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PREVENTION OF ELECTRICITY THEFT FROM DISTRIBUTION LINE BY USING INTELLIGENT ELECTRICAL DEVICES

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ABSTRACT

As the present power generation don't meet with the necessities of the considerable number of purchasers and the ventures, the conventional system should be changed over to the brilliant framework where the power created from the normal assets and the sustainable power sources are coordinated. The circulation organize is inclined to misfortunes progressively when contrasted with the producing and transmission framework. So it is important to prevent the power losses and to improve the quality of the power supply, the traditional feeder terminal unit is converted to intelligent electrical device.To ensure the continuity of the power supply the smart distribution network is connected in ring main distribution system. The automation system made the synchronization of the power from all the sources. So when energy from all the sources are integrated in smart grid, the efficiency of the system increases. But the power demand and power theft in the smart distribution network still remains. Thus finally, the indication for preventing power demand and power theft is presented. Through the information interaction and self-healing process of intelligent electrical device, the quality and continuity of power supply is ensured to all the consumers and industries.

Keywords: power theft, fault isolation, intelligent electrical device, smart distribution grid, fault location, protection from power demand and Smart grid..

I. INTRODUCTION

In recent years, in order to make the power system efficient and reliable, the development of smart grid technology has been realized and effectively promoted the network's intelligence. The future network development is significantly based on smart grid. In order to face the new challenges and to avoid the present power black-outs, the State Grid Corporation accelerates the pace to the strong smart grid. The main features of smart grid are the information technology, automation and its ability to integrate power from renewable energy sources. It is very economical and will be more beneficial if the traditional network system is replaced by the smart grid system and actively promote clean energy development. It focuses on the technologies involved in power generation, transmission, substation, distribution, consumption, dispatching, communication information, usage of renewable energy etc.

To make the smart distribution grid more perfect and be widely used, the fault detection and control methods must be redesigned. The structure of smart distribution network is more complex than the traditional distribution network. The main aim of the smart distribution grid is the information exchange. The information exchange takes place interactively between the terminal units, the terminal units and the distribution master station. The intelligent electrical device 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 treatment, fault isolation, load redirection, restoration, healing and local control capabilities through the information interaction. Even if use IED in the linear system, the continuity of the power supply cannot be achieved. So to improve the quality of the power supply and to ensure the continuity of power supply, smart distribution network is redesigned in the ring main distribution network.

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II. DESIGN OF SMART DISTRIBUTION GRID

According to the requirements of the smart grid, the smart distribution grid is designed by modifying the traditional distribution grid. It is mainly composed of substation, switching station, ring main unit, pole-mounted switch, Micro Grid (MG), a Distributed Generation (DG), feeders, Intelligent Electrical Device (IED), Global Positioning System (GPS), the communication network and the renewable energy. The Advanced Distribution Automation (ADA) system is currently in the smart distribution grid. The ADA is composed of the Advanced Distribution Operation (ADO) and the advanced distribution management. The ADO fulfils the distribution supervisory control and Data Acquisition (DSCADA), Feeder Automation (FA), reactive power control, DG dispatching, etc. The ADM looks the geographical image as the background information to achieve data input, edit, and the network topology data and the feeder breaker running information from the ADM system.

Through sending the operation commands to the switches, the ADO system realizes the fault location, isolation and power restoration with IED. The substation and the IED's are connected into a distributed control system via optical Ethernet.

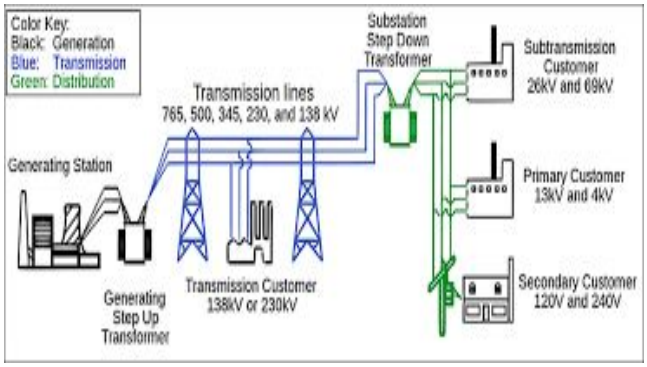

Fig. 1Structure of smart distribution grid

III. CHARACTERISTICS & FUNCTIONS OF IED

Characteristics 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
- Realization of distributed control
- Self-healing function

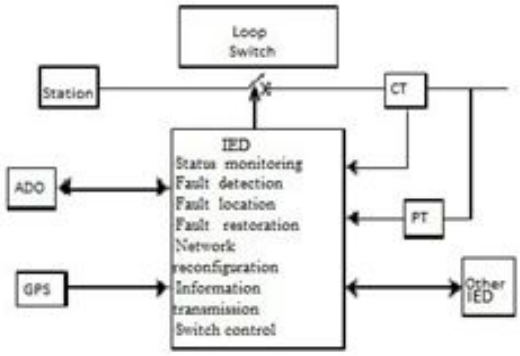

Fig. 2 Structure of IED

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Functions of IED :

The major roles of IED are status monitoring, fault detection, fault location, fault diagnosis, information interaction and switching control. By detecting the loss of voltage, the over current and the transient and steady state current and voltage of the feeders, it detects the location of faults and manipulates the respective switches, isolates faults and restores power supply.

IV. PROTECTION & CONTROL METHODOLOGY

Relay Protection Scheme :

The best relay protection algorithm is the current differential protection method. This method is very simple and has better reliability and gives quick protection and being immune from the power system disturbances, it is widely used in the transmission network. Since the large amount of information has to be transmitted for this method, the protective time will be too long when the communication network is congested. So, it is difficult to meet the requirement of the distribution protection real-time characteristics. To overcome these shortcomings that the conventional current instantaneous trip protection cannot protect the whole line, the direction current protection algorithm comes into existence. When the communication process is disturbed by some means, the direction of the downstream current received by the IED may be opposite to the actual current direction and the operation of the local protection may fail. So the main protection selects both the current differential protection and the direction current protection to improve the protection reliability. The final protection output is obtained by performing the "or" operation. The over-current protection is chosen as the conventional current trip protection when communication network faults.

Fault isolation and power restoration:

When the permanent fault occurs at the k1 of the BC section which is connected in the linear system, the IED2 opens and locks the breaker 2. At the same time, the IED2 sends the opening and locking command to the IED3 and the breaker 3 which is then opened and locked. So, the fault isolation is achieved. Since the DE section is the non-fault region, it needs to restore the power supply. The IED5 and IED7-9 will send restoration power supply command to the IED10at the power system side.

Protective Action After Fault isolation:

When thek1 in the section BC faults, the breaker 2 and breaker 3 isolates the fault section and the DE section is supplied by the power system 2. The network reconfiguration is easy. To the distribution network with more power sources and more branches, the load level, load amount, the tolerant current capacity of the feeder and the power source capacity must be considered integrally. Through interacting information between IED's, the new network structure is constructed by using the genetic algorithm. The network reconfiguration is realized.

After network reconfiguration, the relationships between the IEDs are changed. For example, when the *k1* in the section *BC* faults, before network reconfiguration, the node5 is upstream node of node7 and the node 7 is the upstream node of node 8. After network reconfiguration, the node 5 is downstream node of node 7 and node 7 is downstream node of node8. In the direction current protection, the scheme that the downstream node felt the fault current locks its upstream node protection must be modified. The modified scheme is that the node 5 locks the node 7 and the node 7 locks the node 8. So the protection resetting is realized. Even though the traditional network is converted into ring main smart distribution grid, the existence of power blackout and power outages still remains

V. PREVENTION OF POWER THEFT

If someone illegally interacts with the power line, meddle up with a line or tampers with a meter to avoid recording electricity usage. Electrical power theft can be done by altering, slowing, resetting, swapping, or disconnecting an electric meter. Theft can also occur by rewiring circuits to avoid the contacts with electric meter or by hooking the power supply from another customer's line. Computerized billing systems are used to detect and avoid the power theft

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In the existing smart distribution grid, Intelligent Electrical Device (IED) is inserted in the generating system and transmission poles. But the power theft and power demand still remains. To overcome this, the IED is inserted in each and every individual load, so that the power demand and power theft in each load can be detected and avoided. The greatest advantage of this system is that, if power demand or power theft occurs at any load, protection of the corresponding IED acts and faults gets isolated. So that the other loads of the distribution system remains unaffected.

Layout Of Smart Distribution System:

In this system of smart distribution grid, each substation and their corresponding transmission poles are connected to the individual server and all the servers are connected to the main server where all the generating systems are connected. The transmission poles in the smart distribution grid consist of circuit breaker, section switch, IED with GPS.

The main function of the circuit breaker is to detect the fault and operates automatically by receiving signal from IED's to protect the electrical circuit from being damaged caused due to over loading and short circuiting switch is closed to restore the power supply

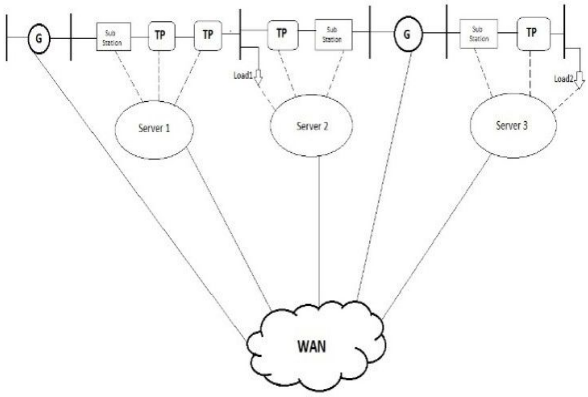

Figure3. Improved Layout Smart Distribution Grid

The function of the section switch is that it separates each power system network into number of segments which contains substation, transmission poles, loads and IED's. If any one of the power system gets failed, the non-fault region receives signals from corresponding IED's and the section.

The Intelligent Electrical Device (IED) is used at all parts of power system to ensure the continuous power flow in the grid system. The IED sends command signal in two forms. The components including substation, transmission poles and loads sends and receive signal from their own server and gets interconnect with other servers through main server where all generating stations are connected to monitor their network system. The server gets fault signal from the IED and locate the position through the GPS connected with those IED's. The fault isolated IED works automatically after delay time or it needs some manual operation to rectify those faults or replacement of the devices over the fault region, it comes back to regular continuous flow of supply through the smart distribution network.

VI. ADVANTAGES

Apart from current grid system the smart distribution grid system provides:

1. Two-way, real time communication.
2. Extensive customer interaction and digital metering.
3. Remote monitoring, predictive operation and condition-based maintenance.
4. Centralized and distributed generation with comprehensive power flow.
5. It is reliable with pro-active, real-time protection and islanding.

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6. It is self-healing ring main topology network system.

VII. CONCLUSION

The traditional distribution system with Intelligent Terminal Unit (ITU) and Intelligent Electronic device (IED-older version) does not satisfy the requirements of smart distribution grid. Thus the ring main distribution system Intelligent Electrical Device (IED-new version) is used to provide the continuity of power supply. Even though the ITU can achieve better relay protection, fault location, fault isolation, network reconfiguration, power restoration and fault diagnosis of the feeders in ring main system, power theft and power blackout occurs. This is rectified and made effective by connecting the IED's with loads and different servers to ensure the continuity of the power supply. So when the renewable sources such as solar and wind energy are integrated with this auto fault isolating smart grid network, the today's electricity demand can be met easily and the electricity can be made available to our future generation.

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