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Pay-As-You-Go Energy Meter with GSM Module

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Abstract - *Prepaid energy metering has become an increasingly popular method for managing energy consumption and billing. This paper provides an in-depth review of prepaid energy metering, including its benefits, challenges, and implementation. We explore the technical aspects of prepaid energy metering, including the hardware and software required to implement the system. We also examine the social and economic implications of prepaid energy metering, such as its impact on energy conservation and affordability for low-income households. Through this research paper, we aim to provide a comprehensive understanding of prepaid energy metering and its potential as a tool for sustainable energy management.*

***Key Words*: Prepaid, Metering, Increasingly, Managing, Consumption, Social, Economic, Conservation, Households.**

1. INTRODUCTION

Energy consumption is a critical aspect of modern life, and the efficient management of energy resources is crucial for a sustainable future. One approach to managing energy consumption is through prepaid energy metering, a system where energy consumers prepay for their energy usage. Prepaid energy metering is becoming increasingly popular globally, with many countries implementing this system to reduce energy waste and promote energy conservation. This research paper aims to provide an in-depth review of prepaid energy metering, including its benefits, challenges, and implementation.

2. Problem Statement:

Prepaid energy meter is a relatively new concept in the field of energy management, which has gained considerable attention in recent years. The traditional postpaid energy meter system is inefficient, as it involves manual meter readings, billing, and collection, which often lead to errors, disputes, and delays. Moreover, the postpaid system does not encourage energy conservation or consumer awareness, as consumers are not aware of their energy consumption until they receive the bill. On the other hand, prepaid energy meter system offers several advantages, such as accurate real-time monitoring of energy consumption, automatic disconnection upon credit exhaustion, remote meter reading, easy recharge, and flexible tariff plans. However, the implementation of prepaid energy meter system faces several challenges, such as technical, financial, social, and regulatory barriers. Therefore, the research paper aims to investigate the feasibility, effectiveness, and sustainability of prepaid energy meter system in the context of developing countries, with a focus on the following research questions:

1. What are the technical requirements and challenges of implementing prepaid energy meter system?
2. What are the financial implications and benefits of prepaid energy meter system for energy utilities and consumers?
3. How does prepaid energy meter system affect consumer behavior and energy conservation?
4. What are the social and regulatory factors that influence the adoption and acceptance of prepaid energy meter system by consumers and stakeholders?
5. What are the best practices and lessons learned from the implementation of prepaid energy meter system in different countries and contexts?

3. Background:

Prepaid energy metering involves the use of an electronic metering system that allows consumers to prepay for their energy usage. The system operates through a prepaid card, similar to a mobile phone top-up card, which is loaded with credits that can be used to pay for energy consumption. When the energy credit on the prepaid card runs out, the power supply is automatically disconnected until the consumer reloads the card with additional credits.

4. Different type of electrical consumer

There are many different types of electrical consumers, but some of the most common ones include:

1. Residential consumers: These are individual households that use electricity for lighting, cooking, heating, and cooling, among other things.
2. Commercial consumers: These are businesses that use electricity for a variety of purposes, including lighting, heating, cooling, and powering equipment and machinery.
3. Industrial consumers: These are factories and other industrial facilities that use electricity to power heavy machinery and equipment.

4. Transportation consumers: These are vehicles that run on electricity, such as electric cars, buses, and trains.
5. Agricultural consumers: These are farms and other agricultural operations that use electricity for irrigation, heating, cooling, and powering equipment.
6. Government consumers: These are government agencies that use electricity to power offices, schools, hospitals, and other facilities.
7. Renewable energy consumers: These are individuals, businesses, and organizations that use electricity generated from renewable sources, such as solar or wind power.
8. Non-renewable energy consumers: These are individuals, businesses, and organizations that use electricity generated from non-renewable sources, such as coal, oil, and natural gas.

5. working principle of prepaid energy meter

1. A prepaid energy meter is an electronic device that allows consumers to pay for electricity in advance. The working principle of a prepaid energy meter involves the following steps:
2. The prepaid energy meter has an electronic circuit that is connected to the electricity supply. The circuit measures the amount of electricity consumed by the consumer.
3. The consumer purchases a prepaid card or token from the electricity supplier, which contains a unique code that represents a certain amount of electricity units.
4. The consumer inserts the prepaid card or token into the prepaid energy meter. The code is then read by the electronic circuit, which credits the corresponding amount of electricity units to the consumer's account.
5. The consumer can then use the electricity until the credit runs out. The prepaid energy meter continuously monitors the electricity consumption and deducts the amount used from the consumer's account.
6. When the credit runs low, the consumer is notified through a warning indicator on the meter. The consumer can then purchase another prepaid card or token to add more credit to their account.
7. If the credit runs out completely, the prepaid energy meter automatically disconnects the electricity supply until the consumer purchases more credit.

The use of prepaid energy meters helps to ensure that consumers only pay for the amount of electricity they use and avoid accumulating unpaid bills. It also encourages energy conservation as consumers are more aware of their electricity consumption and can make adjustments to reduce it.

6. Type of electrical tariff

There are several types of electrical tariffs, but some of the most common ones include:

1. Flat-rate tariff: A flat-rate tariff charges a fixed amount for electricity usage, regardless of the time of day or season.
2. Time-of-use (TOU) tariff: A TOU tariff charges different rates for electricity usage depending on the time of day. Typically, peak periods during the day have higher rates than off-peak periods.
3. Tiered tariff: A tiered tariff charges different rates for electricity usage depending on the amount of electricity consumed. As the amount of electricity consumed increases, so does the rate.
4. Demand-based tariff: A demand-based tariff charges customers based on their highest level of electricity usage during peak periods. The more electricity a customer uses during peak periods, the higher the rate they will be charged.
5. Prepaid tariff: A prepaid tariff requires customers to pay in advance for electricity usage, and the electricity supply is disconnected when the prepaid amount is exhausted.
6. Renewable energy tariff: A renewable energy tariff charges customers based on the amount of renewable energy they consume. This type of tariff encourages the use of renewable energy sources and reduces dependence on non-renewable energy sources.

7. Prepaid energy meter

Prepaid energy metering is commonly used in developing countries, where the traditional postpaid billing system is often unreliable due to the high number of unpaid bills. The prepaid energy metering system offers a more reliable and convenient alternative to the traditional billing system, allowing consumers to monitor their energy usage and costs.

Figure 1.1 Prepaid energy meter

8. Scope of the Projects:

Today, in the twenty-first century, there is no room for mistakes or flaws in any technical system or in everyday applications. Prepaid energy meters are a beneficial idea moving forward. It makes it easier to avoid paying electrical bills. Coupons for electricity will be offered to local businesses. Prepaid energy meters are used to prepay the continuing supply of power to homes, workplaces, and other buildings. The phrase "prepaid" implies "pay before usage."

9. Project Specifications

The energy meter shows the consumed power as a utilization of 1 unit or 1 kilowatt-hour. 1 kWh implies the electrical energy expected to create 1000 watts of force for 60 minutes. The units of consumed energy are identified by the energy meter, which shows the consumed power in the structure of energy units. There are two sorts of energy meters- electromechanical and electronic meters. The two meters are peruse from left to right. The electromechanical meter comprises of an aluminum plate put between two electromagnets, one of which is associated with the heap and is the ongoing loop, what's more, the loop of the other electromagnet is associated with the supply voltage. The association of the current between the two curls makes a force be created on the plate, which starts to pivot at upheavals corresponding to the heap current. The counter registers the quantity of upsets and shows them, demonstrating the energy consumed. Electronic meters comprise of current and voltage sensors that identify the current and voltage consumed and from that simple sign is tested and digitized utilizing ADCs. The advanced signs are then, at that point, handled by a DSP or microcontroller, which shows how much energy consumed on a LCD or Drove screen.

10. Block Diagram

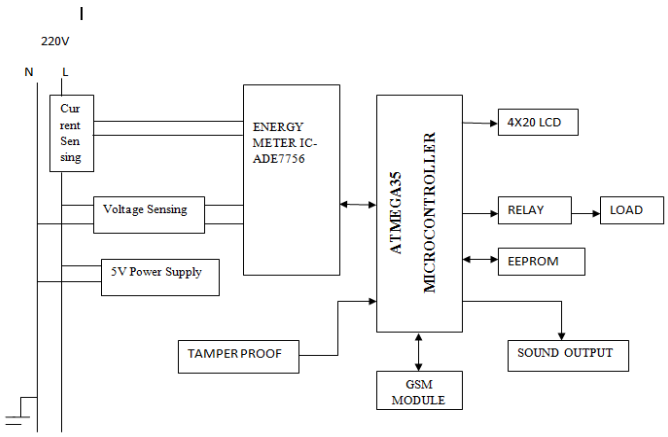

Figure 1.2 Block Diagram

A block diagram of a typical prepaid energy meter includes the following components:

1. Energy Meter: The energy meter is the main component of the prepaid energy meter. It measures the amount of energy consumed by the user and records it.

2. Load Control Switch: This switch is used to control the supply of electricity to the user's premises. It is connected to the energy meter and is controlled by the prepaid energy meter controller.

3. Prepaid Energy Meter Controller: This is the brain of the prepaid energy meter. It is responsible for controlling the load control switch and monitoring the amount of energy consumed by the user. It also communicates with the vending system to allow the user to recharge their account.

4. Display Unit: This unit displays the amount of energy consumed by the user and the remaining balance in their account. It may also display other information such as the current tariff rate.

5. Vending System: This system is used by the user to recharge their prepaid account. It may be a physical vending machine or an online system. The prepaid energy meter controller communicates with the vending system to update the user's account balance.

6. Communication Interface: This interface is used to communicate between the prepaid energy meter controller and other systems such as the vending system or the utility company's billing system.

7. Overall, the block diagram of a prepaid energy meter is designed to ensure that users only consume energy that they have paid for in advance,

thus reducing the risk of default or non-payment by users.

11. wiring diagram of prepaid energy meter

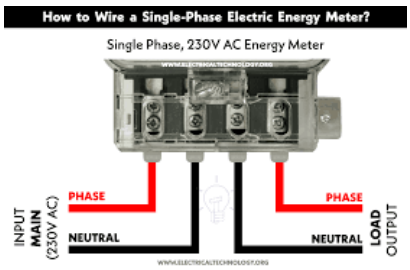

Figure 1.3 wiring diagram of prepaid energy meter

12. Tree Diagram Of Prepaid Energy Meter

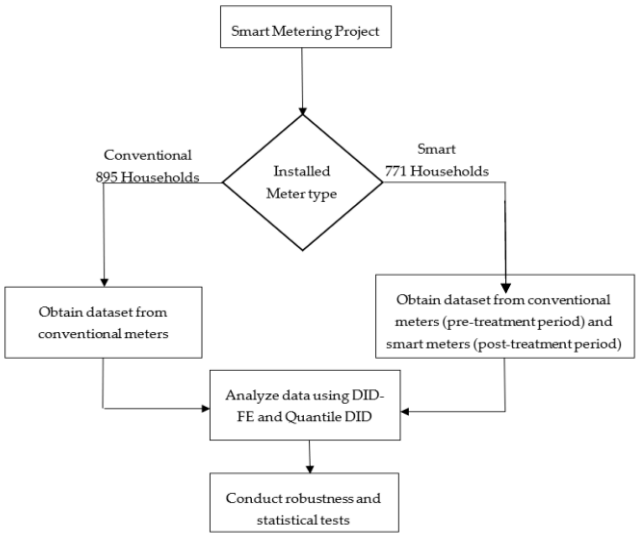

Figure 1.4 Tree Diagram Of Prepaid Energy Meter

At the user end

Initial energy consumption by the connected load occurs when it is connected to the prepaid energy meter. In tandem with the load's consumption, the balance declines. The user receives notification via SMS that is transmitted over GSM when their balance reaches a certain amount. The balance on your meter is low. Please start charging right away. The user will receive the following message of confirmation and the current balance following the electrical board's recharging. Recharge effectively. Equilibrium = XXX XXX is the sum of the user's refilled prepaid energy meter balance plus the unrecharged balance. The user must recharge right away following the notification message, and if the user happens to ignore the notification for some reason, the prepaid energy meter will shut off with a notification message to the user. "Meter is inaccurate. Your balance is about 00 RS. The user will benefit from the notification messages and take rapid appropriate action as a result, preventing the switching off of the power supply and minimizing the utilization of energy to a minimum.

At the electricity board

To continue using energy, the user must top off his prepaid energy meter with some energy at the electricity board's end. The message that has to be sent in order to recharge has the structure listed below."R XXX 12440285" Following the completion of the recharge by the power board, the following confirmation message is delivered to the same. Recharge effectively. Equilibrium = XXXXX is the sum of the user's refilled prepaid energy meter balance plus the unrecharged balance.

13. Calibration process of prepaid energy meter

The calibration process of a prepaid energy meter typically involves the following steps:

1. Initial verification: The meter is checked for any physical damage, and its serial number and other details are verified.

2. Functional test: The meter is tested to ensure that it is functioning properly. This includes testing the display, buttons, and other features.

3. Load test: The meter is connected to a load bank, which is used to simulate various loads. The meter is tested at different loads to ensure that it is accurately measuring the amount of electricity being consumed.

4. Accuracy test: The meter is compared against a standard meter to ensure that it is measuring electricity consumption accurately. The standard meter is usually a high-precision instrument that has been calibrated by a national metrology institute.

5. Seal and certification: Once the meter has been calibrated and found to be accurate, it is sealed to prevent tampering. A certification is issued that indicates the calibration date, the standard used, and the accuracy of the meter.

6. It is important to periodically calibrate prepaid energy meters to ensure that they are accurately measuring electricity consumption. Calibration intervals vary depending on the specific meter and the regulations of the country or region in which it is being used.

14. Difference between prepaid energy meter and normal energy meters

1. A prepaid energy meter and a normal energy meter differ in how they measure and regulate the consumption of electricity. Here are some of the key differences:

2. Payment Method: A prepaid energy meter requires customers to pay in advance for the electricity they will use, while a normal energy meter calculates usage and bills customers after the fact.

3. Usage Control: With a prepaid energy meter, customers can track and manage their electricity usage more closely since they are aware of how much they have paid for and how much is left. Normal energy meters do not provide such real-time feedback.

4. Tariff Plans: Prepaid energy meters often come with flexible tariff plans that allow customers to choose their usage patterns and monitor their energy consumption effectively. Normal energy meters typically have fixed tariff plans.

5. Disconnection: If a prepaid energy meter runs out of credit, it automatically disconnects the power supply. On the other hand, normal energy meters do not disconnect the power supply automatically, and customers may continue to use electricity even if they haven't paid their bills.

6. Convenience: Prepaid energy meters are more convenient in terms of payment options as customers can recharge them through online payment modes or at local payment centers. Normal energy meters require payment through traditional payment methods like cheques, cash or bank transfer.

7. Overall, prepaid energy meters offer customers greater control over their energy consumption and expenditure, while normal energy meters are simpler in their operation and payment method.

15. Prepaid energy metering offers several benefits, including:

1. Energy Conservation: Prepaid energy metering encourages energy conservation by providing consumers with real-time feedback on their energy usage and costs. This feedback enables consumers to make informed decisions about their energy consumption and reduces energy waste.

2. Cost Control: Prepaid energy metering allows consumers to manage their energy costs by prepaying for their energy usage. Consumers can choose to purchase energy credits in small amounts, allowing them to control their energy costs and avoid unexpected bills.

3. Convenience: Prepaid energy metering is convenient for consumers, as they can purchase energy credits from various locations, including online, mobile applications, and local shops. This convenience eliminates the need for consumers to visit energy company offices to pay their bills.

4. Reduced Administrative Costs: Prepaid energy metering reduces administrative costs for energy companies by eliminating the need for meter readers and reducing the number of unpaid bills

16. Challenges of Prepaid Energy Metering:

Despite the benefits of prepaid energy metering, there are several challenges that must be addressed to ensure the successful implementation of this system. These challenges include:

1. Initial Cost: The initial cost of implementing prepaid energy metering can be high, as it requires the installation of electronic meters, communication devices, and software.

2. Technology Limitations: Prepaid energy metering requires a reliable communication network and reliable power supply to function effectively. In areas where the communication network and power supply are unreliable, prepaid energy metering may not be feasible.

3. Social Implications: Prepaid energy metering may have social implications, as it can be seen as stigmatizing for low-income households that cannot afford to prepay for their energy usage.

4. User Education: Prepaid energy metering requires user education to ensure that consumers understand how to use the system effectively. Without adequate education, consumers may not know how to manage their energy usage and costs.

17. Errors in prepaid energy meter

Prepaid energy meters are electronic devices that allow users to prepay for electricity and monitor their energy usage. Like any electronic device, prepaid energy meters can encounter errors or malfunctions. Some common errors that may occur in prepaid energy meters include:

1. Overcharging: Prepaid energy meters can sometimes overcharge, resulting in customers paying more than they should for their electricity.

2. Undercharging: Conversely, prepaid energy meters can also undercharge, which means customers may not be paying for all the energy they use, resulting in a loss for the utility provider.

3. Meter tampering: Some customers may try to tamper with the prepaid energy meter to reduce

their energy bill or bypass the meter altogether, leading to inaccurate readings and losses for the utility provider.

4. Communication errors: Communication errors can occur between the prepaid energy meter and the server, resulting in incorrect billing or loss of data.

5. Power surges: Power surges can damage the prepaid energy meter, causing it to malfunction or stop working altogether.

It's essential to have regular maintenance and inspections of the prepaid energy meters to detect and rectify errors as soon as possible. Utility providers may also provide a customer helpline for reporting and resolving any errors encountered with the prepaid energy meter.

18. CONCLUSIONS

The utilization of prepaid energy meters has arisen as an inventive answer for address the difficulties of customary postpaid charging frameworks for power. Prepaid meters offer a few benefits over customary charging frameworks, including expanded comfort, adaptability, and control for the two purchasers and utilities. They additionally advance energy protection and decrease the gamble of income misfortune for utilities. Regardless of these advantages, there are still a provokes that should be addressed to guarantee the effective execution of prepaid energy meters. These incorporate tending to moderateness worries for low-pay purchasers, guaranteeing satisfactory specialized foundation, and tending to potential security chances related with the utilization of prepaid meters. Generally, the proof proposes that prepaid energy meters offer a promising answer for address the difficulties related with customary postpaid charging frameworks for power. In that capacity, policymakers, utilities, and purchasers ought to think about the reception of prepaid meters for the purpose of working on the proficiency and manageability of energy utilization.

REFERENCES

[1] Jubi.K, MareenaJohn, "Prepaid Energy Meter with GSM Technology", AIJRSTEM, pp. 195- 98, June-August, 2013.

[2]"SIM300 Hardware Interface Specification", 2006- 04-05,SIM300_HD_V2.02

[3]Dr.Boyina.S. Rao, B. Gnanasekaranathan, M. Raguram, S. Pravinkumar, P. Kamalesh, "Domestic Prepaid Energy Distribution System for saving of Power Consumption",IJAET/Vol.III/ Issue II/April–June, 2012/26-29.

[4] Bhavna Patel, ShrikantMhaskar, "Voucher Based Prepaid Electricity Supplier With Auto Cut Off", IJIIT|Volume-II|Issue-I|2013-2014 July |Paper-03.

[5]. Mei-Sung Kang, et.al," Implementation of Smart Loading monitoring and Control System with ZigBee Wireless Network, IEEE Conference on Industrial Electronics and Applications,pp.907-912,2011-

[6]. Khusvinder Gill, et.al, " A ZigBee-Based Home Automation System",IEEE Transactions on Consumer Electrionics, Vol, 55,No. 2, pp. 422-430 MAY 2009

[7]. N. Sriskanthan, et.al, " Bluetooth based Home Automation System", Microprocessors and Microsystems, Vol. 26,no.6,pp.281- 289,2002-

[8]. M. Zeghdoud, et.al, "Impact of Clear Channel Assessment Mode on the Performance of ZigBee Operating in a WiFi Environment", IEEE Workshop on Operator-assisted Community Networks, Berlin, pp. 1- 8,September 2006

[9]Dr. K. Sheelasobanarani1, S. Dinesh Raja2, B. Dhanaraj3, K. Manickam4, K. KarthickRaja5. "A Prepaid Energy meter for efficient Power Management", International Journal of Emerging Technology and Advanced Engineering,Volume 4, Issue 3, March 2014