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Hospital Energy Consumption Survey: The Lived Experience

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Highlights

- The lived experience of the survey administrators of a nationwide hospital energy survey capturing on-ground realities and learnings often precluded from technical survey reports
- Transferrable learnings that can help make future commercial building energy consumption surveys quicker, less cumbersome, less costly, and more effective

Abstract

As part of the effort to foster a more systematic approach to commercial building energy data collection and reporting, this paper aims to bring out the "lived experience" of on-ground data collection from the recently concluded Hospital Energy Consumption Survey conceptualized and conducted by the National Centre for Disease Control (NCDC), Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India, under the aegis of the National Program for Climate Change and Human Health. It was administered and overseen by the Alliance for Energy Efficient Economy (AEEE) and the Centre for Chronic Disease Control (CCDC). This paper captures the authors' on-ground survey experience and transferable learning, typically precluded from technical survey reports. The authors believe that given the challenges in collecting relevant energy data from the buildings sector, their experiences can offer a unique insight into the on-ground realities of collecting technical data and suggest transferrable learnings that can help make future commercial building energy consumption surveys quicker, less cumbersome, less costly, and more effective.

Keywords: Hospital, commercial building, energy efficiency, survey, data

Introduction

The imperative need for healthy, energy-efficient, and low-carbon buildings is growing alongside rising expectations of private and public sectors' environmental, social, and governance (ESG) performance. Per its updated Nationally Determined Contributions (NDCs), India will, inter alia, reduce the emissions intensity of its GDP by 45% by 2030 (over the 2005 baseline) and achieve 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, in the run-up to its long-term goal of reaching net-zero by 2070 [1]. India's Long-Term Low Emissions

Development Strategy (LT-LEDS) launched at COP27 highlights the potential to significantly reduce the national power demand by improving the building sector's energy efficiency in terms of design, construction, and operations [2]. Therefore, enhancing the energy efficiency of the commercial building stock should be an important aspect of India's national energy policy framework. Understanding how buildings use energy is critical to formulating any new policy that may impact energy use, underscoring the importance of credible data. Data enables informed decision-making, and good quality data is essential for policymakers to prioritize energy-saving strategies and track implementation.

A data-driven policy framework for systematically targeting energy efficiency in both new construction and existing buildings has largely been missing. There is currently no quantifiable mechanism to track the impact of code adoption through regular reporting or surveying of energy consumption in the commercial building stock – something essential for developing updates to the codes. Most importantly, benchmarking data can be utilized to formulate building performance standards with targets commensurate with a city/state/country's decarbonization goals – such data-driven building performance standards are currently unavailable in India. As part of the effort to foster a more systematic approach to commercial building energy data collection and reporting, this paper aims to bring out the "lived experience" of on-ground data collection from the recently concluded Hospital Energy Consumption Survey conceptualized and conducted by the National Centre for Disease Control (NCDC), Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India, under the aegis of the National Program for Climate Change and Human Health. It was administered and overseen by the Alliance for Energy Efficient Economy (AEEE) and the Centre for Chronic Disease Control (CCDC).

Background

The survey was intended to be a starting point for, among other things, (i) identifying areas of energy efficiency and renewable energy interventions in hospitals, (ii) formulating data-driven policies and programmes, and (iii) identifying best practices and setting aspirational goals for hospitals towards climate-smart healthcare. It was intended to be administered in all 5 climate zones, 18 states/Union Territories (UTs), and across 10 hospital typologies of publicly and privately-owned "hospitals", i.e., centres of medical care with in-patient beds. The sample stratification was done in layers based on the ownership, climate zone, and hospital typology. The details of the sampling methodology can be found in this peer-reviewed paper: "Towards Climate-smart Hospitals: Methodology and Pilot of India's First Nationwide Hospital Energy Survey" [3]. The survey utilized the AEEE Hospital Energy Survey Questionnaire [4], which was created during this project. A total of 623 hospitals (357 public and 266 private) were surveyed, which is 3.6% of the estimated hospital population in India. For comparison, the US Commercial Building Energy Consumption Survey (CBECS) 2018 selected a sample size of 16,000 buildings, which was 0.27% of the estimated 5.9 million commercial buildings in the US [5]. The project was kicked off in January 2021 and took over 2.5 years to complete. The project timelines were extended due to challenges related to the COVID-19 pandemic. Full details about the survey methodology, the survey findings, recommendations, and future work can be found in the survey report [6]. This paper captures the authors' on-ground survey experience and transferable learning, typically precluded from technical survey reports. The authors believe that given the challenges in collecting relevant energy data from the buildings sector, their experiences can offer a unique insight into the on-ground realities of collecting technical data and suggest transferrable learnings that can help make future commercial building energy consumption surveys quicker, less cumbersome, less costly, and more effective.

The lived experience

Survey agency selection: The survey was conducted by a combination of two different survey partners with different levels of technical competence. Initially, a company primarily experienced in market research (not necessarily technical energy consumption surveys) was chosen to implement the entire survey. The personnel conducting on-ground surveys from this company were generalists with a bachelor's degree and 1-2 years of field experience. Parallelly, a validation group of around 60 public and private hospitals was surveyed by experts in building operations (energy engineers/auditors). These experts were chosen to ensure that the data collected was of high quality and reliable. Their data was used as a benchmark to validate the data collected by the generalist market research company. Though trained (see "surveyor training" below), the on-ground surveyors from the generalist surveyors found the survey too technical and could not provide consistently high-quality data like the experts. Therefore, based on this experience and a few expert consultations, the administrators decided to discontinue with the generalist market research company. The specialists were chosen to complete the rest of the surveys. Although the specialists were at least significantly more expensive than the generalist market research company, a smaller sample size was opted for to keep the costs manageable. The underlying logic for this decision was that while sampling error is likely to comprise only a small share of the total error (up to 10%), inaccurate data transfer between the surveyor and the respondent could lead to larger errors if the questions are not explained and understood well. Hence, it was decided to prioritize data quality over quantity.

Surveyor training: On-ground surveyors were given rigorous training before being deployed in the field for the pilot and the main survey. Surveyors received an overview of the study and specific instructions. A comprehensive survey toolkit and manual were provided to each surveyor. To ensure they were prepared, the surveyors carried out multiple rounds of supervised mock surveys. Thorough feedback was provided to each surveyor at the end of each mock survey. Also, during the first few real surveys, experienced team members were around to help the surveyors. Despite extensive training of surveyors and mock sessions, the survey was perceived to be too technical to be administered by the generalist market research agency. Although care was taken to make the data asks as clear as possible in the questionnaire with additional explanations such as "tool tips", the survey pilot and initial rounds of data collection revealed that sometimes the questions were not being correctly presented to the respondents. Additionally, the survey length sometimes led to respondent fatigue and poor data quality. This highlighted the need for energy specialists to conduct the surveys, which is when the validation group described above was constituted. The energy specialists ensured better data quality by minimizing errors creeping in because of misrepresenting some questions and data asks.

Onboarding of hospitals: Public and private hospitals were identified and onboarded for the survey as closely as possible per the sample stratification. A top-down approach was followed to onboard public hospitals, which NCDC facilitated under the aegis of the National Program for Climate Change and Human Health. NCDC convened a meeting of the State Nodal Officers for Climate Change (SNOCCs) to explain the nature and scope of the national survey and secure their support. This was followed by written communications to each state requesting to nominate public hospitals for the survey. The State and District Nodal Officers for Climate Change facilitated the selection of facilities in respective states where surveys could be administered. Over 500 leads were gathered for contacting public hospitals across 14 states. To identify private hospitals, an exhaustive list of about 7,353 private healthcare facilities was compiled by merging the private hospital network lists of health insurance providers, namely, ICICI Lombard, MD India Health Insurance TPA (P) Ltd., and the hospital list of Association of Healthcare Providers of India. The hospitals were then classified into single-specialty and super/multi-specialty based on the healthcare services provided by them. The list of private medical colleges was retrieved from the National Health Profile 2020 [7].

The following benefits were offered to hospitals in exchange for their participation in the survey:

- A high-level summary of their hospital energy performance, including their hospital's position on various energy performance indicators and how it compares to similar hospitals.
- A compilation of additional energy-saving/indoor air quality improvement measures practised by similar hospitals to help improve the energy/environmental performance of the hospital and the health and well-being of building occupants
- Anonymized raw data of all hospitals participating in the survey
- A training program on HVAC systems operations and maintenance at concessional fees

Clear data confidentiality terms eased the onboarding process. No personal data regarding individual patients, doctors, hospital staff, etc., was collected – only the primary survey respondent's contact information (i.e., name, email ID, and phone number) was asked. As mentioned in the survey insights report, the primary survey respondent agreed to the data confidentiality terms [6]. Once the management felt inclined to participate in the survey, the process of engagement with private hospitals was relatively linear and smooth. In contrast, engaging with the public healthcare systems was less linear since various government departments with varying authorities and roles were engaged to run the public healthcare system.

Survey lead times and questionnaire optimization: At the time of data collection, the survey team learned the opportunity cost involved in a lengthy questionnaire and the need to prioritize the quality of responses over the quantity of responses. Engagement with multiple layers of the system caused delays. Conflicting priorities for healthcare workers, some of which were associated with the pandemic, created bottlenecks for committing time to the survey. It was often found to be difficult to identify the right person to take the survey. In the case of larger hospitals, multiple departments needed to be involved, which also contributed to longer lead times. After the pilot survey, an effort was made to optimize the questionnaire and assess which data fields are most meaningful for meeting the project objectives, including assessing the baseline for hospital energy consumption, gaining insights into their energy intensities of area and bed, energy saving practices, and the energy efficiency of end-use technologies. The questionnaire underwent many revisions (including cutting down the number of questions to one-third from 65 data points to 20 data points).

Respondent profile and modes of data collection: The main survey was administered to chief engineers or other officials from the engineering/facility management department (and the administration department for questions related to business metrics). The biomedical department was approached (for questions related to medical refrigeration and imaging equipment) in the larger public medical colleges and all private hospitals. It was administered to presiding doctors and/or visiting service technicians in smaller typologies. The survey was administered in a combination of 2-3 in-person and virtual meetings per hospital using a digital version of the questionnaire and/or its hardcopy version in those areas where internet connectivity was not reliable. Many respondents showed a preference for hard copies over the digital version of the questionnaire. At the beginning of the survey, the respondents were informed of the data-sharing terms and presented a consent form to sign for the collection of data.

A mix of three methods of data collection was followed:

- **Web-based:** The online survey link was shared with the respondents/departments via email. The respondents then responded to the questionnaire and submitted the survey, which was uploaded to the server. Telephonic follow-ups were made to ensure a high level of participation.
- **Telephonic interviews:** A team of trained personnel conducted telephonic surveys with the concerned person/ department to get feedback. Prior appointments were fixed for conducting the interviews.
- **Face-to-face intervention:** The interviewers carried a tablet with the online version of the questionnaire or a hard copy of the questionnaire to conduct the face-to-face intervention.

A survey tracker to ensure the timely completion of facility onboarding and completion of surveys was established. In some cases, the lead times for interviews were very long due to the lack of availability of staff for the survey. Some of these lead times took as long as a few weeks per hospital. Identification and timely communication with the appropriate respondent was challenging in many hospitals.

Data collection: The on-ground experience of collecting some key data is detailed in Table 1.

Table 1: Experience, ease of collection and data quality

Data ask	On-ground experience	Level of effort	Data quality
Monthly and annual grid-connected electricity consumption (kWh)	Obtaining monthly electricity consumption was difficult. Hospitals would often be missing electricity bills and records for certain months, which would make arriving at annual sums tricky. Hospitals would more often just have the information of the expenditure on electricity than the absolute consumption. This was often found to be misreported as consumption numbers in back-checks. Additionally, back-calculating consumption from electricity bills is not always straightforward and can lead to misleading numbers. Many public hospitals did not have a record of electricity consumption since their bills were paid through the district electricity offices. The electricity consumption was not tracked at the end-use levels by most hospitals.	Medium	Medium
Total gross floor area(ft^2)	ANSI/ASHRAE Standard 105 (ASHRAE 2022, 2018, 2021) uses other definitions, including gross square footage, as included here. For the purposes of this study, the total gross floor area is the super built-up area between the outside surface of the exterior walls of the building. This includes all areas inside the building, including supporting areas. It includes lobbies, common areas, meeting rooms, break rooms, restrooms, elevator shafts, stairwells, mechanical equipment areas, basements, and storage rooms. It excludes exterior spaces, patios, exterior loading docks, driveways, covered walkways, outdoor play courts (tennis, basketball, etc.), all parking areas, the interstitial plenum space between floors that house pipes and ventilation), and crawl spaces. Although the total gross floor area was clearly defined in the questionnaire, the respondents still had trouble reporting the correct information. The accurate area of hospitals was often not available. To counter-check, the team used Google Maps to corroborate the reported gross-floor area of the facilities. There were some reporting issues regarding the units (ft$_2$ v. m^2). In many healthcare units, the staff were not aware of the actual floor area of the hospital as the healthcare units have undergone the addition of new buildings or floor plates over a period of time. The updated building drawings and floor area data were not readily available to the administration team. In the absence of this information, the surveyors either measured using measurement tape or counted the number of tiles with the help of hospital staff to roughly calculate the floor area, which is not practically feasible for bigger hospitals.	Medium	Low
Total number of beds considering male, female, OBG-related, post-op ward, emergency ward, daycare, and other general ward beds	Some healthcare units reported beds that were not operational at the time of the survey.	Low	Medium
Annual number of in-patients discharged	Capturing or estimating the average length of in-patient stay was found to be difficult. The product of the reported average length of in-patient stay and number of in-patients, which could be interpreted as a measure of	High	Low

Average length of in-patient stay	occupancy ("in-patient days"), would sometimes exceed the available bed capacity.	High	Low
Total air-conditioned area (ft^2)	Data on air-conditioned area (sq. ft.) was often not available for air-conditioned hospitals. Among the hospitals that did report air-conditioned area, there was limited data on the installed cooling capacity, i.e., DX and/or chiller. In some cases, the reported air-conditioned area was greater than the total area for hospitals. The reported data was often a guesstimate, which may not have been accurate.	Medium	Low
Total operational cooling capacity for each type of DX unit tonnes of refrigeration (TR)	In some cases, the refrigeration tonnage of individual units was misunderstood as the total installed tonnage of the given unit type.	Medium	Medium
Onsite solar PV to support hospital energy needs	Hospitals that had installed solar PV systems were not always using the power generated by the installation. Some hospitals that used onsite solar power were not capturing the amount consumed.	Low	High
Peak capacity in kilowatt peak (kWp)		Low	High
Annual energy consumed from onsite solar PV (kWh)		Medium	Medium
Share of LED lights as a percentage of overall hospital lighting	Most hospitals were not able to provide an accurate number across types of lighting used in the facility. The associated survey question was later revised to a multi-choice question about the share of LED lighting in the facility.	Medium	Medium

In the case of in-person data collection, the energy specialist surveyors were able to glean anecdotal or qualitative insights by observing and interacting with the survey respondents, who were not a part of the survey questionnaire. These insights helped create more rounded recommendations based on the survey findings. For example, it was observed that most of the solar PV systems in public and private hospitals were observed to be on-grid systems, barring a few public hospitals located in remote areas that had off-grid systems. Most of the hospitals did not deploy solar PV systems as a source for critical load backup; instead, they relied on diesel generators to provide critical services during the hours of power supply failure. In both public and private hospitals, the maintenance of solar PV plants was conducted through an annual maintenance contract issued to the solar PV plant service provider. It is observed that in public hospitals, the maintenance of the solar PV plant was not effectively conducted, with the energy survey team visibly confirming the presence of the broken component of solar panels and as informed by the hospital administrative staff. Some of the hospitals surveyed even indicated that the solar PV plants' components needed detailed repairing and replacement. Nonrenewal of annual maintenance contracts was common in public hospitals, which indicates that solar installations in public health systems have not happened following an institutional approach.

Data quality control: Data quality control systems were established through a rigorous check at frequent intervals of all data collected throughout the survey. The following measures were undertaken:

- Regular check-ins of participating teams to ensure that the standard data collection process was being followed.
- A subset of data was reviewed, and feedback was provided to survey teams where the data monitoring teams encountered additional inputs or missing data.
- Several data points were back-checked with hospitals through a combination of in-person visits and telephonic communications.
- Feedback on the survey experience was also collected from respondents to ensure the genuineness of the survey exercise.

Data screening: A multi-level filtering approach was used to eliminate dubious data points further. The first level of filtering was done based on the availability of consent forms provided by private hospitals for authentication and the availability of critical data points from hospitals, including the number of beds, total gross floor area, and annual electricity consumption for FY 2019-20. The second level of filtering eliminated outliers, which were identified based on ranges derived using a combination of literature and distribution of sample data. Only the hospitals that passed through both filtering levels were considered for the final analysis. Despite the data screening and quality checks, some data points that do not accurately represent the on-ground situation may have yet passed through due to the various factors elaborated above.

Conclusion: Transferrable learnings for future surveys

Building energy data gathering is almost always resource-intensive, time-consuming, and extremely susceptible to data quality problems. As a result, the scope and priorities for data gathering should be carefully evaluated and chosen based on a number of important factors. The authors' lived experience corroborates the suggestions presented in related literature, particularly "Establishing a Commercial Buildings Energy Data Framework for India: A Comprehensive Look at Data Collection Approaches, Use Cases and Institutions" [8].

- **Begin with the use case rather than the data:** To decide on the needs and priorities for data, always refer to the KPIs associated with the use cases or survey objectives. Every data field should be included in the survey for a specific reason, such as serving as an input for a KPI or a normalizing/clustering variable.
- **Keep in mind the level of effort:** The amount of work needed to obtain data varies greatly amongst data fields. Detailed end-use energy disaggregation is much more complex to collect than the total number of guest rooms in a hotel. When deciding which areas to prioritize for collection, it may be helpful to rate the level of work necessary to get the data for each field on a scale of 1 to 5. Consider using proxy fields instead of difficult-to-collect crucial fields whenever possible. For example, use the chiller's nameplate efficiency if determining its real operational efficiency is difficult.
- **Analyze the possibility of poor data quality:** While certain fields might appear simple to fill out, they could be particularly vulnerable to bad data. Experience shows, for instance, that even a seemingly basic data category like gross floor area can contain major errors. Alternative measurements of floor area may be more accurate for specific building types. For instance, it is probably more dependable because net leasable area serves a crucial business function in leased buildings.

The following are crucial factors for the survey design and data collection strategy after the data fields have been chosen and prioritized.

- **Data quality versus quantity:** Sampling error is likely to comprise only a small share of the total error, say up to 10%, while the majority of the error is likely to creep into technical energy consumption surveys on account of inaccurate data transfer between the surveyor and the respondent if the questions are not explained and understood well. Hence, it is important to prioritize data quality over quantity.
- **Onsite versus remote data collecting:** In general, collecting data remotely (e.g., over the phone, using web survey forms, or via email) is easier than gathering data physically. It might be challenging to forgo site visits for some data points totally. However, by gathering as much information remotely as feasible, the amount of time spent onsite could be reduced.
- **Reduce the number of points of contact used to collect the data:** In any particular facility, it's unlikely that any one person will have access to all the information needed. To make the process of gathering data easier, the number of touchpoints should be kept to a minimum. For large portfolio owners, for instance, a central repository might have information on all properties. While such central repositories may currently be scant, mandatory, and self-verified, data disclosure by a certain category of hospitals (large multi or super-speciality hospitals) could, in the future, ease energy data collection and more informed decision-making at the facility as well as policy level.

The methodology used in this survey can be applied to address energy data gaps in various energy-intensive building types, such as hospital and hotel chains, ICT companies, airports, and more. It offers a valuable framework for designing and implementing future efforts in closing energy data gaps for these building typologies. Further, the applications of on-ground learnings in data collection can inform future commercial building energy surveys to make them more effective, less prone to error, less cumbersome, and less expensive. Obtaining accurate and comprehensive information about the building's energy systems, equipment, and historical energy usage is challenging. The complexity inherent in commercial buildings and potential resource constraints underscores the importance of employing skilled energy surveyors and interdisciplinary collaboration. Leveraging the lessons learned from this survey, we advocate for a strategic approach that amalgamates expert energy assessment, multidisciplinary cooperation, and robust data analysis, culminating in more accurate and actionable survey outcomes.

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