

Electricity Theft Detection Using Smart Meter.

Ranjit Singh¹, Dr Supreet Kaur ²

¹ Mtech Student Computer Science Engineering, Khalsa College of Engineering and Technology Amritsar

² Associate Professor, Department of Computer Science Engineering, Khalsa College of Engineering and Technology Amritsar

Abstract

Nowadays electricity theft has become a major problem in the world. It hinders the country's Development and negatively impacts the economy. Electricity generation requires the use of many valuable natural resources, which are expensive and limited. If we fail to prevent electricity theft, these precious resources are wasted, causing significant environmental and economic damage. Therefore, it is essential to take effective measures to prevent electricity theft.

In recent years, electricity theft has been carried out using increasingly advanced techniques. To address this problem, modern technologies are required. Electricity theft is one of the major challenges faced by power distribution utilities worldwide, leading to significant financial losses, reduced system efficiency, and increased operational costs. This paper proposes a real-time electricity theft monitoring and detection system using smart meters based on the integrated with GSM communication and cloud-based data storage. The system continuously monitors power consumption and compares power measurements KWH and KVAH Readings to identify abnormal imbalances that indicate possible electricity theft. By preventing electricity theft, we can strengthen our country's economy and reduce the significant financial losses caused by unauthorized electricity consumption. Furthermore, minimizing electricity theft contributes to economic growth, supports national development, and helps build a stronger and more developed nation. This paper focuses on the issue of electricity theft Detection and highlights the need for advanced technologies, such as smart meters and intelligent monitoring systems, to detect and prevent unauthorized electricity consumption, thereby improving the efficiency, reliability, and sustainability of power distribution systems.

Introduction

The energy problem is one of the biggest issues facing the globe today. We may partially mitigate the energy issue by closely monitoring our energy usage and reducing waste. One of the many difficulties faced by power companies is combating electricity theft. Electricity expenses may rise as a result of theft. This strategy will make it easier to identify electricity theft. We will deploy our smart meter-based electricity theft detection system to confirm sensor readings and notify users. Load shedding, or electricity shortages, is a regular problem for many nations. By keeping a careful eye on electricity usage and reducing energy waste, it can be substantially mitigated. The main issue is that consumers are unable to monitor their power use, which makes it difficult to do timely energy evaluations or inspections. A use plan will only be displayed for the units specified on the electricity distribution authority's bills. Customers have continuously been unaware of their energy usage during this time, and these bills are only sent out once a month. To properly control the monthly energy use, this approach must be used on a regular basis. A customer may occasionally refuse to pay several bills. Power is one of the main issues facing the globe today. Because of industrial needs and our reliance on technology, this problem is seen as a major worry. Globally, there are several issues related to energy usage, distribution, and power supply. Energy efficiency is critical in today's environment.. Therefore, keeping a close eye on energy usage and getting rid of trash is the best strategy. Energy monitoring, however, is insufficient to stop individual power theft; the expenses a distributor must pay to look into electricity theft frequently outweigh the company's losses. The supplier may be held accountable if a client reports suspected power theft.

Electricity Theft

The illegal act of stealing electricity is known as electricity theft. Electricity theft is almost as old as the distribution of power. There are several ways to steal electricity, ranging from simple techniques like connecting directly to a power line to manipulating electronic meters. In poor nations where power systems provide little and inconsistent power, electricity theft is most prevalent. It was estimated that electricity theft costs the world \$96 billion annually. Fines and jail are two possible penalties for the offense. Non-technical losses include the electrical losses brought on by the theft. In real time Approximately 1.5% of India's GDP is lost to electricity theft and commercial losses each year, resulting in significant financial deficits for utility companies and large aggregate technical and commercial (AT&C) losses.

Financial and Economic Effects

GDP Loss: Based on World Bank data, it is estimated to be around 1.5% of India's GDP annually.

Financial Burden: Every year, power distribution firms (discoms) lose billions of dollars in income, which hinders infrastructure upgrades and system maintenance.

Underpaid Power: A significant amount of generated electricity is entirely unmetered or underpaid, according to independent studies and prior industry reviews.

There are several ways to steal electricity, such as tapping a line or getting around the energy meter.

Hooking straight from the line.

An electrical utility power box that has been broken open, making it possible to illegally hook up energy directly from the line. Cable hooking is the most popular technique. Direct tapping from the line accounts for 35% of power theft worldwide. From a location in front of the energy meter, the customer connects to a power line. This energy usage can be obtained with or without switches and is not measured. It may result in a fire or a severe electric shock.

- Getting around the energy meter

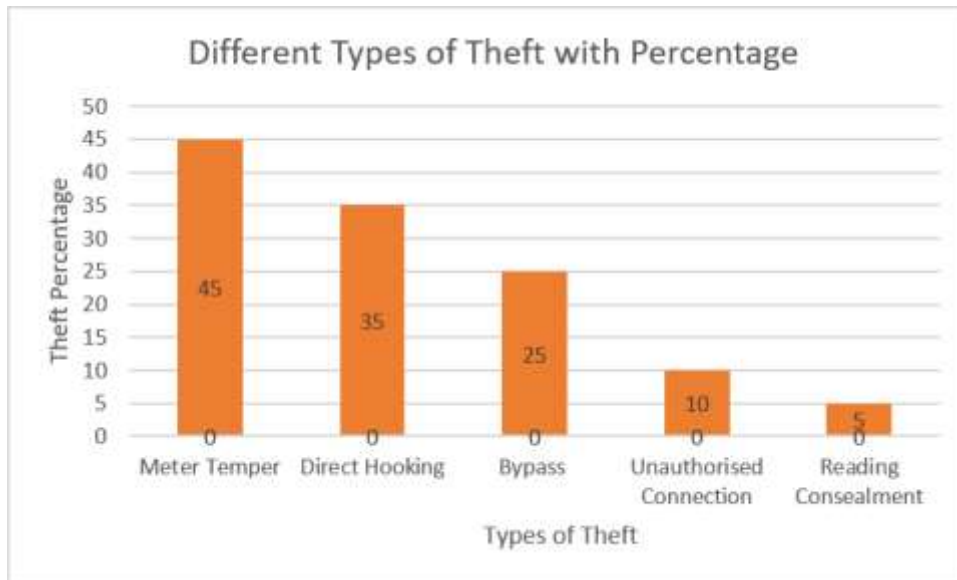
This technique stops energy from registering in the energy meter by bridging the input and output terminals. Adding a foreign component to the energy meter By inserting a circuit inside the meter, a remote control can be used to control the meter's speed at any moment. Since the meter is always accurate unless the remote is activated, this type of modification can avoid efforts at external scrutiny.

- Physical impediment

Electromechanical meters with a revolving element are subjected to this kind of tampering. To prevent the disc from moving freely, foreign objects are inserted inside the meter. Less energy is used when a disk rotates more slowly.

- Attack by ESD on an electronic meter.

Electronic meters are tampered with by ESD to cause either latent or permanent damage and Reading Concealment. Only high-end meters are capable of accurate detection.



Detection

Several methods have been put out to identify electricity theft. Using artificial intelligence, and specifically machine learning techniques, to identify clients who steal electricity is the main focus of research and development. Smart meter technology records utility consumption, including electricity, in real time using sophisticated digital electronic equipment. Utility companies receive use data from these devices via two-way networks for remote diagnostics and automatic invoicing.

Principal Advantages

Automated Data: Removes human mistake from billing cycles and eliminates manual meter-reading visits.

Automated Bill Generation of accurate Reading

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Literature Review

Previous research shows that electricity theft detection was mainly performed using web-based and mobile applications by utility department employees. Employees collected and maintained records of the electricity units consumed by each consumer and analysed the data to identify possible cases of electricity theft.[3]

In other published research paper, titled "Monitoring of Electricity Supply of Consumers Regarding Electrical Energy Consumption Using a Software System," a software-based system was used to analyse energy consumption data for detecting electricity theft.[1]

However, the proposed smart meter-based system offers a significant improvement over these traditional approaches. Unlike earlier methods that relied on manual data collection and software analysis, smart meters enable real-time

monitoring of electricity consumption. This allows electricity theft to be detected immediately, making the system more accurate, efficient, and reliable while reducing revenue losses for power utilities.

Methodology

By using smart meters, one of the most significant challenges of the present time, electricity theft, can be controlled to a great extent. Smart meter technology enables effective monitoring and prevention of electricity theft. A smart meter is equipped with a SIM card, which allows all meter-related activities to be monitored remotely in real time. The smart meter measures electricity consumption and maintains a record of daily meter readings. It also detects any unauthorized tampering with the meter and immediately records such incidents. All these events are stored in the Event section of the smart meter application. The application operator continuously monitors these recorded events and sends instant alerts to the field staff responsible for the respective area whenever suspicious activity is detected. Along with the alert, the consumer account details and the meter location are also shared. This enables the field staff to promptly visit the site, verify the occurrence of electricity theft, and take appropriate action in accordance with the applicable rules and regulations. The proposed electricity theft detection system uses smart meters, a communication network, cloud-based data storage, and a machine learning model to identify abnormal electricity consumption patterns that may indicate theft. The methodology consists of the following steps.

Smart meter, provides complete information about all meter readings, including kWh (kilowatt-hour) and kVAh (kilovolt-ampere-hour) values. A smart meter also enables the utility to identify and track the meter's location, making it easier to locate and manage the installed meter. Each smart meter has a unique primary account number and account ID, which help identify the meter and link it to the consumer's details, including the consumer's name and address. The readings generated by the smart meter are transmitted directly to the central database through a GSM communication network. Every event that occurs in the smart meter, such as power interruptions, tampering attempts, outages, or other operational activities, is automatically recorded in the smart meter's data collection system. The smart meter continuously records data at regular intervals. Its main parameters include energy consumption, voltage, current, power factor, and time stamps. Energy consumption data is typically updated every 15–20 minutes, allowing the utility to monitor electricity usage in near real time. Consumers can also access their daily electricity consumption through the smart meter mobile application, where they can monitor their energy usage on a regular basis. The processed smart meter data provides several advantages. It helps prevent duplicate records, enables monitoring of daily energy consumption, identifies electricity usage during peak hours, and detects consumers who are using more electrical load than their sanctioned load. When a consumer's connected load exceeds the sanctioned load, the transformer supplying that consumer experiences excessive loading. Continuous overloading can lead to transformer overheating, reduced efficiency, and possible failure. Smart meters automatically detect such overload conditions and generate alerts for the utility company. The utility can then notify the consumer to regularize or upgrade the sanctioned load to prevent equipment damage and ensure safe operation. The smart meter also provides information about the consumer's average monthly electricity consumption, helping both the consumer and the utility analyse usage patterns. In addition, smart meters improve the accuracy of electricity theft detection through several advanced features. They help identify consumption variations, showing the periods when electricity usage is high or low. For example, if energy consumption is unusually high during the day and low at night, or vice versa, these usage patterns can be analysed. The system can also detect sudden increases or decreases in load and record all such events.

Furthermore, smart meters maintain history of consumption records, allowing utilities to analyze long-term trends and identify seasonal consumption patterns. These historical and real-time data analyses significantly improve monitoring, load management, and electricity theft detection while enhancing the overall efficiency and reliability of the power distribution system

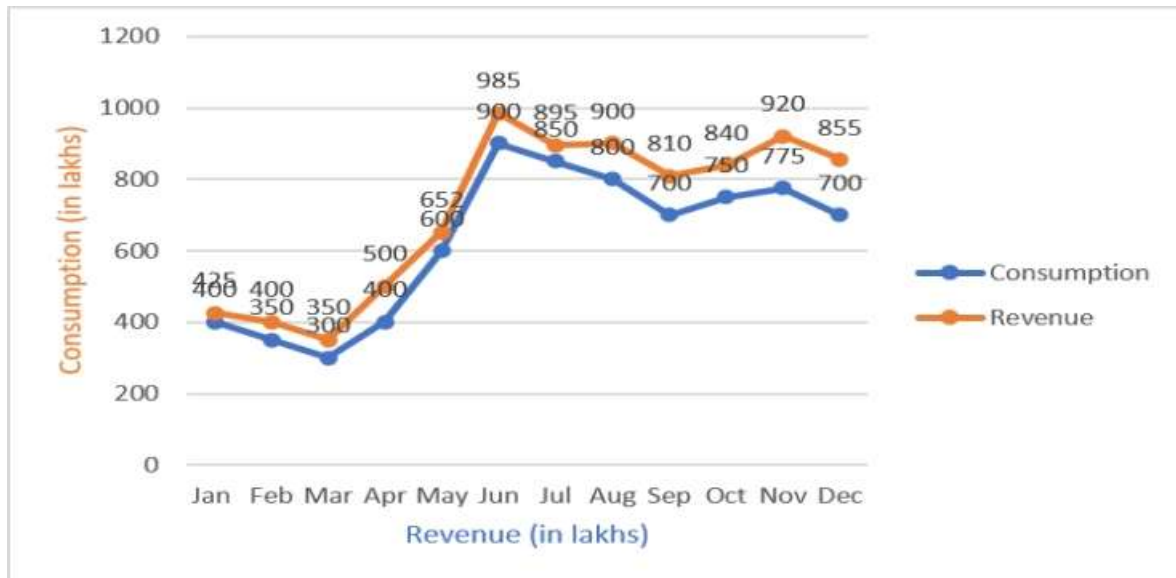
Month	Consumption	Revenue
jan	400	295
feb	350	259

mar	300	225
apr	400	320
may	600	410
jun	900	600
jul	850	612
aug	800	650
sep	700	585
oct	750	610
nov	775	615
dec	700	590



Graph 1 Consumption, Revenue Comparison

This Graph 1 Shows when theft occurred then Consumption Increase and consumers not pay bill of electricity then Revenue of Discom Companies Decrease due to Non payment of bill and as result Revenue Losses in every month of year and Discom companies faces losses, it effects on supply of electricity on Industry and production . When electricity theft increases, consumption also increases. As a result, more electricity is drawn from the grid, but the number of billed units decreases because the stolen electricity is not recorded by company. This leads to a significant loss of revenue for the power utility.



Graph 2

Month	Consumption (In Lakhs)	Revenue(In Lakhs)
Jan	400	425
Feb	350	400
Mar	300	350
Apr	400	500
May	600	652
Jun	900	985
Jul	850	895
Aug	800	900
Sep	700	810
Oct	750	840
Nov	775	920
Dec	700	855

Graph 2 Results shows that By using smart meters to detect electricity theft, unauthorized consumption can be identified and prevented. This increases the number of billed units, improves revenue collection, and enhances the overall efficiency and reliability of the power distribution system.

Conclusion

The problem of power theft, mostly meter tampering and unauthorized connections, causes significant revenue losses for the majority of power providers globally. In order to determine whether there is meter tampering and unauthorized connections in the power system network, the suggested real-time power theft monitoring and detection system with a double metering system demonstrated good simulation results. Simultaneously, the hardware project demonstrated the practical implementation of the smart electric meters of the suggested double metering system in the distribution System Network. Additionally, the hardware project demonstrated how the suggested system can effectively monitor and identify any unauthorized electrical connections on the distribution feeders as well as meter tampering when a customer modifies their smart electric meter. It also demonstrated how the data on power consumption is shown when a computer or smartphone is used to read it from cloud storage. Raising the electricity network's visibility, lowering line losses (mostly non-technical losses), and raising income are all advantages of putting the suggested approach into practice.

Any Discom company that will consider implementing the proposed system can expect the elimination of power theft on their distribution system networks. With this proposed system, the authority office is notified with an alert of where the theft is detected; this reduces data analysis time and leads to the quick arrest of the found offenders with known power losses. When power theft is eliminated in the grid, then discom companies start making profit.

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