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meters of tomorrow

remote disconnect and prepayment options

ELECTRICAL DISTRIBUTION SYSTEMS have seen enormous changes since the early days of power generation. As the global population and economy grow, the gap between supply and demand for electrical energy is increasing exponentially. Depleted natural resources and increased pollution amplify the challenge faced by the engineering community. While many engineers are focused on creating environmentally friendly generators with increased efficiency, others are determined to make smarter, more efficient distribution systems.

There are a number of tools available to help drive efficiencies. Nearly every distribution company is currently implementing load management and efficient revenue collection. Additionally, prepayment metering and remote disconnect are offerings that can help metering utilities achieve their goals. Electrical energy is a widely generated energy source used in residential, commercial, and industrial activities. Electrical energy is not only a dominant energy source; demand is also growing at an average rate of 6–8% per year. The rising demand poses a significant challenge for electricity producers as they make every effort to achieve efficient transmission, distribution, and load management. Enabling utilities to develop and maintain intelligent grids is paramount as we all seek to better manage electric energy as a resource.

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A key component of an intelligent grid is an electric meter. Electric meters have evolved significantly in recent years from their historic role as basic "calculators" used to measure energy consumption to something more of a "super computer" capable of performing advanced mathematical algorithms such as power quality and time of use measurement and detection of tamper, to name a few. Meters are also being designed to house functionality that can allow the utility to remotely connect and disconnect electrical service to a premises as needed. This functionality has many applications such as load control, demand-side management, electricity theft avoidance, and prepayment metering. All of these applications make remote connect/disconnect capability a powerful tool for utilities and a primary building block of an advanced transmission and distribution system or a component of an intelligent grid.

Load Control

Smart load control helps reduce the risk of getting into a condition that may lead to a blackout. In an effort to avoid prolonged outages or operating capacity emergencies, electrical utilities seek to balance their generation to their load. Power system frequency is used temporarily as an early warning signal of an emergency condition. A utility unable to balance its generation to its load will remove sufficient load to allow correction of the outage—in other words, load shedding. In the event of a capacity deficiency, generation and transmission facilities operate at their fullest extent to promptly restore normal system frequency and voltage. If all other actions are unable to relieve the capacity emergency, the system may take immediate action, which includes manual load shedding. Unilateral adjustment of generation to normalize system frequency may jeopardize overloaded transmission facilities. Voltage reduction for load relief is made on the distribution system. Voltage reduction made on the subtransmission or transmission system may prove effective in reducing load; however, it would not be conducted on the transmission system unless the system had been isolated from other interconnected systems. If the overload on a transmission facility or abnormal voltage/reactive condition persists and equipment is endangered, the affected system or pool is able to disconnect the affected facility.

Shutdown and Restoration

If an area disturbance causes abnormal levels of frequency or voltage, making

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it unsafe to operate the generators or their support equipment in parallel with the system, it is necessary to isolate them from the system. Unit separation, or shutdown, is sometimes necessary to minimize the time required to realign and restore the system to normal operation. Customer load is normally restored as generation and transmission equipment becomes available, since load and generation must remain in balance at normal frequency during the restoration. When voltage, frequency, and phase angle allow, the system operator may resynchronize the isolated area with the surrounding area. The electrical network is systematically restored without overloading the remaining system. This phenomenon occurs—and the resulting action takes place—at system level, but customers and utilities seek to maintain a continuous balance and efficient usage of electrical energy. The system-level control is complicated and has a wider impact than localized load control, which leads to the need for a remote disconnect load. The rising prices of electrical energy, the increasing demand/supply gap, and the imbalance of load on the system also mandate load shedding.

Load Management and Electricity Theft Avoidance

There are two popular concepts that provide solutions in this area: prepayment metering and load management. Prepayment metering requires customers to pay in advance for the electricity they expect to use. The prepayment meters have the ability to disconnect and reconnect the load based on the purchase of additional "electricity units" by a customer. This system ensures advance receipt of payment and avoids any potential nonpayment issues. Not all markets accept prepayment as a viable means of load management. Due to various rules and regulations, customer profiles, and availability of electrical energy, an alternative approach was needed for load management. This led to the development of remote disconnect.

By virtue of their application point, meters are clearly the appropriate locations to place the disconnect switch. This allows for easy control of the switch position. Thanks to the rapid development of automatic meter reading (AMR) systems, a meter and AMR system can now control the operation of the switch remotely. This serves as the most convenient remote disconnect prepaid meter product.

Overview of Remote Disconnect Meters

The remote disconnect switch is typically supported on the 240-V, Class 200, Form 2S residential meter in the North American market. The switch is held mechanically inside the meter base, and the remote disconnect terminals are accessible from the rear of the meter. The overall dimension of the meter will be as per the ANSI C12.10 specification, and the switch is typically rated for 200-A RMS current and is able to handle 7-kA peak overload for six cycles (typical). The remote disconnect switch is usually a bistable relay. It consists of a magnet and electromagnet arranged so that the permanent magnets help the contact remain in the two stable states. The electromagnet produces a counter magnetic field to toggle the switch position when electrically excited. Controlled by the meter hardware and firmware, the switch allows for remote connect and disconnect based on various events, such as exceeding the contracted demand and move-in and move-out events. For example, during summer vacations the utility disconnects the load of a school hostel and reconnects when the school reopens.

As utilities look to improve efficiency and customer service, many are using or considering the use of AMR to remotely connect and disconnect customers. A study published by Chartwell Inc. (New Chartwell Report) states that today 3% of utilities use AMR, 18% plan to use it, and 34% are considering the use of the remote disconnect feature. The research is based on Chartwell's 2004 AMR survey of 119 utilities. Rising conventional fuel costs, tougher environmental regulations, and increased demand require more efficient management of the electrical distribution systems. Remote disconnect is going to play a key role in improving the revenue collection and profitability of electrical distribution systems, and it could allow customers to be more responsive to energy conservation requirements.

Remote connection/disconnection can help utilities increase revenue assurance efficiency for delinquent accounts and enhance customer service capabilities for rental and seasonally occupied locations.

Applications of Remote Disconnect Meters

Compared to a manual disconnect, a meter that is able to operate a disconnect switch, on-site or remotely, could serve the following purposes with better efficiency and ease of use and at a much lower cost. Applications include the following:

- ✔ **Load Control:** An intelligent meter and disconnect switch combination could connect or disconnect a load, based on the absolute kW demand measured by the meter. If the load exceeds demand by a preprogrammed threshold, then the meter can activate the switch to disconnect the load. With the development of intelligent two-way AMR systems, it is possible for a utility to monitor and control every individual load connection and removal remotely.
- ✔ **Demand-Side Management:** Demand-side management covers actions taken by the electricity user, on the load side of the meter, to reduce energy consumption. This process helps reduce overall energy consumption, thus delaying the need for new generation, transmission, and distribution facilities. The load management process also helps to balance out peaks. An intelligent meter allows the demand threshold to be programmed (exceeding it could disconnect the load) and restores the connection after a specified interval or following a reported disconnect to the utility. With advanced AMR systems, a remote activation is also possible.
- ✔ **Move Ins and Move Outs:** Meters with remote disconnect and AMR networking can make move-in and move-out events simple and easy to manage. Using the AMR network, the meter controls the switch operation and exchanges the switch status information with the utility. A two-way AMR network and smart meter could activate the switch remotely, which would then transfer the status information after the activation or deactivation of the switch. With the switch control feasible over an AMR network, it is possible to extend or reduce the duration of service without difficulty.
- ✔ **Distributed Generation:** Distributed generation (DG) is the use of small electrical power generation equipment located close to the load. Many consumers use local generation to expand their energy options, lower energy cost, reduce emissions, and add redundancy. Local generation can also power critical processes or emergency systems. For example, hospitals use backup generation systems to maintain a power supply to life-saving equipment. Some industries have byproducts that enable them to generate electricity, helping them perform waste management and thereby reducing their overall electricity bill. DG creates a challenge in interfacing the local generator on the utility distribution system. Typical smaller applications require both systems to operate in isolation yet use the same distribution system. A remote disconnect solution plays the role of a switch in such circumstances. A small DG at an office, for instance, could maintain the critical load during a power outage by activating the remote disconnect switch. As the meter can monitor the load-side voltage on the switch, it could avoid a switch reconnect in the case of a local generator operating on the load side. The AMR could then communicate with the unchanged switch status, providing a warning to the utility. An intelligent meter AMR system could bring this intelligence to the remote disconnect operations, thus avoiding potential errors and reducing inconvenience and risk to the end user.
- ✔ **Other:** Availability of remote disconnect helps manage potential nonpayments or delayed payments by introducing prepay or pay-as-you-use conditions.

Conclusions

With the increases in demand for meters with advanced features and tools for smart energy management, it is apparent that the meters of today and tomorrow will not simply be looked to for basic metering but will be at the heart of a comprehensive transmission and distribution portfolio that enables intelligent grid processes such as remote connect/disconnect. These features help utilities better manage assets and resources by converting data into knowledge that decision-makers use to drive improved reliability and productivity.