

Losses Mitigation & Theft Detection of Electricity by Automatic Controlled System with Ofc Communication in Distribution Line

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ABSTRACT- In the era of Technology the world is growing rapidly to balance or fulfill the needs of the society and the world needs to modernize our equipment and machinery devices too, for that we need “electricity”. Electricity is a thing which can act as a key to unlock the development and growth of the modern technology. It is an essential part of our life which is in form of energy in limited surplus, without which our day to day life becomes intricate. So the saving and management of it becomes crucial. It is possible with the help of smart billing & metering system. Smart energy meter (SEM) not only succour to enhance the efficiency of power system but it also mitigates the thefting & power losses of electricity at the distribution system. SEM assists to obtain the accurate reading of electrical power consumption and also real time information of energy consumption by the consumers. The OFC communication support in theft detection by communicating among the different element required in electricity distribution and their management.

Index Terms- Smart Energy Meter (SEM), OFC (Optical Fiber Cable), Pole System, Traditional Distribution System (TDS), Energy Saving, Power Theft, Distribution Sub-Station.

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I. INTRODUCTION:-

There are many problems in distribution, metering and billing processes face the power distribution utilities and the metering and billing processes are considered complex problems. The existent classical method to retrieve the energy meter data and billing is become not suitable and time exhaustion where the meter reader human must goes to each meter and manually take the reading of that meter then return to the electricity distribution office to issue the bill for each customer. In addition, these collected data from meters would be entered manually to the software billing system for issuing bills and payment the rents. These operations of retrieving meters data and issuing bills in the classical method are suffering many problems. The main problems are the non-existence of the customers sometimes at their houses which leading the meter reader to retry the process of meter reading and sometimes because of the lack of integrity and credibility of some of the meter readers, they didn't retry meter reading where they estimate the meter reading. Also we must not forget the problem of the safety especially in Iraq. The outback areas also form a problem against the meter reader which should be taken into consideration. The existing electromechanical energy meters used suffer well

known measuring errors and these meters affected by the circumstances surrounding the meters like temperature, vibration due to their design in nature in where meters contains mechanical parts.[2]

The available systems area units are mostly associate electronic energy meters that area unit presently in use is limited in extent to measure up to kwh units. The meter readers records the meter units in kwh unit monthly, on foot which required to be managed by a meter perusing companies. For processing the these companies must link every measured usage of electricity knowledge to the people and so confirm the quantity owed by suggests that electricity used by users.[3]

Today the metering instrument technology grown up significantly, such that the Consumed energy can be calculated mathematically displayed, data can be stored, data can be transmitted etc. Presently the micro-controllers are playing major role in metering instrument technology. The present project work is designed to collect the consumed energy data of a particular energy consumer through wireless communication system (without going to consumer house); the system can be called as Automatic Meter Reading (AMR) system. The automatic meter reading system is intended to remotely collect the meter readings of a locality

using a communication system, without persons physically going and reading the meters visually.[1] To identify the theft in the distribution line, input and output electricity consumption of certain pole is compared using electricity transformer. Any negative value in the comparison means that the particular pole has drawn more electricity as theft. Here one electricity transformer is placed in input side of the electricity distribution post line and other electricity transformers are placed at the distribution points of the house lines [2]

The real time monitoring & better quality of power can be provide to the consumer by conquered the mitigation losses and power thefting. And to achieve such a challenge we need a system in TDS which have the ability of real time monitoring, transparency, privacy & security, accuracy and quick response etc.

Here in this paper we have came with the system which have all the essential qualities cited above to make TDS to DS. The DS has pole system and OFC based communication which will assist in real time monitoring, enhancement of power quality & provide transparency in electricity distribution.

Optical-fiber transmission lines appear attractive for a variety of communication applications in which twisted copper pairs and coaxial cables are now used. These applications range from on premises data links and equipment wiring to interoffice and intercity telecommunications trunks. Experiments to explore the technical feasibility of glass fibers in these areas are presently in progress. This paper summarizes the state of the art of the burgeoning field of optical fibers. Progress in research on fibers, cables, devices, and components will be reviewed, and systems applications and field experiments will be discussed.[4]

Different component used in DS:-

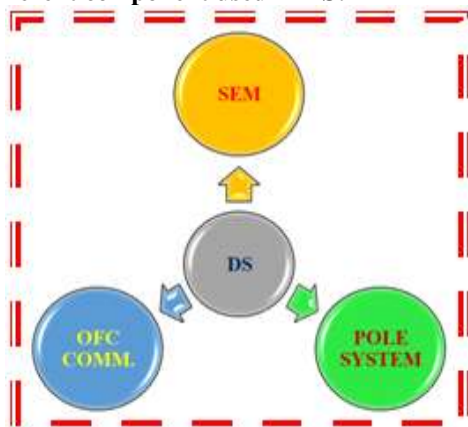


Fig. no. 1 Different component used in DS

Rest of the article is organized as follow: section II anomaly between SEM & AEM. Problem statement is discussed in section III. Section IV put forward the proposed methodology is illustrate & intricate clearly. Section V interpretation of the article and at last section VI ends with future scope.

II. ANOMALY BETWEEN SEM & AEM

S. NO.	PARAMETER	SMART ENERGY METER(SEM)	ANOLOG ENERGY METER(AEM)
1	billing method	automatic & easy	manual & complex
2	manipulation of reading	prevention of manipulation of reading both by technician & consumer	manipulation can't prevented
3	analysis of load consumption	easy	complex
4	Reliable	more	less
5	theft detection	possible	impossible
6	economical	more	less
7	collection of revenue	prepaid	post paid
8	accuracy	More	less
9	monitoring system	real time monitoring	asynchronous monitoring
10	power distribution management	efficient	inefficient
11	customer satisfaction	billing is transparent	billing is ambiguous

Table no. 1 anomaly between SEM & AEM

III. PROBLEM STATEMENT:-

Indian Distribution line is radial and complex in nature. Many type customers taking the power supply from it. So the chances of power theft are enhanced. Power stealing may be in three different ways-

- A. Near to smart energy meter.
- B. In distribution line (between any two poles.
- C. Between pole and energy meter.

We can identify not only tampering but also the un-authorized consumers can be also detected. Ahead the electricity mugger can be punished for their mistake. So this will helps to mitigate the losses & enhanced the efficiency of distribution system.

IV. METHODOLOGY-

Power system structure-

Power system consists of three essential stage generation, transmission & distribution. Indian power Generation capability limited up to 11kV. This generated electrical power boosted with the help of the power transformer up to 765kV and then transmitted to distribution system. Most of the Indian distribution system is radial in nature. In which Unidirectional power flow takes place as shown in figure no. 2.

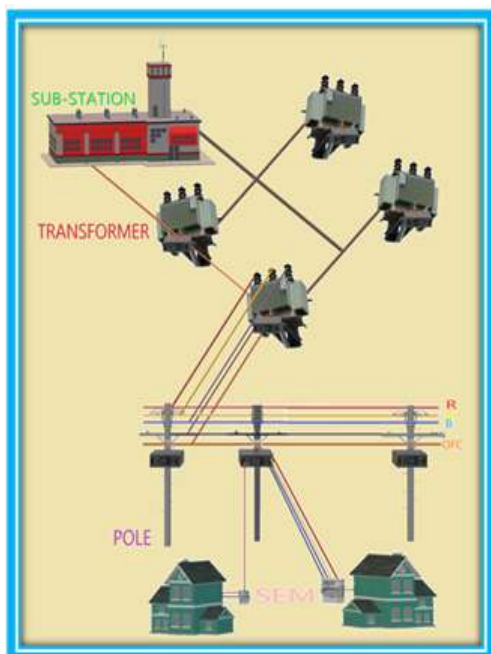


Fig.2 Radial distribution system

Now a day's distribution system is suffering from energy stealing & tracking of it not so easy. Power stealing may be in three different ways-

- A. Near to smart energy meter.
- B. In distribution line (between any two poles).
- C. Between pole and energy meter.

V. CONTROL PANEL-

The control panel is the backbone of the electricity distribution system as shown in fig. no.3. As from the name it is very clear that the control panel means a system which will have the control over the entire Electricity Distribution System and Management for the maintenance and action against the energy thefting can be control from substation itself. For better understanding the management of Electricity Distribution we need to interpret the functions and performance of control panel which will helpful in the process of energy theft detection system.

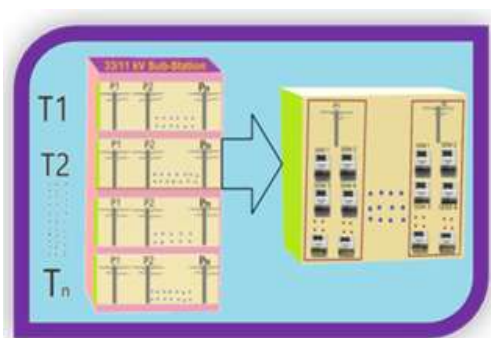


Fig.3 control panel

Control panel consist with the comparison module and is a software based management system. The principal on the basis of which the control panel will work or the detect location by comparing the real power and different electrical parameters. It will gather the information, scrutiny it, compare it and as a result take a particular action against the energy thefting.

Mathematical Model In Comparison Unit

On every occasion the input power passes from supplier to the consumer and the total amount of power receives by the receiver are not equal indicates a possibility of theft of power. Following mathematical comparison occurs in the comparison unit of the theft detection system.[2]

$$\Sigma P_{sent} = \Sigma P_{consumed} + Loss \longrightarrow \text{No Energy Theft}$$

$$\Sigma P_{sent} \neq \Sigma P_{consumed} + Loss \longrightarrow \text{Energy Theft Occurs}$$

Where, P_{sent} = Meter data of the power delivered to the customer

$P_{consumed}$ = Meter data of the power consumed by a customer.[2]

POLE SYSTEM- pole system is that system which consist of two essential parts-

(a) **MEASURING UNIT** – it measure the variable electrical parameter (V, I etc.) of individual pole in which they are connected. Measured electrical parameter feed into optical transducer.

(b) **CONVERTING UNIT-** in converting unit a optical transducer is used, which convert the electrical energy into optical energy, which assist in communication process as shown in figure no. 4.

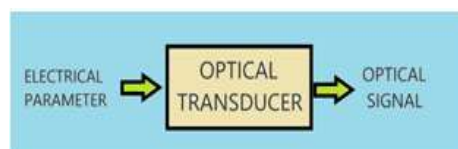


Fig. no. 4 optical transducer

The step generally the control panel will follow to find out the energy thefting.

1. it will collect the information from transformer, pole and SEM.
2. after the collecting the information it separate the information as per the category to which they belong i.e. transformer, poles and SEM.
3. The representation of control panel may be as shown in figure no. 3, where the different rows will indicate the number of transformer connected radially to the substation. In each row we will have

the number of poles and each pole section will have the numbers of SEM.

4. After collecting the information through OFC the role of comparison module will be introduced here i.e. to compare the real power of poles and SEM.

5. Comparison will be done in two different ways
 a) between two adjacent poles :- "in this case the real power of consecutive poles will be analysed and compared for detection of energy thefting between the poles"

b) Between pole and metre:- comparison will be between poles information and SEM connected to it for the detection of energy thefting between poles and SEM.

6. Format to locate the energy thefting:-



Fig. no. 5 Format to locate the energy thefting:-

7. After getting the particular location of the energy theft a specific action is taken against it.

It will generate two types of results either under or over.

i. **Under** : In this case the system will generate a notice or alarm to the substation as well as to the consumer i.e. thefting is being done in a particular transformer or between the poles or between pole and SEM if the thefting is under the range of the predefined limits which can be set as per the requirement of the electric board.

ii. **Over**:- After crossing the predefined limit the control panel trips the power supply of that particular section of the distribution system.

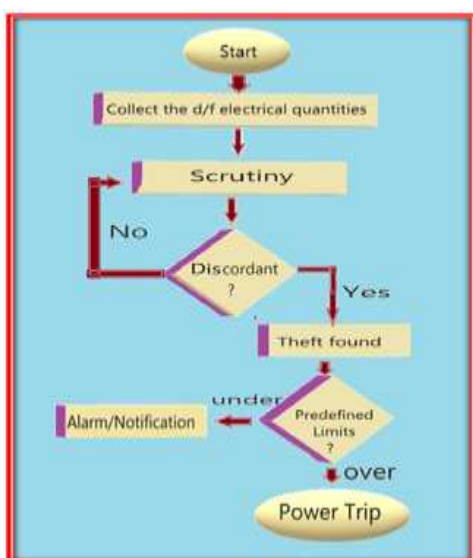


Fig. no.6 flowchart of theft detection in distribution system

ELECTRICITY THEFTING-

Power stealing may be in three different ways-

A. In distribution line (between any two adjacent poles)

B. Between pole and energy meter.

C. Near to smart energy meter.

A.

B. In distribution line (between any two adjacent poles)

Theft between any two consecutive poles can be detected using the pole system compare module (PSCM). In this system the signals from the different poles are fetched to the control panel located at the substation through the Optical Fiber cable (OFC). The control panel inbuilt with the comparison module which has the capability of comparing different electrical parameters (voltage, current and power etc) of any two consecutive poles connected to specific distribution Transformer over a sub-station range. As shown in fig. no. 7.

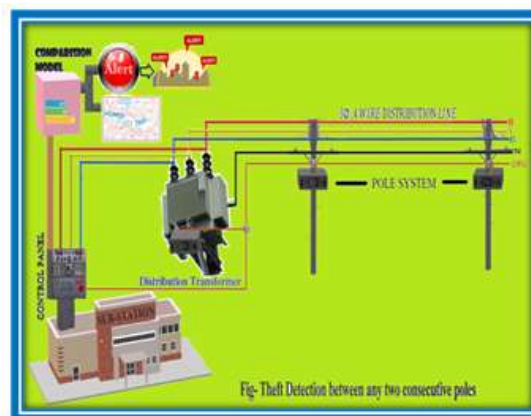


Fig. no. 7 Theft detection between the two consecutive poles

The comparison module will generate two types of results i.e.

1. alert notification and
2. power trip of particular range or a section

1 Alert notification-

As the control panel fetches the signals from the different poles the comparison module starts its comparison action among the different signals of the pole and as a result it generates an alert signal indicating that the power theft has been detected or is occurring between the particular two poles and proper action has to be taken against the power theft.

2 Power trip of particular range or a section-

After the alert notification the system will trip the power over a particular range or a section

of electric power distribution line come under the sub section if the power theft is much larger than the predefined limit of power consumption. Government authority can take the appropriate action against for unauthorized power consumption. Which will helpful in theft mitigation.

Flow Chart

Theft detection between the two consecutive poles is done initially by fetching the different electrical parameter from different poles through the OFC passes from transformer to the local substation. Where we have control panel, which will measure the real power between two consecutive poles and comparison module will compare the real power between two adjacent poles. If the comparison is concordant then loop will continue, if the comparison is discordant it shows the thefting is going on. After the thefting found the model will check whether thefting is under or over the predefined limits as shown in fig. no .8.

It will generate two kind of result as .

- a) **Under**- Alarm or notification to substation.
- b) **Over**:- In this case the power supply of particular transformer to which specific poles are connected where the theft has been found will be trip.

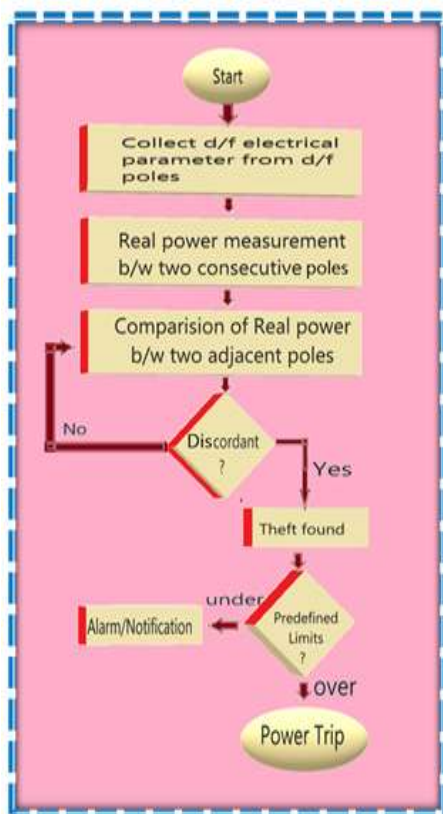


fig. no. 8 flow chart of theft detection between two consecutive poles

B. Between pole and energy meter:-

Theft between a specific pole & SEM can be detected using the pole system compare module (PSCM). In this system the signals from the different pole are fetched to the control panel located at substation through the Optical Fiber cable (OFC). The control panel inbuilt with the comparison module which has the capability of comparing different electrical parameter (voltage current and power etc) of any two consecutive poles connected to specific distribution Transformer over a sub-station range. As shown in fig. no. 9.

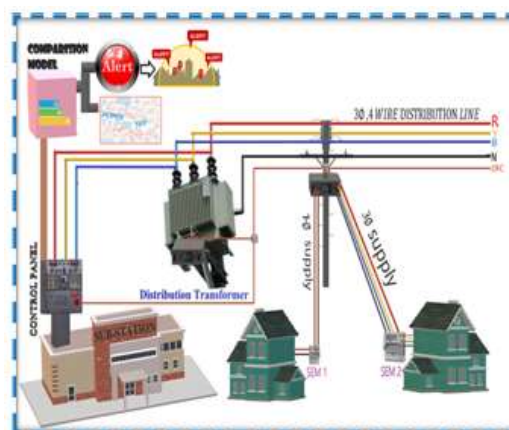


Fig. no. 9 theft detection between pole & SEM

flow chart:-

The detection or tracking of theft of energy between the poles and energy meter can be done with the help of control panel unit which is at substation. In the control panel initially all different electrical parameter data or information's are collected from the different poles through the OFC & information of SEM is fetched through the GSM at control panel. It has the facility to measure the real power between poles and meter to compare of real power between them. If the real power comparison is concordant then the loop will continue.

If the comparison is discordant it means the tempering of energy e is going on between specific pole and meter. After the indication, the system will scrutiny the record of suspected pole and SEM respected to it & will also notify two substation as well as to SEM consumer. If the thefting is under the limit a particular action has to be implementing. If it is over the predefined limit power of a particular section of the distribution system will be trip as shown in fig. no. 10.

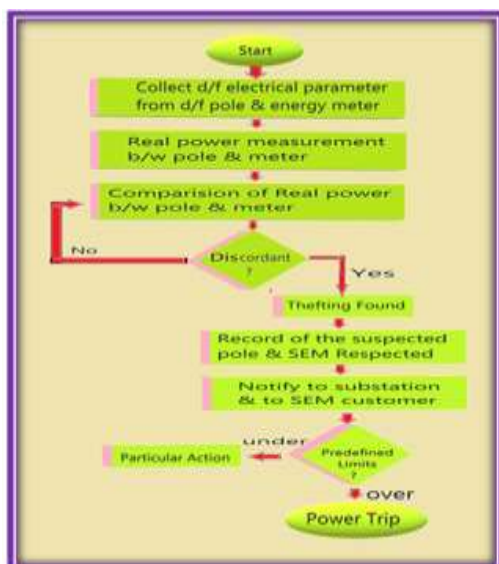


Fig. no.10 flowchart of theft detection between pole and SEM

C. Near SEM:-

Whenever the thefting is done between in the input and the output of the SEM by bypassing the SEM to assess the unauthorized power consumption. The SEM will itself send a message or information to a substation that the tempting is occurring near to that meter and the control panel will compare the input and output information of SEM and finally take a particular action against the energy thefting occurring in that location.

V. CONCLUSION-

In the traditional distribution system (TDS) the billing and revenue generation is very penurious. In TDS Electricity stealing had no arduous & manipulation of reading in energy meter is manageable. Even they can disturb the actual household electricity connection by bypass the energy meter, which leads to degradation in revenue generation and as well as have adverse effect in distribution efficiency. The put forward technique in this paper will help not only in theft detection but also to enrich the power quality of distribution system. It will supports in the transparency of energy billing with real time monitoring of their power consumption. It assist to prevent the manipulation of reading by both technician & consumer & The analysis of load consumption becomes easy and transparent.

VI. FUTURE SCOPE-

Monitoring and analysis of electricity distribution can be improved with the help of PMU system and the communication system require for the detection of theft in energy can be ameliorate with the help of wireless communication system.

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