

Social and behavioral aspects of electricity theft: An explorative review

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Abstract – Menace of electricity theft has plagued the power sector. Electricity theft is the primary facet of the non-technical losses. On account of its adverse impacts on the utility finances, it has become a major concern drawing the attention of many analysts. Numerous significant works have been accomplished in the field of losses analysis. Consequently, author in this work has briefed all the major contributions in the concerned field focusing over social and economic aspects of electricity theft and the possible mitigation strategies. The electricity theft originates from the attitude of electricity customers and the utility employees. Therefore, bringing the change in the attitude of both customers and employees has become incumbent to put check on electricity theft and make the recovery of utility possible from substantial non-technical losses. Hence, author has also posited some suggestive measures for putting the brakes on electricity theft.

Keywords – Electricity theft, non-technical losses, socio-economic determinants, finance.

I. Introduction

Electricity theft has become the whip for the electric utilities. It is approximated that electric utilities lose around 25 billion USD every year on account of power theft worldwide (Sharma, 2016). There is the shortfall of electricity; moreover even that less amount of electricity is not able to reach the end users completely due to many factors like technical and non-technical losses. The non-technical losses include the distribution losses and the losses due to electricity theft, collectively also known as commercial losses. In the country like India, major portion of commercial losses is acquired by electricity theft. Electricity theft causes the loss of around 20-25% of the power generated in India, costing around INR 20,000 crores. Electricity theft has become a menace in the developed countries also, for instance, 80% of the commercial losses in



Figure 1. Various socio-economic determinants of electricity theft

US originates from electricity theft and billing & metering issues. This issue has numerous severe impacts which prevent the utilities from reducing the tariff rate, providing subsidized electricity to poor section, serving the remote areas also. The electric utilities are also not able to provide the efficient services even to the honest and deserving customers. This also hampers the service quality of the electric utilities. In every direct or indirect manner, electricity theft is harming both the utilities and customers.

In addition to technical measures, different psycho-social and psycho-economic determinants also hold the important position in the analysis of electricity theft. Therefore, now the utilities have diverted their focus from mere technical measures to the fusion of technical and socio-economic measures. The utilities are now pondering over the technical and non-technical factors also for more accurate quantification and control of power theft. Electricity theft has become the malaise for the entire society. It has its roots in socio-economic background of the people involved in the cycle whether they are on the consumer side or the company employees. Both the consumers and employees are on the culprit side. Electricity theft is manifested in many forms like bypassing the energy meter, tampering with the meter, illegal tapping of electricity from the overhead feeder lines by hooking onto the wires, connivance of employees etc. Electricity theft has many socio-economic indicators which affect all these manifestations of theft, e.g., corruption, literacy, income, tariff rate, collection efficiency, risk factor, population and many others. All these

socio-economic factors are shown in Figure 1. Many of these factors impact the electricity theft positively, for instance, corruption and many others impact negatively like literacy and collection efficiency. Since all the geographical areas have their different values for all these socio-economic indicators, all these factors showcase the attitude of people towards electricity theft in different geographical areas. Some of the significant analyses covering the paradigm of electricity theft have been posited in the next section.

II. Literature Review

There is a large literature available on the study and investigation of electricity theft. Some analysts have worked upon the impacts of electricity theft and how they can be mitigated. Many researchers have explored the various technical and non-technical determinants of theft. Some of the notable works in this field of study are presented below.

Katiyar S. K. (2005) presents results of a comprehensive study undertaken by Prayas, an NGO, in a primarily agricultural electricity distribution subdivision in south Rajasthan. Author reviews the official policy and practice with respect to distribution losses in Rajasthan. The study is the first phase of a longer-term innovative pilot project to reduce distribution losses. During the first year, the study established the existing level of losses and then looked into the factors causing them. The study showed that the distribution losses are very high and most of them could be clubbed under the category of commercial losses. The results of the study have wider applicability not just within the power sector but within the general range of public services. Inefficient performance of public services is not only a major contributor to poverty but also hinders economic growth. Large scale corruption and inefficient management are common traits. The results of the study show that the solutions to inefficient performance of public services have to be comprehensive and not merely technological. The study presents the micro picture of one location in Rajasthan.

Lewis, F. B. (2015) concludes that electricity theft causes power disruptions and affects the overall economy and its various sectors. The Jamaica island is frequently affected by power interruptions and theft level is relatively high as compare to other countries. Therefore, Jamaica is used as a fascinating case study on power theft. The electricity theft can be of following types:

fraud, directly stealing power, billing irregularities, and unpaid bills. Thus, the electricity theft causes unnecessarily increment in the price of power, poor quality of supply, affects re-investment and unemployment for legitimate consumers. The prominent objectives of the proposed study are: to investigate the power theft event over an extended period, in an international level, present a comparative analysis of electricity theft and to determine the level of lost load due to power disruptions in Jamaica and numerous other economies internationally. This study provides a way to examine the effects of direct losses faced by the respective economies due to electricity disruptions.

Mirza, F. M. et al. (2015) discuss the long run determinants of electricity theft in case of Pakistan. In case of developing countries like Pakistan, maximum population belongs to lower income groups; it is little bit difficult for them to afford the electricity at such a high rates which is further increasing as time passes. Thus, electricity prices greatly influence the electricity theft. The study provides a model to analyze the impact of different determinants of electricity theft that are occurred by transmission and distribution losses. In Pakistan, for different sector of the economy, electricity price is determined separately. The proposed study analyze household sector price because most of the incidence of electricity theft is concentrated in household sector. The WAPDA and KESC weighted average of electricity price is used for the household sector published by NTDC.

Smith, T. B. (2004) concludes that electricity theft is influenced by governance indicators, political instability, low government effectiveness, with higher levels of theft in countries without effective accountability and high levels of corruption. In this paper the extent of electricity theft is investigated in a sample of 102 countries for 1980 and 2000. Further, it is claimed that electricity theft is of numerous forms, namely fraud (meter tampering), stealing (illegal connections), billing irregularities, and unpaid bills. Several financial impacts of electricity theft are: need to charge more to consumers and reduced income from the sale of electricity. This paper proposes different ways to reduce electricity theft, for example, by applying technical solutions like tamper-proof meters, managerial methods such as inspection and monitoring, and in some cases changing the ownership and regulation of power systems.

Yurtseven, C. (2015) investigates the determinant of socio-economic background of illegal electricity consumption. For this, through different econometric techniques, the author estimates an energy theft equation. For the comprehensive analysis, electricity theft and socio-economic data for the period of 2002 - 2010 are used. After the completion of privatization of the electricity distribution in Turkey, it is claimed that the proposed model can help the new coming firms of the sector to decrease electricity theft directly. The study suggests several measures to reduce the power theft in developing countries like Turkey. Thus, it is concluded that temperature index, education, income, social capital, rural population rate, and agricultural production rate are the prominent determinants of electricity theft.

Depuru, S. S. S. R. et al. (2011) discuss electricity theft in terms of social, economic, regional, political, literacy, criminal, and corruption. Several reasons which influence people to get involve in electricity theft are also discussed. Also, the Non-Technical losses affect quality of supply, increase load on the generating station, and tariff rates largely influence genuine customers. The cost-benefit analysis for implementation and maintenance of the proposed model in India is presented. It is suggested that the existing constitution for punishing the illegal consumers need to be revised. All the consumers need to be educated about the cons of installing smart meters in a neighborhood like operation of harmonic generator and possible damage to their equipment.

Sharma, T. et al. (2016) propose the value chain of the Indian power sector giving special attention on its distribution segment. The major threat to the Indian power sector in our society is electricity theft that attributes to large portion of commercial losses. The key idea of AT&C losses was introduced in 2001-02 in India to compensate the gap between billing and collection. Four types of theft have been focused in all power systems, namely: deliberate deception by consumers, stealing electricity, billing irregularities, unpaid bills etc. This paper investigates the inefficiency of technical measures and efficiency of psychosocial factors to reduce this defect as seen by disuse of automatic meters in Haryana. The proposed study needs to be tested on empirical study and it can be applied to understand the phenomenon of electricity theft in countries similar to India, like South Asia and Africa etc.

Ranganathan, V. (2005) proposes the study to reduce transmission and distribution losses.

Heavy prices have been paid for the Delhi discom privatization in terms of loss levels agreed, liability write down, and annual subsidies promised. The data on initial loss levels and the quantum of AT&C losses are not available accurately therefore, the impacts of privatization at Delhi are not yet clearly found at the organizational level. There arises the need to put meters for 100 per cent of consumers. The state must protect itself from selling silver for the price of brass, because it has a coat of dust. There is a need of bifurcation of urban and rural areas so that the problem of the licensee asking for concessions on account of bundling is avoided.

Winther, T. (2012) explains two objectives, first, to show how the phenomenon of electricity theft may be understood and addressed in a more people centered and relational way; secondly to reveal how insights into customers' ways of thinking and acting, and their realizing of sustainable energy systems in general. Author has drawn on empirical findings (rural Zanzibar, Tanzania and the Sunderban Islands, West Bengal, India) and concluded that the two contexts have quite distinct provisional systems; in rural Zanzibar there is a centralized grid, whereas the system in the Sunderbans is decentralized. Zanzibar and the Sunderbans differ in their types of electricity governance structures, technologies, organization and procedures for metering, billing and supply, as well as in their sociocultural setting.

B. Min et al. (2014) have studied the politics of electricity losses by utilizing the data from the power corporation of Uttar Pradesh. Authors have analysed that UP's electricity losses in the form of theft tend to increase in periods immediately prior to state assembly elections. Electricity distribution is manipulated for political gain and this all happens on account of people attraction towards the illegitimate benefits of electricity. Differences between energy supplied and energy billed have been calculated for the most affected districts of UP which show the tremendous penetration of power theft in the society. The findings suggest that power theft is done deliberately as per the political strategies.

Gaur, V. et al. (2016) have examined the role played by socio-economic and governance factors in determining the extent of electricity thefts in Indian states, drawing data from 28 states of India over time span of five years (2005-2009). This is the first study on power thefts that has been conducted at the all-India level. For this study, an econometric study has been done to investigate

about the relationship between power theft and socio-economic indicators, for instance, tariff rate, urbanization, literacy, income, etc. Authors have found that there is significant negative impact of good governance indicators on power thefts. In this regard, regular auditing and increased or surprise inspections have been suggested for maintaining the transparency and honesty and improving collective efficiency.

Golden, M. et al. (2012) propose that range of electricity theft varies with the electoral cycle of the state. There is a strong statistical effect of an electoral cycle in line losses. The study claims that with the intense electoral competition in Uttar Pradesh, power theft has become bound up. The electricity theft is increasing with the intensity of tubewells and relates to unmetered electricity use by farmers. The major objectives of the proposed study are to analyze whether power theft is affected by election to the State Assembly in particular timing, to investigate that theft occurs across all groups in society or few groups are engaged in power theft and to examine several benefits electorally from power theft.

The nation of Uganda has planned to implement electricity prepayment billing system. Mwaura, F. M. (2012) has assessed the potential advantages of adopting this system, its how-todos and analysed the possibilities of adoption of this system in Uganda. This step for prepayment billing has had the motivation from Rwanda where this system has been successfully adopted to reduce the losses due to pilferage and theft. The author has examined the factors for successful implementation of this billing system in Uganda, for instance, ratio of targetable customers, capital availability and enforcement of strict rules for deterring power theft.

Mimmi, L. M. and Ecer, S. (2010) analyze the occurrences and factors of illegality particularly in the low income urban favelas of Brazil. There are certainly many factors behind illegality along with low income, like incorrect usage of electricity appliances, sub-standard energy provision and equipment, using domestic electricity for in-house business etc. The authors have studied the effect of energy demand on energy related illegality and potential benefits of consumption-based energy studies. These types of measures can result in reduction of illegality if associated with other measures like awareness of energy usage, improvement of equipment, promoting energy saving behavior of customers and good metering and maintenance.

Jamil, F. and Ahmad, E. (2013) have attempted to model electricity theft in an electric utility in the framework of individual's choice under risk and through a three-layered principal-agent-client model of corruption. This study has given the analysis that theft occurs if and only if its associated cost is less than the subjective gains. The cost associated with theft may be in form of fine imposed in case of apprehension or job dismissal. The authors have posited certain potential control variables for tailoring the policy measures for curbing electricity theft, like fair tariff, active consumer involvement in complaining against theft, efficient wages, higher deterrence among people due to high chances of detection and penalty and some other factors.

Tasdoven, H. et al. (2012) have emphasized on the governance approach for mitigating the illegal electricity connections that have become a problem demanding urgent attention. After liberalization and privatization of Turkish electric utility sector, various governmental schemes have been implemented. This work has investigated about the present governance tools addressing the illegal connections which are privatization and regulation. The authors have also suggested grants and public information as the important tools for promoting the framework of efficient electric utilities. The potential of these tools in addressing the illegal consumption has been explored. In some areas, political issues offer resistance to these governance tools. So, different barriers of political acceptability have been pondered over in this work.

Depuru, S. S. S. R. et al. (2010) have highlighted the issue of non-technical losses in the developing countries. These non-technical losses accommodate primarily electricity theft and billing irregularities. These losses have adverse impact on the tariff to the genuine consumers, electrical loads on the generating side, quality and quantity of supply etc. Authors have presented various factors responsible for forcing the people to steal electricity. They also discuss some illustrations of electricity theft and certain measures to curb the menace of electricity theft. In this work, setbacks for various measures implemented to control theft are also discussed. All these measures have been suggested for the electric utilities to quantify and control electricity theft so that they can provide good quality of electricity to genuine customers at affordable tariff rates.

Jamil, F. (2013) puts focus on the causes behind electricity shortage that is troubling the power sector and customers since 2006. Many efforts, for instance, increasing the installed generation

and transmission capacity, have been directed to solve the shortfall in electricity. But there are various other factors also which are responsible for electricity shortage, e.g., electricity theft. Hence, the author has concentrated on the relationship between electricity shortfall and electricity theft. After-effects of theft like hike in tariff rate are also discussed. Analysis has been done through Granger causality test through error correction model which suggests that there is large impact of electricity theft on electricity shortfalls due to illegal pilferage and inefficient use of electricity.

Never, B. (2015) has put emphasis on the need of considering the socio-economic dimensions of electricity theft affecting the utilities and customers also with the technical analysis. He has analysed the relation between the socio-economic factors, electricity tariff effect and informal social norms in Uganda. Two technical innovations were done in Uganda after the power sector reforms, prepaid metering for domestic consumers and bulk metering for micro and small enterprises (MSE). Through semi-structured interviews with MSEs and experts in Uganda, this study shows the efficacy of bulk metering for MSEs. Power theft originates from the distrust between utility and consumers, high tariff rate and consumers' unwillingness to pay. The author has suggested certain measures related with bulk metering and pre-paid billing for lessening the incidences of theft by employing the social control among the consumers.

In some underdeveloped areas like few areas of Brazil, electricity services have not reached to every corner (Silva et al., 2008). In case it has reached, people will have to afford the electricity service with high cost. But some marginalized section of society can't afford such a high price for electricity. They are left with the only option of accessing electricity illegally. According to the author, these clandestine residential consumers should not be treated as criminals. Those people think to have electricity as their right. This study has highlighted the poor services provided to marginalized section of society.

Authors (Taylor et al., 2003) have presented the severe repercussions of stealing electricity and other hardware also from electric utilities. This study has covered the people who risked electrocution during stealing electricity from electric utility from 1981-2001. Medical consequences have been highlighted for different cases of electricity theft.

Saini, S. et al. (2016) have explored various socio-economical determinants of electricity theft. They have investigated the non-technical distribution losses due to electricity theft specifically in the area of Charkhi-Dadri, a district of Haryana where high number of theft cases have been reported. Losses in three types of feeder lines have been analyzed, i.e., urban, rural and industrial. The role of various theft determinants in the pattern of losses has been illustrated in this work. Despite the reform measures, the problem of electricity theft is not coming under control particularly in rural feeder lines. The findings of this study show that losses are the all-time highest in rural lines in all the consecutive years from 2013-2015. Hence, authors suggest some corrective measures to lower down the occurrences of theft especially in rural areas of the country.

III. Measures deterrent to electricity theft

Despite the technical measures like RAPDRP, electricity theft is becoming a critical issue for electric utilities and consumers. As per the annual Emerging Markets Smart Grid: Outlook 2015 study by the Northeast Group, LLC, electricity theft causes the monetary losses of US\$89.3 billion annually (PR newswire, 2014). The statistics of largest financial losses due to electricity theft are presented in Figure 2. Unfortunately, India is at the top in the financial losses due to electricity theft. In India, only the state of Maharashtra alone has the loss of \$2.8bn per year. This demands the strategy to explore and work upon certain socio-economic determinants of electricity theft to prevent this huge amount of losses. In

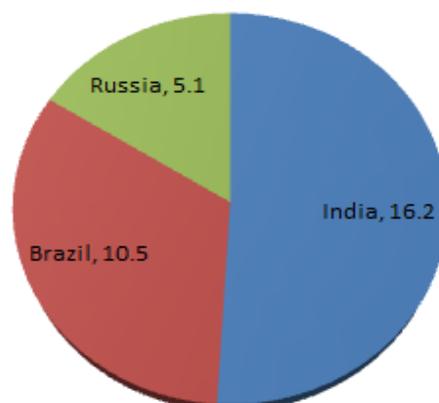


Figure 2. Annual monetary losses in billion dollars

today's scenario, utilities have understood that technical measures are not alone sufficient to nail the menace of electricity theft. Social control and trust between utility and consumers is essential

for putting check on theft cases. Stern regulatory steps should be enforced by the utility to induce fear among people. And these measures should be accompanied with good governance. As electricity theft is a multifaceted phenomenon, interdependency among variables should also be analyzed. The literature of electricity theft abounds with the suggestive measures but the electric utilities need to adopt them with full focus.

IV. Conclusion

Power utilities are losing big revenue due to electricity theft, a major chunk of commercial losses. Theft is scourging the electric utilities and thereby their customers also. It is hampering the service quality of the utilities and consequently customer satisfaction is rapidly declining causing large financial losses to the utilities. The failure of many technical measures has made the utilities realize the fact that electricity theft can be taken under control only if they ponder beyond technology and adopt some socio-economic and behavioral strategies to influence the people who do electricity theft. Neither technical analysis nor non-technical analysis paints a complete picture of electricity theft. Hence, it is the need of the hour to integrate the technical solutions and behavioral changes to curb the problem of electricity theft. Some of the important analysis of electricity theft has been posited in this work.

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