs, i.e., lower than the Indian average.[11] For instance, all the 70 districts in Uttar Pradesh have less than 50 per cent of the PHCs with regular electrification. Similarly, the majority of the districts with poor rates of regular electrification in PHCs are located in high focus states (Figure 2). This suggests that just by prioritising these clusters for the electrification process, we can expect improvement in healthcare services at the PHC level in two ways, assuming other factors are constant. First, the PHCs which were not able to provide healthcare services at all due to poor or no power supply could initiate the process of the service delivery. Second, PHCs that did not perform well only due to erratic power supply could become more responsive. This could enable healthcare services for more patients at the primary level and

All the 70 districts in Uttar Pradesh have less than 50 per cent of the PHCs with regular electrification

Figure 2: District-wise percentage of regularly electrified PHCs in 2012-13



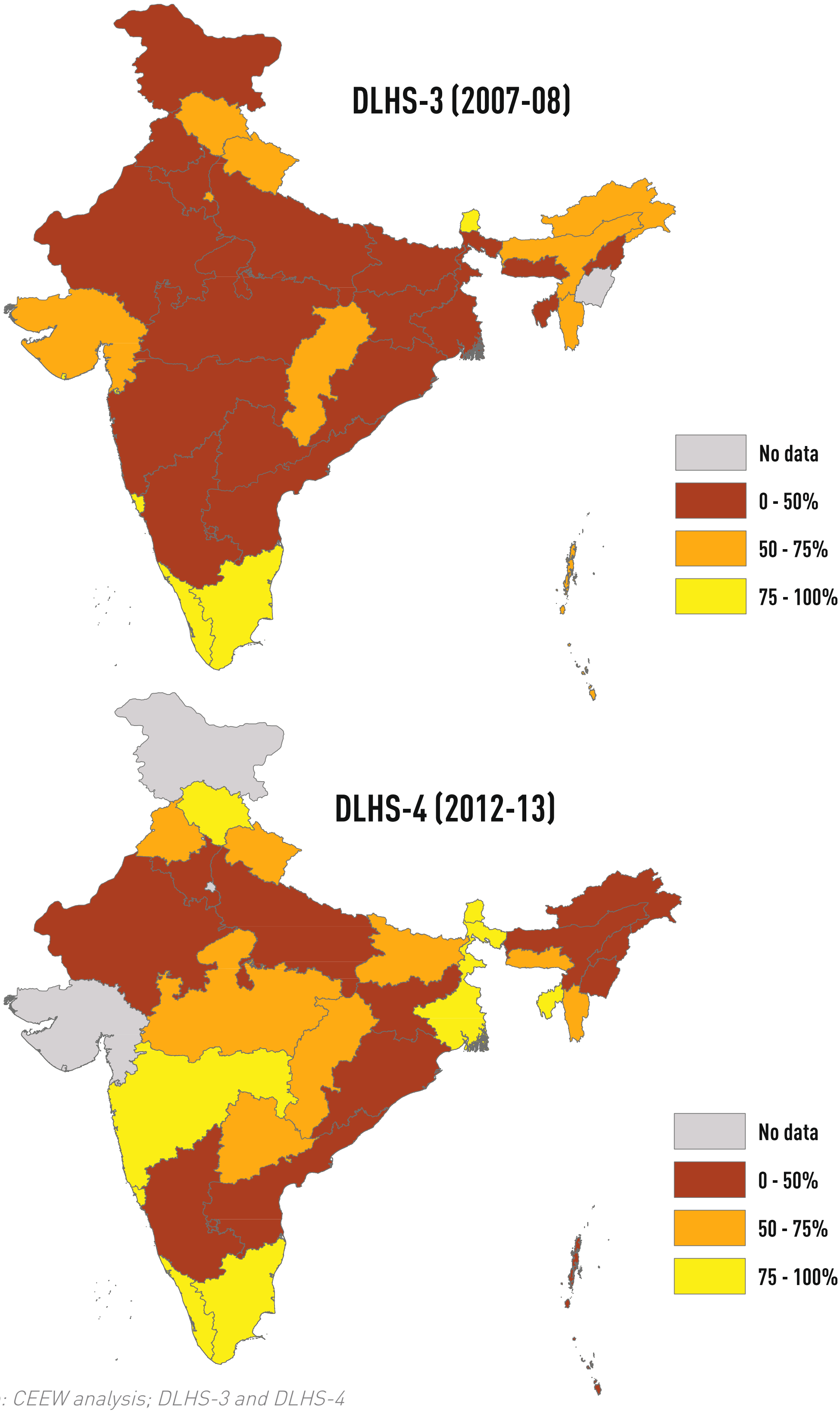
Source: CEEW analysis; DLHS – 4

[11] In addition to Uttar Pradesh, where 100 per cent of the districts have poorer electricity supply for their PHCs than the Indian average, 93 per cent districts in Karnataka, 89 per cent districts in Manipur, 82 per cent districts in Nagaland, 81 per cent districts in Arunachal Pradesh, 78 per cent districts in Rajasthan, 65 per cent districts in Assam, 63 per cent districts in Odisha, 62 per cent districts in Haryana, 61 per cent districts in Jharkhand, and 54 per cent districts in Andhra Pradesh have poorer electricity supply than the Indian average.

reduce the burden on the secondary and tertiary healthcare facilities, provided access to electricity was a major barrier for these health centres.

State-wise improvement in electricity supply to PHCs

Figure 3: Percentage of regularly electrified PHCs across Indian states during 2007-08 and 2012-13



Source: CEEW analysis; DLHS-3 and DLHS-4

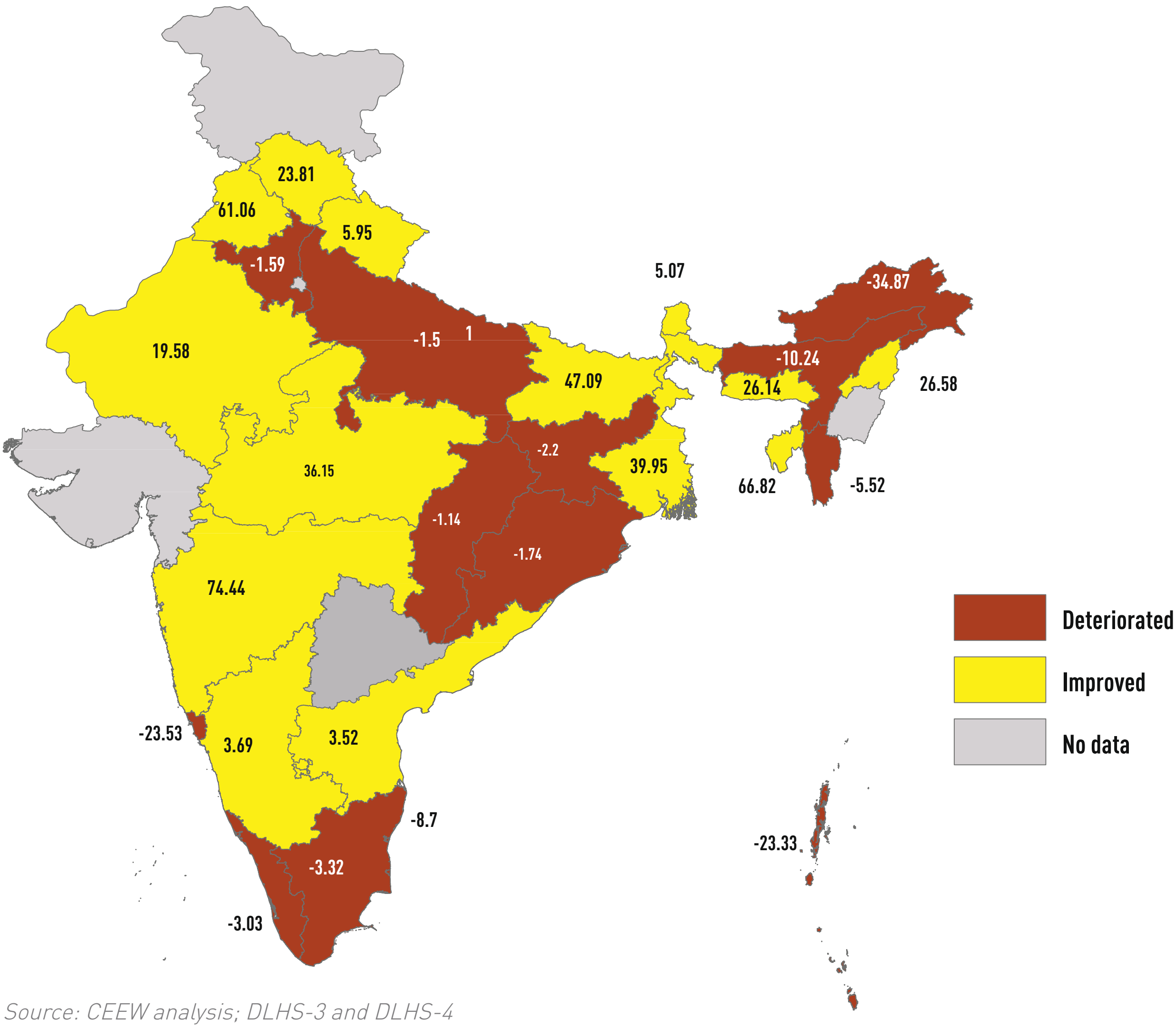
The maps below capture the change in the proportion of PHC electrification from 2007-08 to 2012-13 across Indian states.

In 2007-08, 15 of the 33 states surveyed, had less than 50 per cent of their PHCs with access to regular electricity supply. Of the remaining 18 states, only eight had more than 75 per cent of their PHCs with access to regular electricity supply (Figure 3(a)). However, Figure 3(b) indicates that the overall situation of electricity access at PHCs improved between 2007-08 and 2012-13, and in 2012-13 around two-thirds of the states (including Union Territories) had access to regular electricity supply at more than 50 per cent of their PHCs.

14 states witnessed a decline in the percentage points of PHCs with regular electricity supply

Even though the above figure shows an improvement in the electrification situation, it is important to know that DLHS is not a panel data of PHCs. Higher proportion of PHCs lying in

Figure 4: Proportion of PHCs with regular electricity supply reduced in some states between 2007-08 and 2012-13[12]



Source: CEEW analysis; DLHS-3 and DLHS-4

[12] DLHS-3 was conducted in 33 states and union territories, while DLHS-4 was conducted in 29 states and union territories. Thus, there is no data on improvements in PHC electrification in states like Gujarat and, Jammu & Kashmir.

the regularly electrified category at the state level does not reveal an absolute improvement in the electrification situation of the PHCs. Sometimes, the results depend on the way the situation is analysed. For instance, in Figure 4, we observe that 14 states witnessed a decline in the percentage points of PHCs with regular electricity supply.

The most prominent decline in electricity supply was observed in three North-Eastern states with Arunachal Pradesh facing as high as 35 percentage point decline in the percentage of PHCs with access to regular supply of electricity

Figure 4[13] shows that 14 states witnessed deterioration in electricity supply at the PHCs (in percentage terms), implying the overall improvement was driven by a few states like Maharashtra and Punjab. Five of these 14 states are the high focus states (including UP, Assam, Odisha, Jharkhand, and Chhattisgarh). The most prominent decline in electricity supply was observed in three North-Eastern states with Arunachal Pradesh facing as high as 35 percentage point decline in the percentage of PHCs with access to regular supply of electricity. However, since this is not a panel data of PHCs, the decline in the proportion of PHCs with regular supply of electricity could be a result of many changes. The obvious ones include – i) conversion of PHCs with regular electricity supply (in 2007-08) into CHCs (between 2007-08 and 2012-13) thus reducing the number of PHCs with regular electricity supply in the dataset, ii) an increase in the absolute number of PHCs[14] with irregular or no electricity supply may have reduced the overall proportion of PHCs with regular electricity supply, or iii) the response to the question on supply of electricity is driven by the perception of 'regular' for the respondent, which is likely to change between the years of survey and differ with respondents. However, to seek better explanation, we would need further research.

[13] In Figure 4, the states highlighted in brown are the ones where percentage change in regularly electrified PHCs is negative. This means that the PHC electrification has deteriorated in these states over the years. On the other hand, states highlighted in yellow are the ones where the percentage change in electrification is positive and the situation has improved over the years.

[14] Time period between 2008 and 2013 witnessed a net increase of 990 PHCs in India (from 23458 PHCs in the year 2008 to 24448 PHCs in 2013).

Image: iStock

3. Understanding the Relationship of Electricity Access with Equipment Availability, Service Delivery and Staff Availability within PHCs

As already highlighted in earlier chapter, access to electricity in the healthcare facilities is an important determinant of the efficacy of health service delivery. This chapter will assess the existing situation with respect to the availability of electricity, critical equipment and medical staff in PHCs. It will also qualify the potential impact of availability of electricity or lack of it on the provision of critical healthcare services.

> Prioritising electricity back-up units for the PHCs with irregular or no electricity supply can enhance their ability to provide improved healthcare services

3.1 Availability of electricity backup

In the absence of regular electricity access in the PHCs, electricity backup is necessary for 24X7 availability of healthcare services and the functionality of medical equipment. Although the proportion of the PHCs with irregular or no electricity supply has reduced, much remains to be achieved.

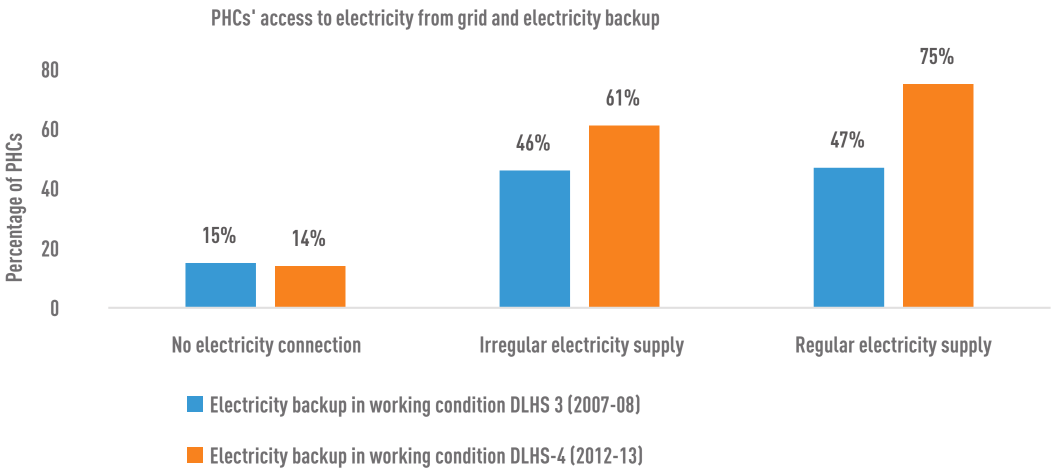
To meet the deficit in electricity access, health facilities rely on expensive electricity backup options like diesel generators that have significant cost implications and may be difficult to procure in remote areas. However, electricity backup is essential for the PHCs for not only the provision of essential healthcare services but also for the expansion of services in the PHCs, such as providing electricity to staff quarters so that the staff can stay at the facility to provide emergency and delivery services in the night.

While both electricity supply from the grid and the availability of electricity backup in the PHCs has improved over the years (Figure 1 and Figure 5), our analysis shows that these electricity backup systems are installed at a much higher rate in the PHCs that already have electricity supply from the grid.

In an evaluation of electricity backup of the PHCs in Chhattisgarh, we found that installation of an electricity backup (solar photo-voltaic system in this case) can efficiently support the functioning of the equipment and the maintenance of cold chain services. The PHCs with poor supply of electricity, when augmented with a solar electricity backup system reported significant improvement in their ability to provide 24X7 healthcare services in comparison to those without such a facility (Ramji , Patnaik, Mani, & Dholakia, 2017). Thus, prioritising electricity backup units for the PHCs with irregular or no electricity supply can enhance their ability to provide improved healthcare services.

> Availability of functional newborn care equipment in the PHCs has significantly improved between 2007-08 and 2012-13. 37 per cent of all PHCs continue to operate without the newborn care equipment

Figure 5: Availability of functional electricity backup in the PHCs



Source: CEEW analysis; DLHS-3 and DLHS-4

3.2. Availability of critical equipment

The availability of regular electricity supply or a good quality electricity backup alone is not enough for healthcare services if the fully functional equipment is not available. The Indian Public Health Standards (IPHS) lists essential healthcare equipment needed in a PHC. However, some equipment are more critical than others, and thus, it is also important to focus on their availability in the PHCs.

Reproductive and Child Health (RCH) is the most important programme under the National Rural Health Mission (NRHM) for improvement in Maternal and Child Healthcare (MCH) (CAG, 2016). Forty per cent of newborns in India have low birth weight (LBW)[15] and one in two infants die because of LBW or premature birth[16] (Saha, 2016). PHCs are primarily responsible for catering to the MCH needs in rural India and thus the availability of newborn care and cold chain equipment is important to provide the necessary services (MoHFW, 2014). Their unavailability at a PHC can have a significant social cost of health, as nearly all LBW babies need specialised care in the Neonatal Intensive Care Unit (NICU) until they gain the desirable weight. Lack of this specialised care can further compel people to visit private health clinics or unqualified doctors in the villages.

Figure 6 compares DLHS-3 and DLHS-4 in terms of availability of equipment in the PHCs. It is clear that the availability of functional newborn care equipment in the PHCs has significantly improved between 2007-08 and 2012-13. The most significant improvement was evident in the availability of radiant warmers. The number of PHCs with radiant warmers has almost quadrupled between 2007-08 and 2012-13. Nonetheless, 37 per cent of all PHCs continue to operate without the newborn care equipment. The proportion of PHCs with cold chain equipment has remained similar over the years.

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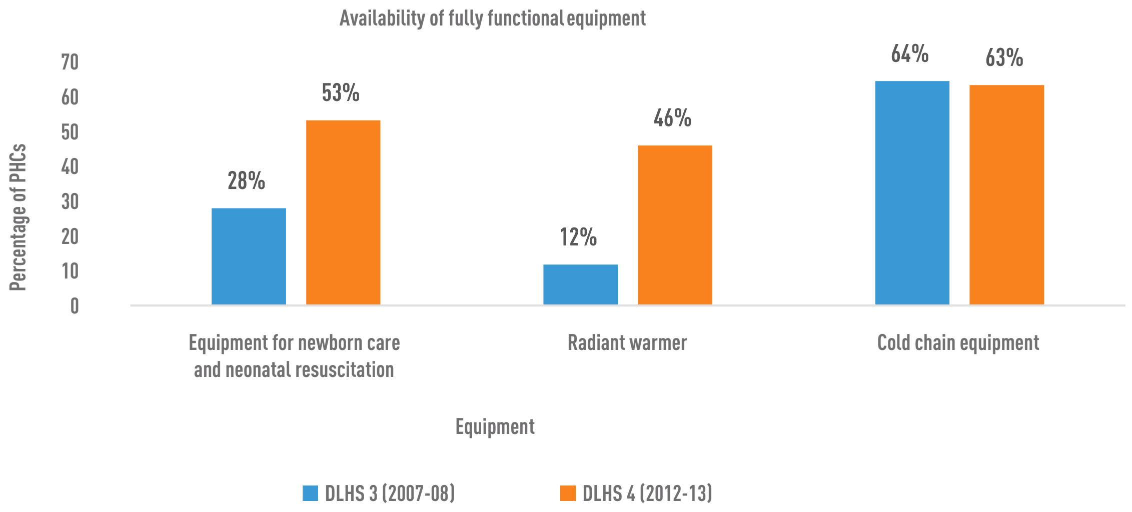
[15] A birth weight of under 2.5 kg (5.5 pounds) is considered LBW.

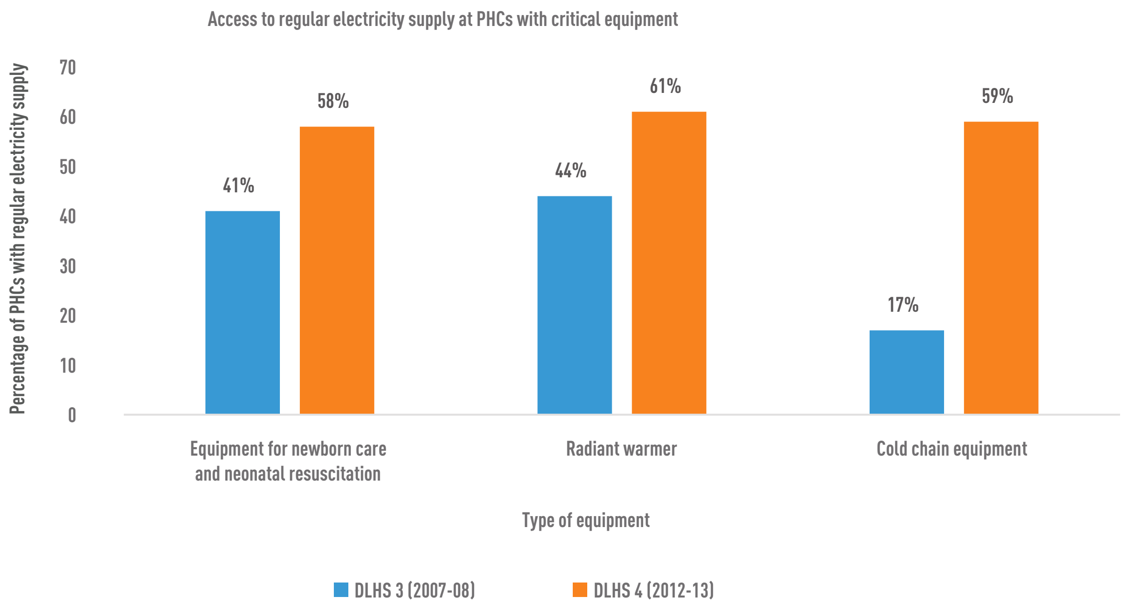
[16] A premature or preterm baby is one born alive before the completion of 37 weeks of pregnancy, according to the World Health Organization (WHO).

Figure 6: Availability of fully functional equipment improved over the years



Source: CEEW analysis; DLHS-3 and DLHS-4

Figure 7: Access to regular electricity supply at PHCs with critical equipment has improved



Source: CEEW analysis; DLHS-3 and DLHS-4

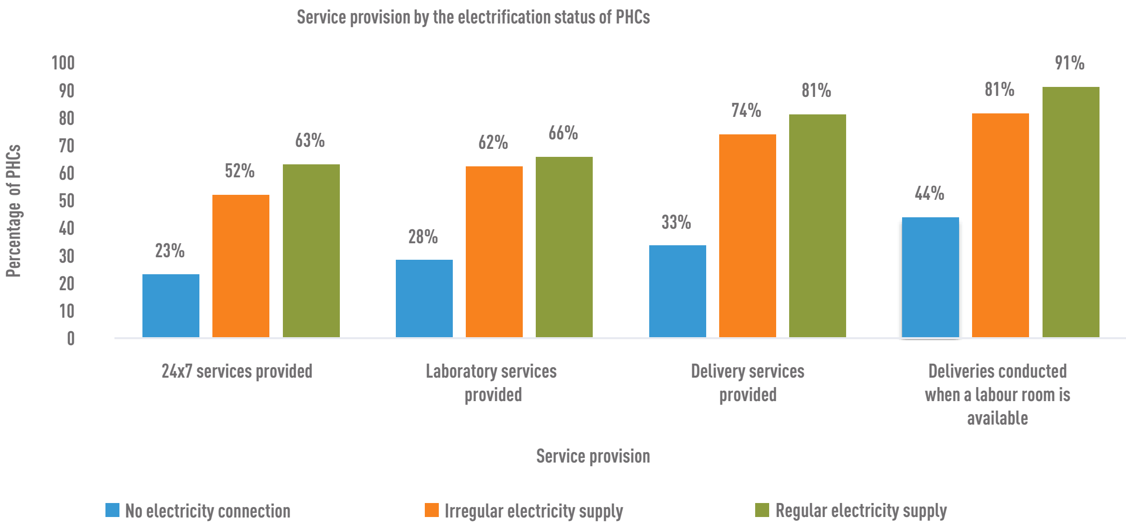
3.3. Access to electricity for the functioning of critical equipment

Access to electricity is essential to run the newborn care and cold chain equipment. To analyse the effective use of these equipment, it is also important to understand the access to electricity at the PHCs.

Figure 7 shows that only 61 per cent of PHCs with radiant warmers had access to regular electricity supply in 2012-13. However, the situation has improved since 2007-08 when only 44 per cent of PHCs with radiant warmer had regular electricity. Similarly, 59 per cent of PHCs with cold chain equipment had access to regular electricity supply in 2012-13 as compared to only 17 per cent in 2007-08. However, the improvement varies by state. For states like UP, Nagaland, and Karnataka, this number is as low as 15 per cent. This indicates both availability of equipment and regular access to electricity should be considered to assess utilisation of healthcare equipment, and the remedial action will vary by state.

Both availability of equipment and regular access to electricity should be considered to assess utilisation of healthcare equipment, and the remedial action will vary by state

Figure 8: Service provision improves with improvement in electrification status of the PHCs



Source: CEEW analysis; DLHS-3 and DLHS-4

3.4. Better access to electricity could potentially improve the ability to deliver services

This section analyses the impact of electricity access on service delivery at PHCs. While the quality of service delivery cannot be attributed directly to access to electricity alone, we use co-relation to evaluate that.

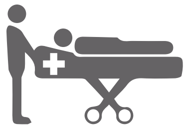
Figure 8 highlights two key points. First, PHCs with access to the regular supply of electricity handle a significantly higher proportion[17] of delivery and other round-the-clock (24x7) services[18] in comparison to PHCs with no or irregular electricity supply.[19] For instance, 81 per cent of the PHCs with the regular electricity access provide delivery services, while only 33 per cent of the PHCs with no electricity connection are able to provide the same. When the labour room is available, the rate of delivery goes up across all categories of PHCs. When controlled for the availability of staff

[17] All the significance tests for differences in proportions were carried out using the two-tailed two-sample test approach.

[18] P-Value for two-tailed two-sample test for '24x7 service provision', 'delivery service provision', and 'deliveries conducted when a labour room is available' (between 'regularly electrified PHCs and irregularly electrified PHCs', and between 'regularly electrified PHCs and not electrified PHCs'): 0.0000

[19] P-Value for two-tailed two-sample test for 'Provision of laboratory services'- between 'regularly electrified PHCs and irregularly electrified PHCs': 0.0156; and between 'regularly electrified PHCs and not electrified PHCs': 0.0000.

(both ANM and Medical Officer) and the labour room,[20] the two other essentials for conducting deliveries, 96 per cent of the PHCs with the regular electricity access provide delivery services, against 67 per cent in case of no electricity connection. This highlights a significant relationship between access to electricity and provision of the most critical healthcare services.



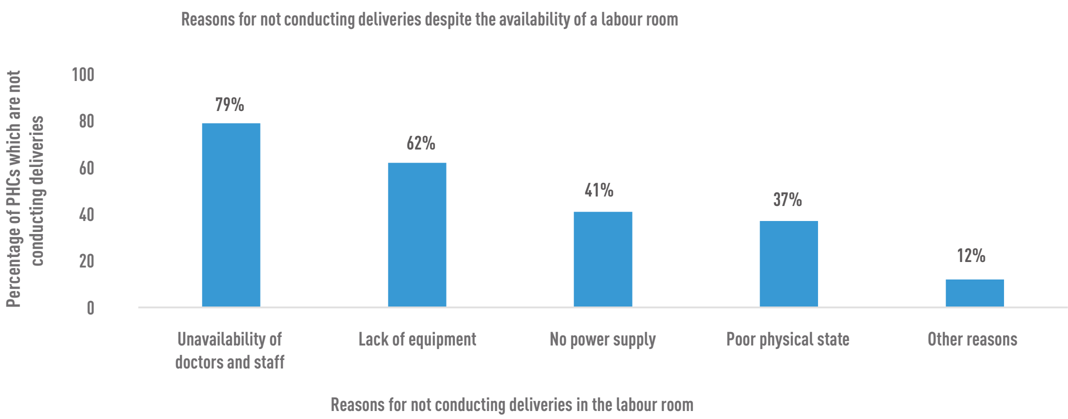
There exists a significant relationship between access to electricity and provision of the most critical healthcare services

Second, 44 per cent (167 in number) of the PHCs that have the labour room available and conduct the deliveries have no grid connection. Two-thirds of them (110 in number) have no electricity backup. This implies deliveries are conducted in these PHCs without any functional lights or newborn care equipment, which has significant risks for the mother and newborn. Almost all such PHCs are concentrated in the six high focus states (Uttar Pradesh, Bihar, Jharkhand, Chhattisgarh, Madhya Pradesh, and Odisha), which are also among the states with the highest IMR and MMR in India (NFHS-4, 2015-16).

Further, the analysis reveals that around 13 per cent of the PHCs that have the labour rooms available are not conducting deliveries. This suggests that even if the facilities have the required infrastructure in place, it does not necessarily translate into the service provision. This is also a serious case of under-utilisation of resources, given that a quarter of the births in rural India are still not institutional (NFHS-4, 2015-16). The reasons for not conducting the deliveries despite the availability of labour room in the PHCs are represented in Figure 9.

Figure 9 also highlights the importance of workforce availability for the smooth functioning of the health system. As high as 79 per cent of the PHCs that are not conducting the deliveries despite the availability of a labour room attribute the reason to the lack of doctors and medical staff. Despite the availability of infrastructure, PHCs cannot provide the required services in the absence of relevant staff. Further, 62 per cent of PHCs report lack of equipment and 41 per cent report lack of electricity supply as the reasons for not conducting deliveries. As literature suggests, aspects of equipment availability and electricity supply are interlinked, where absence of one renders the other useless. While designing healthcare systems, availability of equipment and ability to use the same should be considered simultaneously.

Figure 9: Unavailability of staff is the most common reason for not conducting deliveries at PHCs



Source: CEEW analysis; DLHS-4

[20] Only PHCs which have both labour room and workforce available are considered for this comparative analysis.

Unavailability of regular electricity supply in the PHCs has an adverse impact on the availability of the medical staff in the facility (Chaudhary & Hammer, 2003). Residential quarters for the staff are available in most of the PHCs to ensure 24x7 availability of staff in case of emergencies. However, of all the PHCs where residential quarters for the Medical Officers (MOs) were available, in 47 per cent cases MOs did not live in the allotted PHC quarters.

41 per cent of the PHCs report lack of electricity as the reason for not conducting deliveries, despite the availability of a labour room

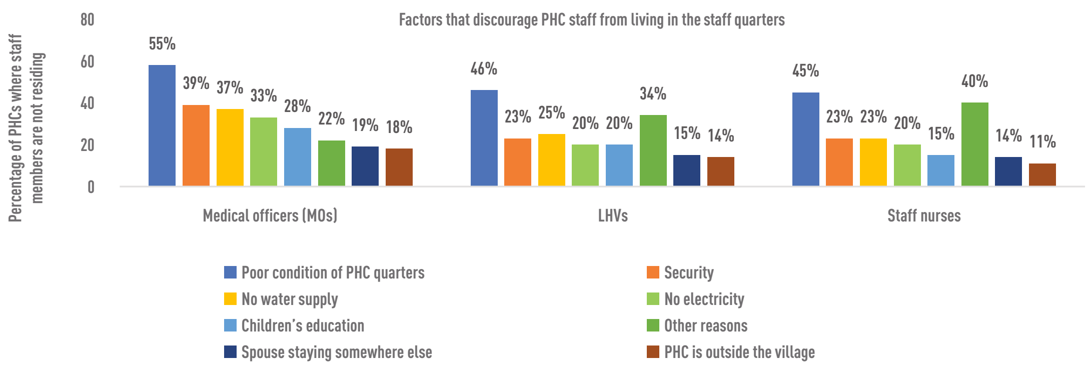
3.5. Poor condition of PHC quarters the most common reason for discouraging staff to live in the quarters, electricity access the fourth most common

Figure 10 represents the reasons that dissuade staff members from living in the allotted PHC quarters. The lack of electricity was the fourth most common reason; the poor condition of the quarters, poor security and lack of water supply being the top three causes. One-third of the MOs and one-fifth of Lady Health Visitors (LHVs) and staff nurses report 'lack of electricity' as the reason for not residing in the PHC quarters.

One-third of the MOs and one-fifth of Lady Health Visitors (LHVs) and staff nurses report 'lack of electricity' as the reason for not residing in the PHC quarters

From Figure 11, it is clear that higher proportion[21] of staff members (particularly MOs and LHVs[22]) prefer to live in PHC quarters where availability of electricity is better, given other needs are adequately met. However, 38 per cent of the PHCs with regular electricity supply, do not have the resident MO, emphasising the importance of other factors in improving staff retention in the allotted quarters.

Figure 10: Quality of PHC quarters the most common reason for the staff to not live in the PHCs quarters

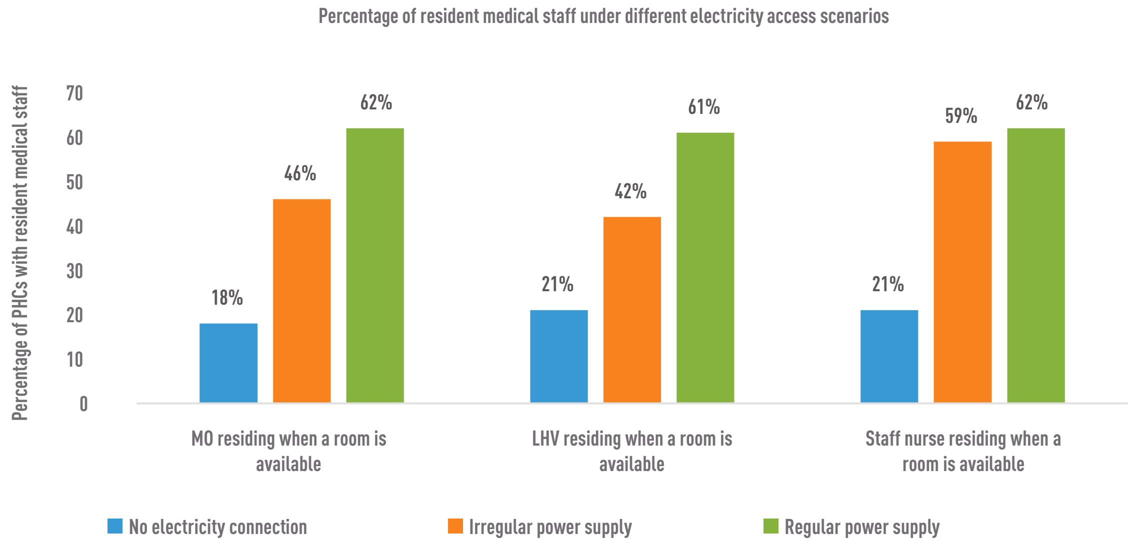


Source: CEEW analysis; DLHS-4

[21] The significance tests for differences in proportions were carried out using the two-tailed two-sample test approach.

[22] For MOs and LHVs, the proportional difference is statistically significant with a p-value 0.00, both between 'regularly electrified and irregularly electrified PHCs', and between 'regularly electrified and not electrified PHCs'. Only in the case of staff nurses, the proportional difference of staying in the PHCs is not significantly different between regularly electrified PHCs and irregularly electrified PHCs (P-value: 0.1641)

Figure 11: Proportion of resident medical staff increases with improvement in electrification at PHCs



Source: CEEW analysis; DLHS-4

Image: iStock

4. Limitations of the Study

This brief highlights the importance of access to electricity by PHCs in providing healthcare services (Figure 9) and the retention of medical staff (Figure 10) in the primary healthcare system. Inconsistent electricity supply affects the functionality of the cold chain for vaccines and newborn healthcare equipment. It also affects the working conditions in labour rooms and staff quarters in the PHCs. Therefore, there is a serious need for the policymakers to include electricity access as one of the critical components of the health system infrastructure.

> This brief illustrates a positive correlation between the regular supply of electricity to the PHCs and improved service availability. A rigorous study under a controlled environment, the magnitude of the impact of improved electricity access on health service delivery is difficult to measure

This brief does not establish that improved electricity access will necessarily translate into improved service provision. It, however, illustrates a positive correlation between the regular supply of electricity to the PHCs and improved service availability. It is difficult to establish the causation using secondary data where the sequence of events is not known. The findings can be similar in cases where only PHCs with higher footfall or better services have been deliberately provided with better electricity access. Indeed, better electrification may not be the 'cause' of improved services but the 'effect' of services availability. Therefore, without a rigorous study under a controlled environment, the magnitude of the impact of improved electricity access on health service delivery is difficult to measure. Even under the controlled environment, it may be difficult to capture the actual impact as the health service delivery is a combination of many confounding factors, like skills and knowledge of the staff, availability of equipment and medicines, proximity to treatment, and so on.

Further, sometimes there is a lag between when an intervention is undertaken (say, of improved electrification) and when the measurable improvements start taking place. Thus, if such a study were to happen, it would be necessary to ensure the requisite amount of time for the study to effectively track and capture the impact.

In addition, the access to electricity is analysed based on the reporting of healthcare centres. DLHS does not explicitly mention how many hours account for 'occasional supply of power' or supply of how many hours a day is considered 'regular supply of power'. This, to some extent, is driven by the perception of the respondent, which can have a bearing on the analysis. The choice of options provided in the survey were - i) regular power supply, ii) occasional power supply, iii) power cut in summer only, iv) regular power cut, v) no electricity connection. The second and fourth options, in this case, could be construed as having similar connotations, which poses the challenges for objective analysis.

Image: iStock

5. Exploring Solutions to Address the Energy Challenges of the Healthcare System

This study demonstrates that a significant number of PHCs in India still suffer from the lack of access to regular electricity supply (whether through the grid, or through diesel generator sets). As far as the health facilities are concerned, the benefits of improved electrification can be profound (GVEP International, 2013). The lack of electricity access from the conventional sources can be met through renewable forms of energy like solar or wind to improve the durability and reliability of electricity access. As the costs of renewable energy technologies fall, they end up being more affordable both as a primary or backup energy source. This is particularly true in the case of photovoltaic (PV) solar power (WHO, 2015). In fact, this has already been experimented with in some parts of the world, including India.

There is a need to integrate more energy indicators into routine health facility infrastructure surveys conducted by the ministries and donors

The Government of Maharashtra, with support from the Ministry of Health and Family Welfare (MoHFW) and United Nation Children's Fund (UNICEF), has deployed hybrid solar PV systems across 407 rural PHCs in the state. Similarly, Tripura Renewable Energy Development Agency (TREDA) has installed SPV systems in all PHCs (5 kWp each), CHCs (10 kWp each), and District Hospitals (10 kWp each) in Tripura. It is now aiming to electrify state Medical colleges using SPV systems.

Globally, solar PV systems have enabled electrification of health facilities in countries with little grid coverage. In Liberia, for instance, the first-line of public health facilities are provided electricity through solar systems. A 2012 survey of these health facilities revealed that a majority of health facilities used solar PV rather than generators as their primary energy source. Also, a significantly higher proportion of PHCs with solar PV system (as the primary source of energy) reported the availability of electricity during the survey, as compared to PHCs with generator sets (WHO, 2015). Similarly, in Cuba, 170 rural clinics provided with PV systems showed improvements in both quality of life and infant mortality (GVEP International, 2013).

In 2008, the World Bank concluded that renewable energy can help bring down the cost of providing immunisation services and be a part of the routine services offered by a clinic (Independent Evaluation Group, 2008). Based on many such successful experiments, we list some recommendations that can help address energy challenges in the Indian healthcare system:

1. **Leverage technology to collect better data on the status of electricity availability** – In order to effectively design an electricity backup system that can cater to the needs of the patients, it is important to measure the actual energy needs and the status of electricity available in the health facilities. One way to accomplish this is by integrating more energy indicators into routine

annual health facility infrastructure surveys conducted by the ministries and donors.[23] These surveys can collect important information related to the quality and reliability of electricity supply (like the number of hours of electricity supply instead of ambiguous options like regular or irregular electricity supply, frequency of voltage fluctuations, impact on health services because of power outages, including others). Further, as these surveys can be affected by human bias, technology like sensors can play an important role. These sensors can be deployed in health centres to get real-time information on the day to day energy requirement and its availability.

2. **Have a special focus on PHCs with irregular or no electricity supply –** It is observed that electricity backups are installed at a much higher rate in PHCs that already have grid electricity supply. This should be verified and priority for installation of backup should be given to the PHCs with irregular or no electricity supply from the grid.

3. **Design renewable energy systems to augment the grid** - In order to augment the electricity supply to PHCs, many state governments, under the National Health Mission (NHM), have preferred to spend on providing electricity backup through diesel generators (UNICEF & UNIDO, 2016). However, the recurring cost of diesel generator makes it an expensive solution for critical healthcare services. On the other hand, as alternative sources of energy (like solar PV with storage) are becoming cheaper and competitive, it has become more affordable for the health facilities to be equipped with solar energy (both as a primary or backup energy source) to address the energy deficit (WHO, 2015). With lesser operation and maintenance cost and greater reliability, renewable energy has the potential to meet the energy requirements of the healthcare centres.

4. **Guidelines for optimal system sizing to meet the needs of each PHC –** While acknowledging the potential improvements that solar system can bring in the healthcare services in the country, it is also important to develop guidelines around the optimal system size that will be required for installation. It is estimated that a typical PHC (as per IPHS norms) has the mean daily electricity requirement of around 45.8 kWh/day and solar PV systems of 5 kWp could meet 70 per cent of the mean daily peak electricity requirement of PHCs (Agarwal, Ramji, & Dholakia, 2016). However, it is also important to identify and consider the local needs in the design of the solar PV systems for the health centres. For instance, in conflict affected areas, PHCs might need to have blood storage units and thus will have a higher electricity requirement.

[23] Even though DLHS (in India) does that to a certain extent, its way of categorising current electricity supply into five different categories (regular power supply, occasional power supply, power cut in summers, regular electricity cut, and no electricity connection) is ambiguous. For instance, 'regular power supply' in DLHS may mean very different hours of electricity supply in different states. Hence, average number of hours of supply may be a better measure.

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