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Efficient Energy Perception and Power Theft Preclusion Using Ied

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ABSTRACT

The energy efficient utilisation and management of the power is monitoring using IED. The Production of electricity through (Solar, wind, Fossil, Nuclear Biomass biogas) do not congregate with the requirements of all the consumers and the industries, the smart grid network requires to avoid power theft in traditional network. The distribution network is prone to excessive power loss in comparison with the generation and transmission system. So it is mandatory to convert the traditional feeder terminal unit into intelligent electrical device to prevent the power losses and to improve the quality of the power supply. First the module of intelligent electrical device is designed and its functions and characteristics are described. Then the algorithm for fault detection, fault segregation and power restitution based on the information interaction and self-healing process of intelligent electrical device is proposed. But the power theft in the smart distribution network still remains. The perception of power theft preclusion is proposed.

Keywords: Intelligent electrical device IED

INTRODUCTION

Generally the power system is subjected to losses in all the three phases, Generation, Transmission, Distribution and utilisation. Mostly technical losses will be prevalent in the generating station. Even the technical losses in the transmission and distribution system can be easily calculated from the information about total load on the grid and total energy billed. But the Non-Technical losses in the transmission and distribution system cannot be estimated. The major Non-Technical loss in the power system is the power theft. Power theft can be defined as using electricity from utility company without a contract or valid obligation to alter its measurement. Some of the older ways to steal electricity is by direct hooking from the main power line, by-passing the energy meter, inverting the energy meter, injecting the foreign elements such as resistor, transistor, neodymium magnet or IC into the energy meter, drilling holes in electromechanical meter. Another complicated method to steal electricity is to dig a long power wire into the ground and connect it properly to the resistive load. This type of power theft can be prevented by many modern tools such as tamper proof seals and label, Meter leaders, Tamper resistant screws, Energy meter and remote meter readers, interfere alarms and sensors. If the illegal customers tapped the power from the nearby house meters or from the distribution line and utilised through their meters, it can be easily identified and prevented by various methods (Q.Pang, H.Gao, M.Xiang, 2010). Some of this method is by using zigbee technique, fuzzy logic, wireless meter and smart meters. Computerized billing system also avoids the power theft. But, if the illegal customers tapped from the distribution line or from nearby customers and utilised directly to the load, it can be detected that the power theft if occurring but cannot be prevented and eliminate this unwanted load from the line. So in this paper we used Intelligent Electrical Device (IED) to detect the power theft and proposed an idea to prevent this type of power theft.

MATERIALS AND METHODS

Design of intelligent electrical device: An IED is the programmable Interface controller (PIC) that performs electrical protection functions, local control aptitude, has the ability to monitor process and can communicate directly to a SCADA system. Normally an IED receives data from the sensors and power equipment and issue control commands to the relay which in turn gives command to the circuit breaker if it senses the abnormalities in the desired current, voltage and frequency. Since an IED knows the current network and load situation, it can operate the tap changer. So both the high voltage and low voltage problems can be solved with the help of IED. The IED in the smart distribution grid not only has real-time monitoring function of running status and fault status, but also has data processing and computing, fault determination and handling, fault segregation, load redirection, the restitution, self-healing and local control capabilities through the information interaction.

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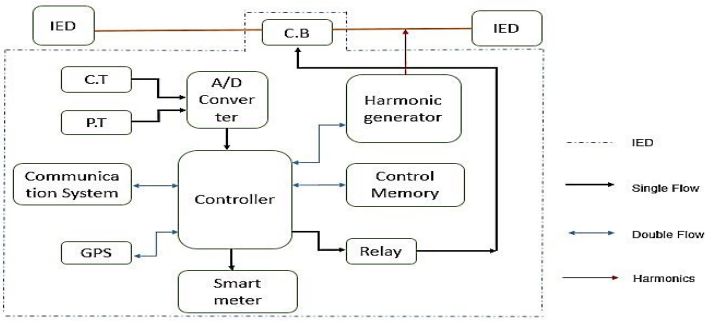

Figure.1.Block Diagram of Pole Attached IED

The fig.1 represents the pole attached IED. The pole attached IED contains Current Transformer (CT), Potential Transformer (PT), Analog to Digital Converter (ADC), Communication System such as Power Line communication (PLC), Controller, Control Memory, Global Positioning System (GPS), Relay, Circuit Breaker (CB) (Z.Jianghe and W.Liyan2009) and Harmonic Generator.

The figure 2 represents the transformer attached IED. The transformer attached IED contains the same component as the pole attached IED except the backup transformer to generate high voltage is added instead of harmonic generator.

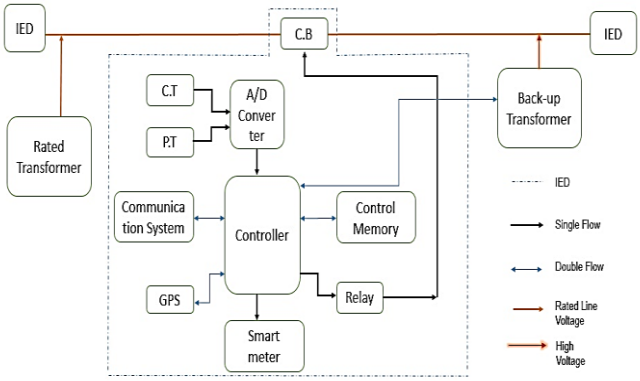

Fig. 2 Block Diagram of Transformer Attached IED

CHARECTERISTICS OF IED

The IED for smart distribution grid compared with the traditional Feeder Terminal Unit (FTU) has the following characteristics.

Realization of complete information interaction: The distributed control network is connected by the fibre optic Ethernet and is supplemented by microwave and power line carrier. The complete information interaction takes place between one IED and the other, and IED and the control master. The information interaction includes not only node voltage, current, active power, reactive power, power factor, frequency, harmonics, voltage fluctuation, flickering of voltage, position of switches signal, failure of breaking signal, all those off-limit signal, reclosing and fault identifying signal, but also protection and isolation of fault signal, and fault diagnosis, decision-making signals, etc. Through this complete information interaction, the IED can improve the speed of the protection action, accuracy of the fault location and avoid the false-operation of protective relays.

Realization of distributed control: The IED performs the sequence of protecting action such as tripping, fault location, decision of fault analysis and power restoration. The remote modulation order of the control master only plays a back-up role. This not only improves the real-time monitoring but also improves the distribution network reliability to avoid the control failure of the entire network as a result of fault in the control master.

Self-healing function: The analysis function of the IED not only results in the IED's self-healing function, but also provides the self-healing function of the entire distributed network. When a failure IED is detected, the IED is out of

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network and its functions are taken out by nearby IED. When the entire distribution network is failure, the IED can automatically isolate faulty region and restores power supply of the non-faulty region to achieve the self-healing function of the distribution network. Simultaneously, the IED can diagnose the device of the local node. Using the real time data of the feeder and device, the IED detects the weak links or the possible fault links to warn in time and take the respective preventive measure for the link.

PROTECTION AND CONTROL ALGORITHM

The controller plays a main role in the IED. Programmable Interface Controller (PIC) is used in the IED. The PIC uses the current differential protection method. The efficiency of the PIC will be lowered if all the logic in the IC is used simultaneously. So we have used two IC burnt together to have six control logic throughout the system. Logic 1 is used as a sensor which senses both the magnitude of current and voltage. Logic 2 is used as a comparator to compare the magnitude of the current from the successive IED's. The output of the logic 2 indicates the occurrence of power theft if the current value exceeds the maximum limit of the corresponding distribution transformer. Logic 3 is as a signal for relay which operates the circuit breaker according to the output of the logic 2. Logic 4 is used as a signal for Global Positioning System (GPS) which is used to detect the exact position of the place at which the fault occurs. Logic 5 is used as a signal for transmitting the information to and from the IED's in each and every smart meter. Logic 6 is used as a signal for harmonic generator which sends the harmonics in the line when the power theft by the illegal customer is detected by the output of the logic 2, after disconnecting the entire genuine customer for a short while. The harmonics affects the performance of the load of the illegal customer tapped in the line. Logic 7 is used as a signal for the back-up transformer. This signal sends the high voltage greater the nominal voltage when the power theft is detected by the output of the logic 2 even after sending the harmonics in the line by the harmonic generator. This high voltage which will be greater than the withstand voltage of the load will totally burst or adversely affect the performance of the load of the illegal customer.

Power theft prevention method: The solution to power theft problem is proposed as a conceptual design. The power theft that occurs can be detected by the determination of non-technical losses method. The smart meter containing the IED in each and every house senses the energy consumed by the consumers, after which data transmission takes place between the successive IED. The IED's then compare the magnitude of current from the two corresponding IED and calculate the cumulative technical and non-technical losses. The percentage of non-technical losses is also determined. The percentage of non-technical losses which cannot be determined in advance, when it is above 5% is considered to be the power that is tapped without acknowledgement i.e. power theft. The consumer who tapes the power without acknowledgement is considered as illegal customer and the others are considered as the genuine customers. Thus the power theft is detected at first hand. But it is impossible to find the exact location of the illegal customer. So steps are taken to isolate and prevent the loads of the illegal customer.

Primarily after the detection of power theft the controller sends signals to the relay that operates the circuit breaker, tripping of it, thereby disconnecting the entire genuine customer. Thus only the illegal customer continues to draw energy from the electric grid. The harmonic generator is now operated to generate unwanted harmonics in the line at desired times. This acts a warning to the illegal customer as harmonics affect the device performance. Now the harmonics are filtered and the supply is restored by signals from the controller after a pre-set time delay. Now again the IEDs check for non-technical loss. If it is found above 5%, now all the IEDs are disconnected, then high voltage well above the consumable range is passed in the line. Thus the illegal customer's device gets damaged. This can be considered as a conceptual method where the illegal consumer will avoid connecting his load. Later all the IEDs are reconnected after which the genuine customers are reconnected. The IEDs performs the calculation of non-technical losses and ensures that the apt operation in time.

Layout of smart distribution system: In the IED Interfaced Smart Grid System, every substation and its transformer and street end transmission poles are attached with individual IED and all the IED's are connected through the communication link to the generating side. The IED's at the street end transmission poles consists of circuit breaker, Loop switch and IED with Harmonic Generator. The major application of the Circuit breaker is to operate under fault condition and to automatically reclose after the fault is cleared by getting the signal from IED's. This is to protect from power theft, load demand, high and low voltages.

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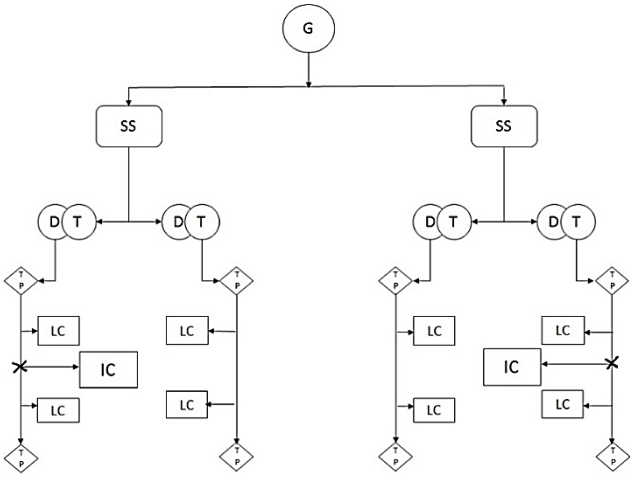

Figure.4.IED Interfaced Layout of Smart Grid System

The Layout describes that generated power from generating station (G) flows through substation (SS), Distributing transformer (DT) and street end transmission poles (TP) to Legal Customers (LC). The cross line between TP's indicates the power theft by the illegal customer (IC).All the components of the smart grid system have separate IED's which are interconnected with each other to server through communication link by which the fault section gets update and isolated. The fault occurs after the smart meters can be neglected easily by the smart function of the meter but if it occurs between two meters and transmission poles, it can be corrected by two means. If the fault is at negligible level the street end IED will act, which then gives signal to the harmonic generator. If the fault level exceeds, the IED at the distributing transformer gets operated which then gives signal to the back-up transformer which contains high voltage. Some faults should be manually operated in case of replacement of devices are required for continuous supply.

Simulation results: The simulation for the detection and prevention of power stealing is done by using MATLAB/SIMLINK software. The name MATLAB stands for matrix laboratory. MATLAB/SIMLINK was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. MATLAB is a high-performance language for technical compute. It integrates computation, revelation, and programming where problems and solutions are expressed in familiar mathematical notation. MATLAB/SIMLINK is an interactive system whose basic data element is an array that does not require dimensioning. This allow you to work out many technical computing problems, more than ever with matrix and vector articulate, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN.

The simulation result for the loads of the genuine customers under normal condition occurs at 0-0.5 and the result of the abnormal condition occurs at 0.5-1

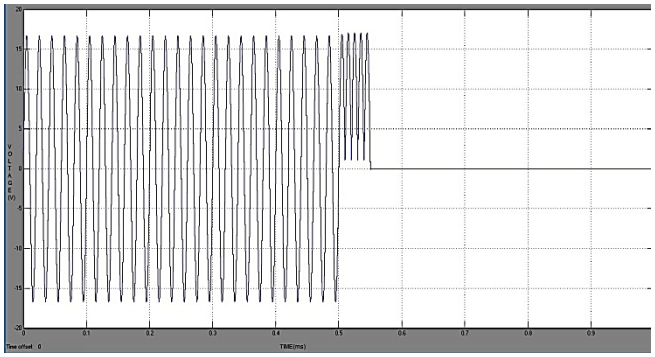

Figure.5.Simulation Result for the Genuine Customer

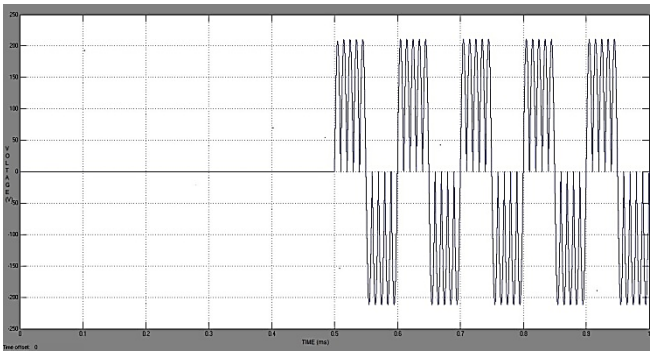

Figure.6.Simulation Result for the Illegal Customer

CONCLUSION

The major problem prevalent in most of the developing countries is the electricity demand. This problem of electricity demand is further triggered by the higher percentage of Non-Technical losses which is called power theft. So we proposed a solution to this power theft by using a device called Intelligent Electrical Device (IED). By using this intelligent device, not only power theft but also the voltage problems and power blackouts can be prevented

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through continuous monitoring and control. This prevention of power theft increases the overall revenue of the electricity department and also the Gross Domestic Product (GDP) of the country.

REFFERENCE

A.Sinha, S.Neogi; R.N. S.Chowdhury, S.P.Chowdhury, N.Chakraborty, Smart grid initiative for power distribution utility in India, Power and Energy Society General Meeting, 2011.

P.Biswas, Frequency controlled protection scheme to protect the theft of electric power at distribution end" IOSR Journal of Electrical and Electronics Engineering, 5(4), 2013, 60-67.

Q.Pang, H.Gao, M.Xiang, Design of intelligent terminal unit for smart distribution grid, 2010, 1-6.

R.Amarnath; N.Kalaivani; V.priyanka, Prevention of power blackout and power theft using IED, IEEE Global Humanitarian Technological Conferrence 2013,

S.S.S.R.Depuru; L.Wangn; V.Devabhaktuni, Electricity theft: overview, issues, prevention and a smart meter based approach to control theft, Elsevier Journal, Energy Policy, 39, 2011, 1007–1015.

Z.Jianghe and W.Liyan, Information structure of smart distribution network", Power System Technology, 33(15), 2009.