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RESEARCH ARTICLE OPEN ACCESS

Feasibility Study of Prepaid Energy Meter in Bhutan

Dheynay Zangmo[1], Chimi Dem[2], Sangay Thinley[3], Roshan Chhetri[4]

(Department of Electrical Engineering, College of Science and Technology, Royal University of Bhutan)

Email ([1]dheynayzangmo@gmail.com, [2]chimidemtt47@gmail.com, [3]sthinley123@gmail.com, [4]roshanchhetri.cst@rub.edu.bt)

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Abstract:

Having numerous new smart energy meters adopted around the world, Bhutan uses the conventional electromechanical energy meter. Prepaid energy meter is one of the rising innovational technology with precise and error free facilities which is being implemented throughout the world. It is a smart meter which enables the power utility to collect the electricity bills before its consumption. This paper presents the feasibility study of a newly proposed prepaid energy meter which can be adopted in Bhutan. The feasibility of the market and technical is determined. The proposed prepaid meter is recharged based and online system with GSM communication technology. The detailed recharging process and the communication network is presented along with the cost benefit analysis.

Keywords **—GSM, prepaid meter, cost benefit, consumer, tariff.**

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I. INTRODUCTION

Efficient use of electricity is the priority around the world and various new technologies are paving its way towards achieving it. Smart energy meter is one of the emerging technologies which is gaining its popularity. Majority of the energy meter used in Bhutan are the conventional electromechanical type. Electromechanical meter is error prone and requires more time and labour[1]. Those meters have poor accuracy and lack of configurability. Therefore, with the recent development in technologies, there are opportunities whereby implementation of efficient energy meter with high accuracy, precise and error free are being adopted.

A Prepaid Energy Meter enables the power utilities to collect electricity bills from the consumers prior to its consumption. The prepaid meter is not only limited to Automated Meter Reading but is also attributed with prepaid recharging ability and information exchange with the utilities pertaining to customer's consumption details through GSM communication technology [2].

In the paper, a design of GSM based prepaid energy meter is developed and the communication network is also determined. Thismeter is validated for its feasibility through market technical and the cost involved. If implemented its payback period for the cost is also determined and various options are presented.

II. PREPAID ENERGY METER

Prepaid energy meter is a smart meter which enables power utility to collect the electricity bills before its consumption. Prepaid stands for 'PAY BEFORE USING'. The benefits of this meter are:

- Reduce problems associated with billing
- Reduces deployment of manpower for meter reading.
- No need of bill production and bill distribution.

- Get payment on time, thus reduces financial risk for utility company.
- Pay for the exact amount of energy consumed.
- Minimized human intervention and errors related.
- Cost saving and effective method of payment.
- Reduces the problem associated with billing consumers living in the isolated areas.
- No wastage of energy therefore, efficient.

III. MARKET FEASIBILITY

A market feasibility study would determine the current condition of the energy meter in Bhutan and how customers would respond to the new smart meter i.e., prepaid energy meter. A survey was conducted in Chukha Dzongkhag households to collect data on the present energy meter to analyse the problems that people are facing and also determining the market feasibility of prepaid energy meters.

Although there is an online system to pay the electricity bills which is easier and reliable, people residing in rural areas are still going to the utility office to pay their bills. Many take more than an hour to go pay their bill and some even have to leave their daily work. Due to non-availability of frequent cheap transport, they spent around Nu.100-300 to reach to the utility office which in many cases is more than their electricity bills. Some people prefer to pay their bills two or three months at a time and are penalized for the late payment. The reasons for not paying the bills on time were:

- Shortage of money
- Long travel distance
- Not getting the bills on time

With the present meter, people are facing technical problems, miscalculations and it has been found that some households are sharing the same energy meter. This is unfair to the people who are consuming less energy. People are uncertain about the bills charged as they are charged very high even when the usage is less. Some people pay their bills to their house owner. Thus there is no transparency.

With the adoption of prepaid energy meter, time, energy and money would be saved. There would be efficient utilization of energy as the prepaid meter has a feature of monitoring the energy usage as well. Thus, the market, from the analysis is concluded to be feasible in Bhutan.

IV. TECHNICAL FEASIBILITY

Technical feasibility is an assessment of present technical resources for the applicability of the proposed system. It includes the system architecture, communication system for a GSM based prepaid energy meter and the recharging process.

A. *System architecture of Prepaid Energy Meter*

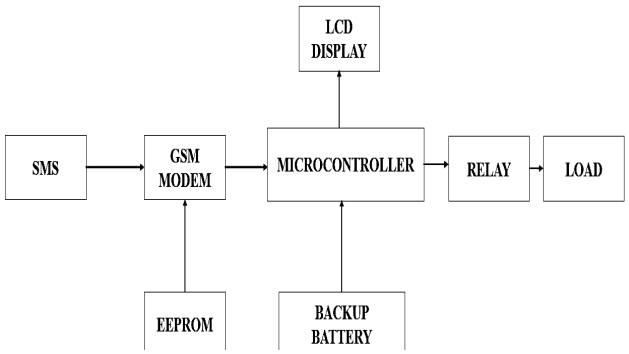

Fig.1. System architecture of prepaid energy meter

Fig.1 shows the system architecture of the proposed prepaid energy meter. When the SMS is sent from the power utility to the prepaid meter of the consumer which is equipped with GSM modem, the SMS is send to the microcontroller. On verifying the data, the microcontroller decodes the information and the recharges the meter. Based on the recharge amount, the relay connects the meter with the load i.e., if the balance is greater than the threshold value, the load is connected and if the amount is below the threshold value, the load is disconnected. The remaining units of energy and the recharged units are displayed on the LCD display of the meter and is stored every 15 seconds in the EPROM of the meter to avoid loss of information during power outage. The backup battery gives power to the prepaid module during power failure in order to notify the utility about power outage [2].

B. *Communication network*

The communication network for recharge-based system is shown in fig. 2.The power supply is given

to the prepaid energy meter which is GSM based. The BPC would supply the recharge card through which the consumer would recharge their energy meter by using their phones.

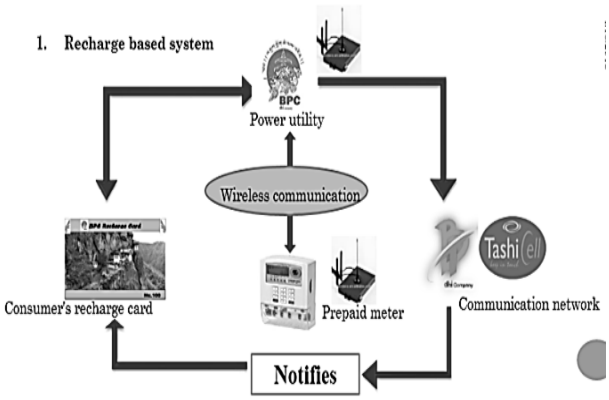

Fig.2. Communication Network for recharge based system

The BPC card would range from Nu.100, Nu.200, and Nu.500 and so on. As soon as the consumer recharges, the server at BPC would get the notification whereby they would read the consumer's meter ID and its detail.

If the meter ID and pin number of the recharge card is valid, then the server sends a SMS to the customer's meter which is equipped with GSM modem. The meter receives the SMS, decodes it and recharges the meter. As soon as it recharges, the consumer would be notified through SMS. The Bhutan Telecom would act as a medium and serves a mode of communication between the meter and the server. It provides the service wherever necessary and notify the consumers when their balance is about to finish. When the balance is finished, the supply would be cut off and the consumer would be notified. The process for online recharging of the meter is similar to the scratch card method except for the first step i.e., whenever a consumer recharges the meter, the respective bank is notified first and which then sends the signal to the BPC as shown in fig.3.. The banks and BPC are interlinked.

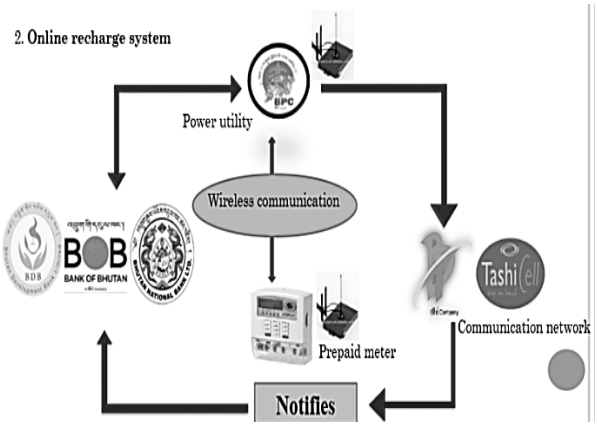

Fig.3. Communication network for online based system

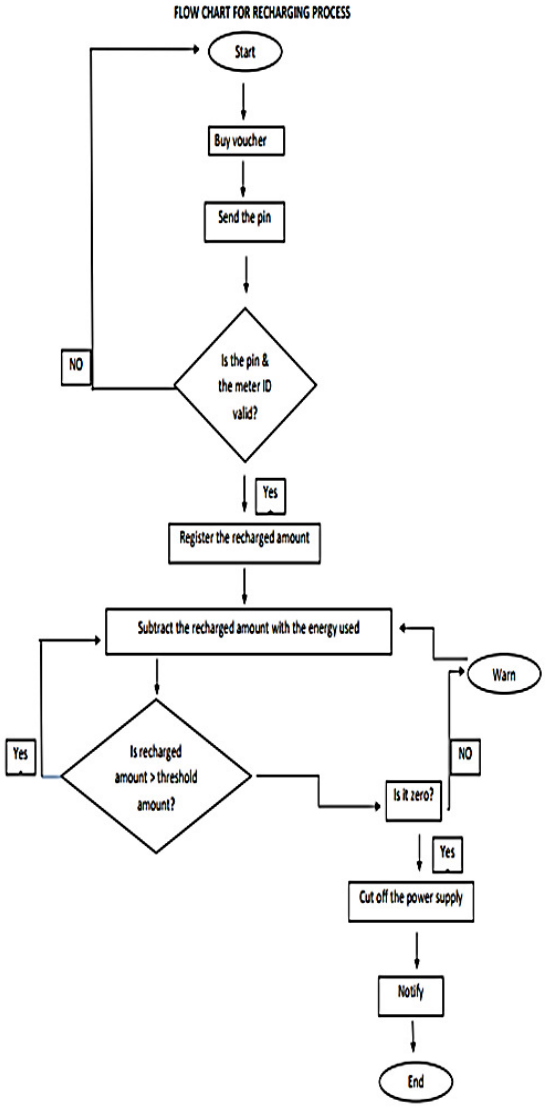

Fig.4 Flow Chart for recharging process

C. ***Recharging process***

The flow chart for recharging process is shown in fig. 4.

Step 1: Purchase the energy vouchers

Scratch cards provided by the utility company

Step 2: Requesting for recharge

For example,

*121*10001*12456123 201#

Where number *121* represents the recharge in the task index of the sms protocol and *10001* represents the meter id* 12456123201# represents the pin number of the scratch card

Step 3: Verification process

The pin send by the consumer is verified at server of the utility company.

Step 4: Activation of prepaidenergy meter

Recharges the energy meter according to the requested amount by the consumer

V. COST BENEFIT ANALYSIS

The cost associated for adoption of prepaid energy meter are meter cost, installation cost, transportation cost, communication charge and other additional charges like contingency, miscellaneous and maintenance cost. The total cost for the Chukha Dzongkhag (14482 household) is estimated to be about Nu. 326 million.

The meter readers are no longer required. Thus, the monthly payment of those employees can be used to reduce the overall cost. The total number of meter readers in Chukha dzongkhag is 24 and their payment in 10 years would be Nu.34million which reduce the overall cost of Nu.326 million to Nu.292 million.

The overall cost can be recovered within the useful life of the meter (10 years) by increasing the tariff by minimum of Nu. 0.4/kWh. However, with the change of technology, the present energy meter should be replaced. Thus, distribution company should plan such that the burden is heavy on the consumers.

The increase in the tariff system would not pose much problem to the consumers as the cost that were involved previously for the transportation is comparatively higher than the amount, they would be paying monthly for the prepaid energy meter.

VI. CONCLUSIONS

The market and technical were both found to be feasible in Bhutan. The prepaid energy meter system that is suggested is technically feasible with the existing GSM method employed currently.Although the cost of prepaid energy meter is high, there are still many benefits along with it andthe cost can be recovered through reducing the workforce and increase in tariff system. However, it requires an uninterrupted communication network for its effective function. Other than the risk of technological advancement, this meter is a smart choice for the consumers as well as the utility. Time may come when such energy meter may not be manufactured and available in market. Therefore with the change in technology, Bhutan should upgrade to newer and smarter technology for efficient usage of energy.

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