What Is an Advanced Meter?

The technology behind demand-side response.

By Sharon Allan

Across the country, policy-makers are working with both federal and state legislators and regulators to define policies and laws that will impact how utilities do business in the coming years. One policy receiving much attention right now may require electric utilities to offer voluntary demand-response programs to their customers. Demand-response programs allow customers to voluntarily adjust their daily energy usage in a manner that is acceptable with their needs. Many utilities have already implemented demand-response programs and it is the success of these programs that is driving regulators and policy makers to make it standard practice on a national basis.

Before demand-response policies become laws and regulations, it might be wise to stop and take a look at what the policy makers and their lobbyists consider to be advanced or smart metering technology. If the national energy policy requires all utilities to offer demand-response programs to their customers in the future, then utilities do not want to be tied down to a particular metering technology to accomplish that goal.

Some of the ongoing discussion today in regards to defining demand-response program policy is centered on the technology that will enable utilities to create and implement demand-response programs. As expected, metering technology is at the center of these discussions and hence the terms "advanced meter" and "smart meter" were born to name the technology.

This article looks at the terminology used in state and federal policy planning documents to describe advanced or smart metering. Typically terms like solid- state, load profile, interval data, and communications are used to describe the meter technology needed to implement a demand-response program. Yet it is uncertain that these terms are understood by all, are being used consistently, or that the technology represented is the best technology available for demand-response programs.

Solid-State Meters: Your Grandfather's Technology

For many decades the electromechanical meter has been the ideal meter for use on residential accounts. Single-phase residential electromechanical meters are low cost, accurate, and have a long life. Even though communication modules can be installed on electromechanical meters, their functionality is limited to measuring kilowatt-hours. This limited functionality makes them unsuitable for demand-response programs.

Advancements in solid-state technology have enabled meter manufacturers to develop electronic meters that can perform many other functions in addition to measuring energy consumption. But to qualify as an advanced meter or smart meter, the solid-state meter must have additional functionality that makes it suitable for demand-response programs. At a minimum, a smart meter should be capable of measuring, recording, storing and reporting usage according to predetermined time criteria. The measurement, calculation, and storage of energy consumption over time should be done in the meter. This ensures there is an audit trail because the energy usage stored in the meter and reported through an automated meter reading system is used to bill the consumer.

While it is self-evident that an advanced meter should be capable of communicating, communications alone does not make a meter an advanced meter. Automated meter reading (AMR) systems that can communicate with meters and collect energy consumption data have been available for years. For many electric utilities, the motivation to implement an AMR system has been to streamline the metering reading process and lower operating costs. Using this criteria to build the business case for implementing an AMR system, many AMR solutions were chosen based on the benefits they delivered to the electric utility. Allowing customers to participate with the utility to manage their load usage was not an issue.

Shortcomings of One-Way Communication

Much of the communications technology used for AMR systems today is one-way. These one-way systems typically consist of meters with communication modules installed. The meter reader walks by or drives by the meter and, using a handheld device, reads monthly energy consumption and in some instances demand.

If the meter is capable of collecting interval data, time-of-use (TOU) data can be calculated and presented to the consumer on a monthly basis, but there is a downside to collecting interval data in this manner. There is no audit trail to the consumer if interval data is converted to TOU data. TOU data directly from the meter provides an audit trail for the consumer to view their usage and compare with their bill. Furthermore, interval data collected on a monthly basis is no longer real-time data. It can provide a history of how energy was used in the past, but it does not provide the real-time data needed by both the utility and the energy consumer to participate in demand-response programs where energy prices can change frequently. This shortcoming of one-way communication is one reason why it is not suited for demand-response programs. It is not cost effective to make daily or hourly meter reads and a site visit is required to program the meter. The logistics and cost of frequent site visits to reprogram the meter for dynamically changing TOU rates would be prohibitive.

Intelligent Two-Way Communications

Some AMR systems on the market today have state-of-the-art two-way communications that make them well suited for demand-response programs. These systems are affordable, scalable, and robust.

One two-way communication system available today uses standard wide area network (WAN) communications such as landline or cellular telephone to communicate with area data collectors. The data collectors manage a local area network (LAN) of meters that use unlicensed 900 MHz radio frequency (RF) technology. The 900 MHz communications technology provides full two-way communication to every end-point meter.

The system is robust because all meters on the 900 MHz LAN can function as repeaters. This greatly expands the coverage area of the communication network around a data collector and lessens system capital cost, lowers maintenance, and reduces communication expenses. Additionally, this two-way communication network is self-healing. If local RF conditions change and a meter can no longer communicate with its data collector, the meter automatically registers itself on the network through an alternate path or through another data collector. Since this system uses two-way spread spectrum frequency hopping technology, meters are self-registering. Network expansion is reduced to the simple task of installing a meter. The installed meter automatically registers with the area data collector.

This level of performance from a two-way communication system should be good news to utility companies that have already implemented a demand-response program or are in the planning stages. Federal legislation on demand-response programs dictates that utilities need to offer their customers only the option of enrolling in a demand response program. Participation is not mandatory for all consumers. With this technology, utilities have a lot of flexibility in how they plan and implement their demand-response programs.

Are Interval Meters the Only Choice?

Historically, interval data has been the chosen method for collecting daily load usage data. Interval data recording has been used on large commercial and industrial utility accounts and at delivery point substations to provide daily usage of kilowatts, kilovolt-amperes reactive, kilovolt-amperes and power factor (PF). Until today, utilities had no other choice but to use similar data recording devices to collect interval data from residential accounts with the objective of providing hourly load-use profiles for both the energy consumer and energy provider. In addition to providing load profile data, interval data has been used to compute total energy consumption, maximum demand, TOU energy, and to implement dynamic or critical-tier pricing (CTP).

Are interval meters the only technology to use for resi- »

dential demand-response programs? Some in the industry say no for several reasons. One problem with using interval meters for demand-response is cost. The cost of populating residential areas with interval meters equipped with communication modules could be prohibitive to many utilities. Interval meters collect pulse data and that data needs to be converted into energy usage and billing data that can be understood by the consumer and the utility. A better practice is to collect interval data and store it in the meter as measured energy usage rather than collecting pulse data in an optional meter module. This practice eliminates the chance of losing interval pulse data. Regardless of the method selected, there is additional cost to the utility to convert pulse data into data that is useable by both the utility and the consumer.

In addition to the extra time and expense needed to calculate usage data from interval data, interval data can become corrupt if there is an interruption in the data transmission stream. If interval data is lost or corrupted, additional manipulation of the interval data is required to validate it and there is no way for the consumer to know if their bill accurately reflects their actual energy usage. Calculating load profile data in the meter eliminates this risk and enables consumers to verify their energy bill at the meter. The calculated data a consumer can read on their meter is what appears on their bill.

It should be clear that using interval data for demand-response programs could potentially become an expansive and burdensome task. Fortunately, there are other solutions available that eliminate the need to collect interval data to compute TOU and billing data.

Advanced Metering Technology

New meter technology on the market today provides a better solution for residential demand-response programs. These single-phase solid-state meters can measure, calculate and store data within the meter. They are capable of calculating daily load usage, demand, TOU, and critical-tier usage data. This data is available to both the consumer and service provider locally at the meter via the meter display. The data can also be transmitted to remote metering automation or collection systems. Even though these meters store and transmit billing data, they can also record interval data for load studies, but interval data is not needed for the acquisition of daily energy usage and complex forms of billing data.

These meters give utilities choices in how they set up their demand-response programs. Meters can be programmed to operate as:

- TOU meters with blocks of time;
- Meters that measure time-differentiated usage;
- Load profile meters; and
- Meters with dynamic TOU that have defined blocks of time that can be changed daily.

Additional functionality includes:

- Scheduled and on-request remote meter reading services for billing or other data needs;
- Advanced energy measurement options, including energy in (delivered); energy out (received), sum, and net metering;
- Implementation of consumption, demand, TOU and critical-tier pricing rates, with no on-site visits for reprogramming or meter change-outs required;
- Load profiling of selected meter locations;
- Tamper indications and alarms;
- Remote connect and disconnect in the meter; and
- Demand limiting in the meter.

Meters with this advanced metering or smart metering technology can be deployed on metering automation systems that are available today. These systems are designed to meet the needs of utilities in both regulated and deregulated markets and are suitable for either large-scale deployments or targeted applications. F

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