Access to Standardised, Transparent, and Granular Electricity Consumption Data: A Novel Engagement Model for the Indian Consumer

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Abstract Electricity consumers in India receive their energy consumption information through monthly bills with limited data (such as per-unit rate, units consumed). Application of advancement in digitisation of metering data limited to improving the billing and collection efficiency. Post the COVID-19 lockdown, consumers in different parts of India complained about inflated electricity bills. The bills in lockdown were generated based on past data and no opportunity for consumers to monitor their real-time consumption. This strengthens the need to provide consumers with easy access to transparent and granular electricity consumption data. The growing penetration of technology has evolved consumers into digitally-enabled consumers, and their requirements have changed significantly. One prominent example is telecom consumers who can track their real-time usage (internet data usage, calls, bill dues, economical plans as per usage). However, such flexibility is not available with electricity consumers to track their consumption to manage bills, evaluate the benefit to opt for ToD rate plans, etc. With this backdrop, this paper attempts to answer two key questions: Does the consumer have sufficient, straightforward and standardised electricity consumption data to make informed decisions? What are the potential value propositions for different consumer types? This paper will develop a standardised end-use (In the paper, end-use refers to the data of electricity consumers. Data access refers to consumer access to energy usage data.) data-sharing framework. It will also draw inferences from how end-use energy data is shared with consumers in other countries and with consumers in India's different sectors. The findings will help develop better energy efficiency interventions such as effective demand response programmes and customer engagement strategies.

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1 Introduction

With the growing penetration of technology, consumers are evolving into digital consumers throughout the world. This has resulted in a massive shift in their expectations and requirements. The transformation is primarily driven by the availability of web and mobile-based tools, enabling consumers to access more granular information about their consumption pattern in various fields ranging from personal finance to health, and fitness [1].

However, the experience differs when it comes to electricity consumers. Utilities' services haven't progressed much over the years with consumer interaction limited to the payment of electricity bills, complaints against outages, and getting or changing electricity connections [1–3]. In India, electricity consumers continue to receive their energy consumption information through monthly bills with limited data (such as per-unit rate, units consumed). The monthly bills provide little to no insights on consumer usage patterns [1]. However, some DISCOMs are advanced than the other. For example, in Delhi, if you are under time-of-use rate, they will give you consumption in the block, for net-metered consumer share self-generation and grid generation data. Another example is CESC Calcutta provides the consumption for the previous five months and the same six months of the last year. Application of advancement in the digitisation of metering data limited to improving the billing and collection efficiency.

The criticality of sharing granular data[1] with consumers became evident post-COVID-19 lockdown. Consumers in different parts of India complained about inflated electricity bills as meter reading couldn't be taken during lockdown [4, 5]. Thus, the bills during lockdown were generated based on past months' consumption and adjusted later on causing a spike in bills, with no opportunity for the consumer to monitor their actual consumption and manage their consumption if they choose to do so. Availability of standardised, timely-consumption data allows active consumer participation by evaluating available options and making informed decisions to manage their consumption [6]. One prominent example is the telecom sector where consumers can track their real-time usage (internet data usage, calls, bill dues, and economical plans as per usage).

Access to granular data by electricity consumers has significant energy saving potential varying from 6 to 18% as per different reports [1]. The detailed information about their energy usage will accelerate the energy efficiency behaviour in consumers and facilitate utilities to develop demand-side management (DSM) programs [6, 7]. Globally, several key drivers are changing consumer experiences such as solar

[1] Granular data is defined as electricity consumer energy usage data (frequency can be 1-min, 15-min, hourly, daily, or monthly depending on meter type), load curves, load factor, demand factor, cost information, etc. The extent of detailed information is contingent upon on meter type such as smart meter, conventional meter, bi-directional meter, etc.

rooftop penetration, electric vehicles, development of innovative devices, and smart appliances and forcing utilities to relook the consumer engagement strategy from being passive to active [2].

The energy sector is at the forefront of developing and implementing long-term strategies to meet climate action goals, especially for coal-based economies such as India. A special report on Energy and Climate Change highlight that energy efficiency can reduce the growth rate of world energy demand to one-third by 2040 [8]. In addition to energy efficient technologies, making consumers aware of their energy consumption can help nudge consumer behaviour towards managing or reducing their energy consumption. These factors further reiterate the need to provide consumers with easy access to transparent, standard, and granular electricity consumption data to undertake informed choices.

The availability of granular data is beneficial for consumers and provides monetisation opportunity for utilities [1, 6]. Additionally, the availability of standardised data will enable technology companies to develop innovative solutions to meet consumers' growing requirement [1, 6]. Role of technological advancements will be critical in transitioning from the traditional method of data sharing to a more customer-centric approach. Digitalisation can significantly reduce the transaction cost to disseminate the information to consumers compared to conventional channels [2] and to provide consumer-targeted messaging.

The present paper is a unique study which outlines the importance of sharing electricity data and discuss the potential value proposition of various stakeholders relevant to data sharing. The objective of the paper is to develop a standardised end-use data-sharing framework considering the value propositions and contextualising the experience of other countries for India. To the best of the author's knowledge, no holistic study is done on sharing electricity data and providing a framework for a common information-sharing model. The intent of the paper is to get the feedback and initiate discussions among policymakers on the requirement of a common information-sharing model in the electricity sector.

2 Information Sharing Models

Sharing of data with consumers is not a new concept, and it is already happening in several sectors, including finance, health, telecommunication, among others. Several utilities in other countries have recognised the need to share data with consumers and have made significant improvement in sharing real-time consumption data with electricity consumers. This section will discuss the information sharing models existing around the world and in other service sectors in India.

2.1 Other Countries

One of the leading examples concerning data sharing is Green Button (GB) Standard developed in the US. This initiative started with "White House call for action in 2012 to provide utility customers with easy and secure access to their energy usage information in a consumer-friendly and computer-friendly format for electricity, natural gas, and water usage" [1, 9]. It is formally known as the North American Energy Standards Board's (NAESB) REQ21, the Energy Services Provider Interface (ESPI) [2]. There are two options to share the data—download my data (DMD) and connect my data (CMD). In DMD, a utility customer can download their usage data into a file after selecting the duration, resolution, and data source. In CMD, a utility customer can authorise a utility to share certain defined data with a "third party" company that will provide services to the customer (solar financing, analysis of the usage, etc.) [1, 9]. This data sharing standard is widely adopted by utilities across the US [1]. The standard shares data in XML format and could be adopted irrespective of meter type—smart meters, conventional meters, or bi-directional/net meters. However, the amount/granularity of data shared is a function of the meter type.

Canada has already adopted GB standard, and South Korea is also in discussion with NAESB to translate the standards into Korean [10]. Another data sharing initiative is Midata in the UK which started back in 2012 to give consumers access to their personal data in a portable and electronic format across all sectors banking, energy and telecommunication sectors [11, 12]. This started initially as a voluntary regime, but the implementation of the program got stalled. There have been certain advancements in this program with UK Government publishing a Call for Evidence to seek inputs from different stakeholders to formulate draft regulations. This was further supported by the adoption of the General Data Protection Regulation (GDPR) in May 2018. The new data protection regime provided consumers with the right to request their personal data which will be electronically ported from a data controller, to them or to a third party [12].

Analogous to GDPR of UK, Australia announced the adoption of Consumer Data Rights (CDR) in 2017, which will allow consumers greater access to and control over their data [13]. The rights intend to empower consumers to make rational decisions by comparing products and services, promoting competition among suppliers, and encouraging innovative products and services [13]. These will be implemented in a phased manner, starting with the banking sector followed by energy and telecommunication sector.

The key learnings that could be drawn are that implementation of standardised data sharing framework is mostly driven by Government and complemented by data protection rules or rights in other countries such as the US, the UK and Australia. Additionally, success was limited in case of voluntary implementation (such as the UK) vis-à-vis mandatory (such as Canada and some utilities of US) [11, 14].

2.2 Other Industries in India

Certain industries are leading example in providing consumers with easy access to their own data such as telecommunication, banking, etc. Majority of the telecom companies have developed both web and mobile-based application to track the monthly bills, internet usage, different plan options suitable to consumer requirements, track previous consumption, among others.

On similar lines, the finance sector, including banking, allows consumers to operate their accounts through web and mobile applications and do away with physically visiting the banks. Consumers can update their passbook, transfer money, check account balance, account statement, open fixed deposits, and other facilities through mobile apps. Development of Unified Payments Interface is a successful example of creating standardised protocol in India's banking sector. It allowed the merger of various banking service under one umbrella. It simplified the process of payment from paying at retail outlets (grocery, restaurant) to utility bills (mobile, electricity), and money transfer [15]. One UPI Id is generated for each account and used to make payment both online and offline. The model is quite similar to IMPS initiative but with the flexibility to make instant payment beyond banks.

One of the key takeaways from other sectors is the ease consumers have in accessing their own data and taking informed decisions. Having a standard protocol for sharing electricity consumption data will enable compatibility between different service providers and apps and thereby provide more choice to consumers while also ensuring compliance to data privacy rules.

3 Potential Value Propositions for Different Stakeholders

Different stakeholders will benefit from the sharing of standardised end-use consumption data. First and foremost are the consumers who are the actual owner of the data. Second, utilities which are the custodian of consumer data. Other stakeholders include third party companies (such as energy management companies, demand response, solar, smart thermostat [1]), research organisations, and policymakers. The detailed value propositions for each of the stakeholder are identified (Table 1) and discussed in the next subsections.

3.1 Consumers—Industrial, Commercial and Residential

One of the primary beneficiaries of end-use energy data is consumers who are the ultimate data owner. Access to granular data in a standardised format allows consumers to better understand their energy usage (depending on the granularity of data, which

will be contingent upon meter type) and identify potential areas to shift electricity consumption and reduce bills. This benefit is common across all consumer types.

Industrial consumers with insights into their energy consumption (by the time of day, and season) in a standard format can better plan their operation [6]. Standardised data access allows both industrial and commercial consumers to track their energy and carbon footprints. It saves the additional cost that industrial or commercial consumers may need to bear to track their energy consumption, such as sub-meters, data loggers, installation cost, etc. [6].

Industrial and commercial consumers stand to benefit more as availability of standardise data will empower them to compare their energy usage with similar consumers provided utilities or third-party service providers present such data to consumers (same locality, profile, size, etc.); compare with similar consumers within enterprise portfolio (e.g. schools having multiple branches in different states); compare against a benchmark for specific typology. For example, companies having offices in multiple locations (such as IT companies) can study their energy usage patterns, compare the differences, identify potential interventions, and implement energy management solutions to address it. Similarly, industrial consumers can save on electricity cost by using the information on their load curve and time-of-day (ToD) rates to shift the flexible load from peak hours to off-peak hours provided ToD rates are being offered by utilities.

For residential consumers, access to detailed and timely energy consumption data will enable them to track their energy consumption and manage or reduce their energy consumption. A study by AEEE and Oracle Utiltiy estimated the saving potential of 17–51 billion nationally of behavioural energy efficiency programmes in the residential sector facilitated by home energy reports [16]. Consumers will be not be shocked with high monthly bills as happened post COVID-19 lockdown if they can track their energy consumption. It also allows them to analyse their load curve and compare potential benefit of transitioning to ToD/ToU plans if utilities offer ToD rates. They can utilise the information to make short-term (such as postponing an activity based on usage and rate information) and long-term decisions (purchase an AC or not) about their electricity usage [6]. Appliance-level measurement is typically an expensive proposition for residential consumers. They can easily share the standardised data with a third party which can analyse it on consumer behalf and provide actionable tips for saving energy and money such as customised heating and cooling recommendations [1, 6, 17]. It also facilitates consumers to use the web and mobile-based tools to make more informed energy decisions or verify energy-efficiency retrofit investments [17].

3.2 Utilities

The utilities tend to benefit significantly from sharing granular end-use data with consumers. Sharing of data could also be the pathway for utilities for better consumer engagement [16]. Ease in accessing data enables the consumer to understand

their usage pattern and rationalise their consumption and bills. The transparency afforded by this could help utilities engage with consumers for participation in DSM programmes, thereby helping with load management [2]. Another opportunity is to engage with the product/service companies to develop new products and services and emerge as an 'energy solution provider' with new revenue sources [2].

Utilities can effectively design their ToD rates as they can measure how much electricity is used during on-peak and off-peak hours and charge customers accordingly. They could also carry out targeted demand management programs that target a specific cluster inside consumer segment (residential consumers with xx demand during peak hours), which has high potential or a geography (local distribution area experiencing congestion). The utility will benefit from detailed energy data analysis as it would help them to plan for the addition of new types of consumers such as consumers with storage, prosumers, EVs etc. Generation of significant data further complemented by smart meters and IoT will provide monetisation opportunity for utilities after they establish robust mechanisms for data privacy and security [2]. The needs and requirements vary from consumer to consumer and to offer new services to consumers require an understanding of these consumer needs [6]. Using data analytics, utilities can provide customised service and build a strong relationship with their consumers and increase consumer retention by developing consumer-centric products and services [7, 6].

3.3 Technology Companies

The availability of end-use data in a standardised format has significant potential to promote innovative product and services (such as assessing solar potential, energy efficiency potential, insights on energy usage, energy management solutions, among others). It will promote the open standard ecosystem for application development and growth of smart devices, and third parties providing such services. It will help bridge previously unconnected aspects of consumers' lives and begin conversations about efficiency [1]. The consumer can use third-party companies' services by providing them consent to study the data on their behalf and suggest them energy efficiency measures to cut down their consumption and reduce their energy bill. One such example is WeatherBug Home (WBH) an application which provides hyper-localised meteorological data to governments and sports stadiums. They recently started offering energy efficiency services through their mobile applications. In addition to local weather forecasts, the app suggests consumer energy-saving potential; by changing their thermostat setpoints. They partnered with Honeywell and Nest, allowing the consumer to control their temperature from the application itself, taking advantage of weather conditions to heat or cool most efficiently [1].

Additionally, energy management companies can devise better solutions to manage/reduce their consumers energy usage by accessing utilities data with consumers' consent. Availability of data can facilitate peer to peer comparison,

informed decisions concerning energy efficiency retrofits, and verification of benefits of energy efficiency investment.

3.4 Policymakers and Research Organisations

Scarcity of data, especially end-use energy data, is a significant hindrance faced by most research organisations working in India's energy domain. The availability of end-use data at a certain level of aggregation will significantly improve the energy demand analysis and enhance forecast accuracy, thereby, contributing to data-driven research and strong policy recommendations. Energy policies developed based on quantitative data insights will be far more effective compared to those developed with insufficient information. For example, adoption of demand-side management programs requires continuous engagement and feedback from consumers [17]. The data insights will empower the policymakers to make informed decisions and enable better planning and management. The easy access to the granular data will also allow the policymakers to monitor and evaluate various programs and contribute to energy benchmarking. It can also be used to conduct community and student energy efficiency competitions such as California's energy challenge where different schools participate, or Solar Decathlon Initiative, which started with the US now also running in India.

To realise the above listed benefits, Common Information Model for data sharing is needed. It will enable consumers, especially, industrial and commercial, to get their energy data in a uniform format from all their service providers or third-party services making it easier to integrate with their own systems for analysis while ensuring compliance with data privacy regulations. Sharing of information should happen in standard format instead of each utility developing their own. A standard will also enable utility to work with all compatible technology providers and win consumers' trust in terms of transparency, data privacy, and data security.

4 Existing Initiatives in India

This section will discuss India's existing initiatives concerning end-use data-sharing in the energy sector, their current status, outcomes and learning from such initiatives.

Table 1 Summary of the potential value proposition for different stakeholders

Stakeholder	Potential value propositions
Electricity Consumers	
Industrial and commercial	• Energy-aware—useful for reducing bills, managing energy use, managing demand • Energy management solutions and track their performance • Track energy and carbon footprint • Avoided cost to track their energy consumption, such as sub-meters, data loggers, installation cost, etc • Comparison with peers
Residential	• Energy-aware—useful for reducing bills • Better prepared for unprecedented events such as high bills post COVID lockdown • Compare potential benefit from transitioning to ToD/ToU plans • Track the performance of energy-efficiency retrofits
Utilities	• Peak load management • Design better energy efficiency programs, and ToD rate structure • Potential to engage with product/service companies • Make anonymised data available "commercial" use for a small fee; • Better understanding of consumer needs, offer consumer-centric services and build a strong relationship
Technology companies	• Energy management solutions: direct services for specific clients to manage/reduce clients energy usage • Business opportunities
Policymakers	• Energy data analysis • Benchmarking • Policy implementation, monitoring and evaluation • Conduct community and student energy efficiency competitions
Research organisations	• Energy demand analysis and forecasts • Data-driven research and policy recommendations

4.1 Green Button Implementation in India—Case Study of MSEDCL

A pilot was conducted in Vashi area of Mumbai to implement the GB standard in India [17]. This was initiated by IIT Bombay, along with India Smart Grid Forum (ISGF) [17, 18]. In this pilot, energy usage information (such as demand factor across days, load factor across days, consumption in different slots, etc.) was made available for 1388 consumers [17]. The key steps identified in the implementation were gathering of consumer information from the database, plan preparation to collect energy usage information, check the format definition, develop convertor to GB, develop GB database, develop consumer portal with GB download link, and innovate and implement a wide range of application for consumers engagement [18]. The GB implementation time typically ranges from two to six months, depending on the DISCOM database management practices. However, the green button standard implementation

was a one-time effort to show possibilities of standardised data sharing. Still, it didn't scale up either in MSEDCL area or other areas. One of the key learning from the MSEDCL pilot was that the GB standard needs to be modified to adopt the Indian conditions taking into consideration such as records of extended load, power quality, prosumer activity, etc [17]. Apart from the pilot project, "Green Button educatIon Tool" (GamBIT) was developed to improve consumer understanding about green button standards and assist the user in building standardised consumer applications [17].

4.2 Formation of LITD10 Committee—Common Information Sharing Model

To adopt GB like standard for India, panel 3 of BIS LITD-10 committee is working under the chairmanship of Shri NS Sodha. They started drafting the national standard to pursue Green Button. However, it has been recognised that GB std is a standard specific to the US conditions. Therefore, there is a need to develop some standard on similar lines considering the Indian scenario. Additionally, there is a need to pay a royalty to use the GB standard [10]. LITD-10 committee is in-principle agreement to develop such standard but requested to develop a proof of concept first and present it to the committee before accepting it for roll-out [10].

5 Framework of Common Information Sharing Model

This section discusses the framework for common information-sharing model for end-use energy data. There are six major components of the framework—metadata, standard and protocol, testing and compliance, data privacy and security, stakeholders and regulations. They are discussed in detail below.

5.1 Metadata

To adopt a common data-sharing model, the first step is to prepare the metadata. Metadata will include information not limited to customer type, device, location, readings, interval data, unit rates, summary information and power quality metrics. There is a need to prepare the standard set of information that will be gathered and shared with the consumers across India irrespective of the Utility servicing them. The granularity of data points will improve further with the implementation of the Smart Meter National Programme.

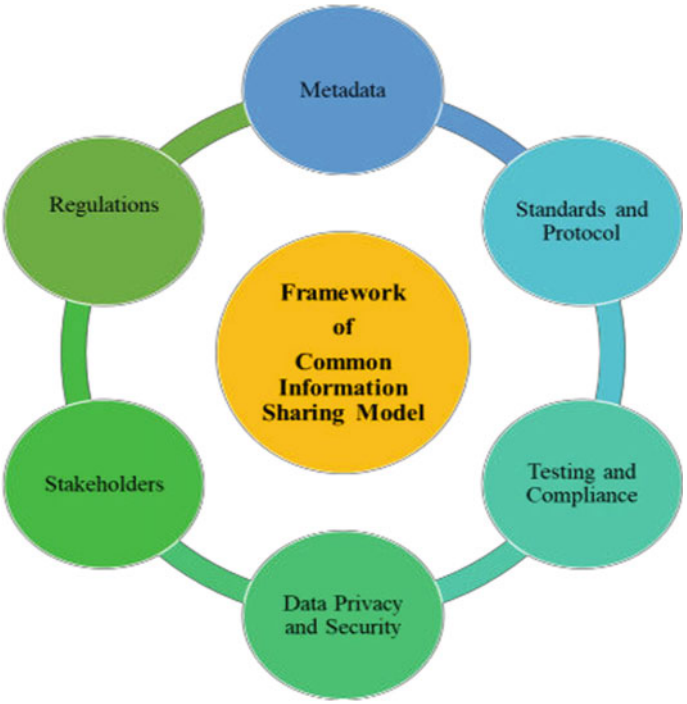

Fig. 1 Flow of customer data between utility, consumer and third party [6]

5.2 Standards and Protocol

The second critical component is the standard and protocol which will be used by all utilities throughout India. Inferences can be drawn from GB standard which is widely adopted with modifications as per Indian requirements. GB use extensible markup language (XML) including atom syndication format as CSV and EDI are not secure or have inconsistent formats. There is a need to have a standard format for data sharing. LITD-10 committee is already contemplating the development of standard similar to GB, and when developed, it will pave the way for standardised data sharing across the country. Figure 1 illustrates how the data will flow between Utility, consumer and third party.

5.3 Testing and Compliance

After developing the standard, there is a need to put in place a testing process for product and services to ensure compliance to the standard. It is a industry practice to do conformation testing to assess whether any product or service developed to

comply with the set standards or specifications is compliant or not. This becomes more critical to ensure consistent data format and data security so that consumers receive standardised information anywhere in the country. There is a need to identify who will assume the role of testing agency in this. Some utilities do the testing in-house under GB while some of them have outsourced it to Utility API.

5.4 Data Privacy and Security

While providing benefits to consumer through standardised data sharing, there is a need to ensure consumer data privacy is not violated. To ensure this, there is a need to carefully interpret the existing policies that will guide this case. For example—the Information Technology (IT) Act, 2000 addresses the concern related to compensation or punishment in case of breach or misuse of personal data [19]. However, it is difficult to comprehend whether DISCOMs comply with the IT Act or not [19]. Supreme court of India has also recognised "Right to Privacy" as the fundamental rights.

One of the successful examples is how California implemented GB standard. They ensured that third party needs to meet certain criteria before they can access consumer data such as demonstrate technical capability, not be present on the Commission's list of banned third parties, provide contact information and a federal tax identification number, among others. In case of a data breach for more than 1000 consumers, they need to notify to the Commission. Data privacy and security will become more critical with the implementation of smart meters [19], as smart meters collect more information about consumers such as appliance ownership, usage pattern, their occupancy etc. Some of these aspects will be addressed with the implementation of Personal Data Protection Bill (2019), which will be applicable even for consumer data with DISCOMs with or without smart meter [19].

5.5 Stakeholders

To implement any product or service, it is critical to identify who are the potential beneficiaries. The development of a common information-sharing model will benefit different stakeholders. First and foremost are the consumers who are the actual owner of the data. Second, utilities which are the custodian of consumer data. Other stakeholders include third party companies (such as energy management companies, demand response, solar, smart thermostat [1]), research organisations, and policymakers. Detailed value propositions for each stakeholder group are discussed in detail in Sect. 3.

5.6 Regulations

Several countries worldwide have realised the potential of data and the need to put in place regulations to avoid data misuse and provide the right to consumers to access their data. This has also been highlighted in the Sect. 2.1 of Sect. 2. India has tabled the "Personal Data Protection Bill 2019" and also drafted "Non-Personal Data Framework" in 2020. Recently, the Ministry of Power proposed a new set of rules for the rights of electricity consumers and prosumers. But such rules existing or new provides no mention about consumer right to access their energy usage data or how data can be shared. There is a need to develop a comprehensive data protection framework providing information on consumer rights, consent to share data, access to data and data privacy.

Therefore, developing a common information-sharing model should be in conjunction with the Acts mentioned above concerning personal and non-personal data and Acts and policies related to the electricity sector to ensure compliance to the existing regulations and highlight gap, if any, in the current Act, policies or rules.

6 Discussion and Way Forward

The framework discussed in the paper highlights the key considerations relevant for data sharing in the electricity sector of India. It has significant potential benefits but there are certain challenges and barriers in developing and implementing common information-sharing models for end-use energy data. One of the critical barriers is the lack of consumer awareness. Utility will share the data if consumers starts asking for their own usage data. Consumer presently lack information about the potential benefits that will accrue from the availability of standardised data and need to be educated about the benefits and rights to demand their energy usage data. A second most important barrier is the cost of implementation. DISCOMs in India witness high loses contributing by several factors. Such standard implementation can be seen as an additional burden by them without considering its benefits. Another question which can arise is who will bear the cost of implementing such a standard.

As discussed in Sect. 2, such initiatives are primarily driven by the Government with complementing policies to support the initiative. Therefore, there is need for conducive policies and guidelines to support data sharing in India. There is a need to define consumer rights concerning access to energy data clearly, and data access should be considered as a requirement without charge. With more and more penetration of technology, data privacy becomes a critical concern. Presently, IT Act, as mentioned earlier deals with the disclosure and misuse of data.

Additionally, "Right to Privacy" is recognised as a fundamental right by India's Supreme court, including informational privacy. There is a need to clearly outline the aspect related to data such as access, rights, penalty on misuse, among others in the personal and non-personal bills that are under consideration. Common Information

Model can include provisions for data security and privacy, and will be strengthened by clearly defines laws.

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