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October 16, 2015

Abigail Daken
US Environmental Protection Agency
Climate Protection Partnerships Division
Washington, DC 20460

Subject: Draft ENERGY STAR® Connected Thermostats Specification – V 1.0 – Grid Responsiveness Criteria

Dear Ms. Daken:

Comverge is pleased to provide this material in response to the US Environmental Protection Agency request for comments on the draft Grid Responsiveness Criteria for the Connected Thermostats (CT) Specification – V.1.0 as presented in your communication of September 21, 2015.

Comverge is an industry-leading provider of integrated demand response, energy efficiency, and customer engagement solutions that enable electric utilities to ensure grid reliability, lower energy costs, meet regulatory demands, and enhance the customer experience.

Through its combination of software, hardware, and services, Comverge helps utilities optimize the management of every aspect of an energy management program, from participant recruitment and device installation to call center support, control events, and measurement and verification. Comverge has worked with hundreds of electric utilities to deploy nearly six million energy management devices and enroll more than 1.8 million residential customers into mass-market demand management programs. Most importantly, Comverge is unique in the industry in providing residential demand response on a pay-for-performance basis where we are paid only if we deliver load reduction when needed. This experience gives us a unique perspective on the drivers of value from a demand response resource.

At a top level, many elements of these criteria are challenged as they more appropriate as system level specifications rather than requirements for an end-use control device. This is especially true of a two-way connected device that can be remotely reconfigured. For example, the number of events in a day and the allowance or disallowance of local override are clearly system level decisions and should not be mandated by an endpoint device. Capabilities and functionality that depend on server systems are at odds with the goal of portability of the device between service providers.

Comverge believes that the creation of the ENERGY STAR specification and implementation of the certification program for the Connected Thermostats can significantly enhance the deployment of the thermostats that will improve energy efficiency and enable greater participation and performance of demand response programs. The efforts of the US Environmental Protection Agency to include Connected Thermostats in its ENERGY STAR portfolio is commended and applauded by Comverge.

Sincerely,

Wendell Miyaji

Wendell Miyaji, PhD
Vice President, Energy Sciences
Comverge, Inc.

Definitions

We suggest you consider adoption of the Federal Energy Regulatory Commission definition of *Demand Response*:

> Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.[1]

This definition recognizes that demand response can change electric usage in either direction depending on the price of electricity. Increasingly, and in particular in price responsive scenarios with greater intermittent and renewal electrical resources, there are many opportunities where the ability to "take" load as well as "shed" load constitute valuable demand response benefits to the "Grid". The recognition of price responsive demand response in Section 3B5d can enable price responsive thermostats to potentially provide ancillary services, including ramping and regulation as well as the more common capacity service.

Based on this definition for Demand Response, the first clause provides a definition for *Price Response*:

> Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time.

The definition for Load Management Entity appears to us to be awkward in that it mixes the program administrative entities (utility or third party), and a system (a home energy management system (HEMS)). We see that from this document these entities are the recipients of data from the ENERGY STAR CT. Perhaps a better approach would be to define a Demand Response Management System (DRMS) as the system operated by a program administrator, such as the utility or third party, with functions such as sending messages with demand response instructions or price signals to the ENERGY STAR CTs and receiving messages such as the CT Signaling (as defined in Table 3-1). The Load Management Entity would then be either the DRMS or the HEMS. The information would still be required by the DRMS, and the presence of an HEMS would alternately be the device that provides data to the DRMS.

We would suggest the term "Program Administrator" for the collection of entities that may have responsibility for developing and operating Demand Response (DR) programs. This follows the approach adopted by the North American Energy Standards Board for DR Measurement & Verification Model Business Practices.[2] Besides classic utilities and third-party Demand Response Service Providers, some of the other organizations that may fit within the class include the Independent System Operators (ISOs), Regional Transmission Organizations (RTOs), and other organizations providing portions of the classic utility functions, such as Retail Energy Providers, Load Serving Entities, and Generation & Transmission providers. Currently, many ISOs and RTOs competitively procure DR services from multiple providers.

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[1] Federal Energy Regulatory Commission, http://www.ferc.gov/industries/electric/indus-act/demand-response/dem-res-adv-metering.asp

[2] North American Energy Standards Board, Measurement & Verification (M&V) of Demand Response Programs, REQ13, Version 2.1, August 30, 2013.

Open Access

We believe that the objectives of prescribing open standards and open access to allow consumers to migrate the ENERGY STAR CT from one Demand Response Service Provider to another, particularly in the case where one provider discontinues service, enhances the value of the CT to the consumer. This capability can insure that the consumer participates in the program that provides them the optimal set of benefits. Besides an open protocol, the certification requirements should insure that information that is needed, such as access or replacement of encryption keys and other private data, can be handled in a secure manner.

There are certainly significant consumer privacy issues and operational security issues that will need to be verified under an open protocol environment to insure that the consumer is protected and that demand response cannot be initiated or terminated by bad actors.

DR Capabilities

We appreciate the efforts by the US EPA to define standard DR capabilities, Type 1 and Type 2. This approach conceptually fits well with the industry trends in residential Demand Response to develop a "Bring Your Own Device" capability whereby a consumer could potentially participate in a Demand Response program with their own purchased CT rather than one selected and installed by the Demand Response Program Administrator. However, this limited set of two capabilities does not cover the complete set of capabilities to participate fully in the existing Demand Response markets.

The CT should support both Type 1 and Type 2 capabilities. The requirement could be as simple as an approved CT must respond to an event notification either immediately or on a scheduled basis any time within the next 24 hours. In any case, the CT should support immediate release from the Demand Response control upon receipt of a message. The CT should also incorporate a cold load pickup control that would randomize resumption of HVAC operation after a power outage to mitigate power surges after such an outage. The specification should emphasize that additional capabilities will be implemented by the CT provider and that the capabilities and protocols should be disclosed.

Length of Demand Response events, the number of possible events per any time period, cycle rates, degree of temperature offsets, and other parameters that might be varied should be left to the Demand Response Program Administrator to set based on the agreements with the participants. These should not be parameters that are hard code limited by the CT. The requirements that limit the response to signals per rolling 24 hours or per hours should be struck.

Similarly, the definition of an opt-out should be parameterized and left to the design of the Demand Response Program Administrator. The opt-out model may reflect the DR reliability required by the Program Administrator. The choice of customer terms, such as compensation, may be adapted to support different DR event parameters, such as event length, cycling rates, temperature offsets, and opt-out limitations.

Relative to these two types, we offer below some discussion on the benefits and issues with these proposed DR capabilities.

Type 1 – Temperature Offset

This Type 1 approach adopts an easy-to-understand and communicate approach for consumers since they are made aware of how they will be impacted by DR events and there is a clear limit to the extent of any discomfort. In the case where the duration of the DR event is short, the effect on individual customers tends to be identical to Type 2. Upon the start of the DR event, all of the CTs will discontinue calling for cooling or heating. With rare exceptions, the temperature rise or fall in the premises as measured at the CT will not reach the limit states in ten minutes.

Over the course of the DR events, the thermostats will reach their offset temperatures and return to normal operations. There will be some, but minimal, reduction in energy use, as the HVAC system requirements will be lower at the increased premises temperature, in the case of cooling, and decreased premises temperature, in the case of heating. However, gradually there will be a significant decrease in DR performance.

In most cases, the procurers of DR services, such as the ISOs, RTOs or utilities, desire a flat response performance. DR providers that cannot maintain a committed response throughout the event period would not be viewed favorably as the reduction in the fourth hour may be just as necessary and valuable as in the first hour and evaluated equally. If there is no reduction in the later hours, the DR system would receive no capacity value. Even worse, any energy snapback that occurs as a result of a device that releases early would be significantly penalized by the DR procurer.

This methodology is also subject to gaming by programming a thermostat at a much lower temperature in advance of an expected event. That said, very clever algorithms could potentially defeat these customer strategies.

Some of these issues have been mitigated by implementing the temperature offset in a step wise fashion (*i.e.*, one degree offset in the first hour, two degree offset in the second hour, etc.). It may be preferable to allow for multiple offset levels rather than one of just 4 degrees, and to allow offsets in either direction for both heating and cooling.

Type 2 – Immediate Shed

As noted, the simple 10-minute immediate shed has no significant difference in customer impact or DR performance compared to a 10-minute temperature offset of 4 degrees. The value to the system would come from cycling repeatedly over a significant period of time.

Most residential DR programs operate to reduce the peak demand. To provide meaningful value to the consumers in a particular zone, this generally means curtailing tens of hours per summer rather than infrequently for ten minute periods. Since capacity is generally evaluated in one-hour intervals, deferral of energy use from one 10-minute period to the next provides limited value. As the difference in energy demand between highest and twentieth highest hours narrows considerably and load in adjacent hours in a day becomes very close, the value comes from reductions lasting several hours for a number of days.

While there are other grid services in which DR can participate, such as regulation and synchronized reserve, the potential value is much smaller. In part, this is due to the fact that residential HVAC use varies considerably over the 8760 hours per year and the value in these services is not necessarily coincident with high HVAC use.

There are some DR programs in which 50% of the participants opt to allow 100% curtailment for four hours. The other 50% of the participants choose 50% curtailment. In those programs, the curtailment percentage is the reduction in energy consumption by the HVAC equipment compared to the hour prior to the start of the DR event. As a result, the off time of the equipment may be considerably more than 30 minutes out of each hour for some participants.

There is often significant activity and investment in order to integrate the ENERGY STAR CTs into a DR program. Generally, a program administrator needs customer approval for enrollment. Often a program administrator provides a customer incentive for participation. Operational systems and processes need to be deployed. The program administrator stands up measurement & verification (M&V) protocol and systems to assess the delivered demand response. The costs of all of these elements generally exceed the value of limited 10-minute curtailments by themselves.

CT Signaling Requirements

This section appears to be motivated to provide an M&V capability based on data provided by the ENERGY STAR CT. Normally, the Program Administrator would have their own *ex ante* estimate of DR that the system can be expected to provide. In the case of something that is HVAC based, this estimate would be based on prior performance, time of day, calendar and weather. The acknowledgements would be valuable to scale this *ex ante* performance estimate to the current performance period. The signal timing should depend on from where it comes. Is it the intent that each individual CT would communicate directly back to the DRMS or does this data flow through the CT service provider's system? In the latter case, the <10-minute response time is probably optimistic as a goal. In any case, there doesn't seem to be a reason why the response time is different for each DR capability type. If the signal is from the CT on the customer premises, then the <10-minute response time should be the requirement. If the signal is from the CT service provider's system, then <1-minute response time is more reasonable. End devices should continue to attempt communications until they get a confirmation of receipt from the DRMS.

DR Program Administrators should be provided information on the locations and capabilities of all customer participants *ex ante*. This information is critical to system operators to understand response of the CTs.

The later set of messages can help provide an *ex post* estimate of the DR performance. There are three typically used performance evaluation methods for assessing delivery when measurements are available for all end points. These performance evaluation methods[3] are:

[3] These are the defined terms from the NAESB Model Business Practices. In some jurisdictions other nomenclature is used for the same performance evaluation methods.

(1) *Maximum Base Load* – A performance evaluation methodology based solely on a Demand Resource's ability to maintain its electricity usage at or below a specified level during a DR event.
(2) *Meter Before, Meter After* – A performance evaluation methodology whereby electricity demand over a prescribed period of time prior to deployment is compared to similar readings during the Sustained Response Period.
(3) *Baseline* – A method of estimating the electricity that would have been consumed by a Retail Customer or Demand Resource in the absence of a DR event.

HVAC runtime during the response period can help with an assessment under the Maximum Base Load performance methodology. Typically, assessments are performed on an hour-by-hour basis. For comparison with service meter results, it would be preferable to collect data on a clock-hour-basis even if the response period did not start precisely at the top of an hour. Even better would be to collect and report runtime data in small intervals such as 5-minute intervals, which provide an even better picture of the DR performance of the CT.

HVAC runtime preceding and during the response period can help confirm performance under the Meter Before, Meter After performance evaluation methodology. This performance methodology however is seldom applicable to residential HVAC DR.

Baseline performance evaluation methodology generally used the load profiles from prior days to the event day. For instance, a common approach is to take the four highest energy use days out of the previous five days that are similar to the DR days. On an hour-by-hour basis, the load on the four days is averaged to obtain a baseline. The difference between the energy use during the performance hours between baseline and the event day profile define the DR reduction performance. To be able to apply this methodology, hourly runtime for several days prior to event day would be required. Worth noting is that other algorithms specify as many as 10 days of data to form a baseline and, for a weekday baseline, weekends, holidays, and prior event days are generally ineligible.

For HVAC DR, *snapback* (also referred to as "*payback*") is an issue of frequent concern. Snapback refers to the increase in energy use after the end of the performance period due to the unsatisfied HVAC demand created during the DR performance period. The runtime after the performance period helps to assess the snapback. To do this assessment well, one would also need baseline type information like that discussed in the previous paragraph as the energy use varies by hour of day.

What is missing in all of this analysis is the ability to convert from runtime to energy consumed. However, this factor is unobservable unless there is electrical meter data to correlate with use, nameplate information from the HVAC system, or direct measurements of the HVAC system. In the absence of such data (which is costly to acquire), we agree that it is valuable to aggregate data available from the ENERGY STAR CT to improve DR performance evaluation. The ideal requirement would be that the CT provide a net reduction in each hour of the event period.

Overrides

The draft specification states that consumers can override the CT's response to a DR signal. It is currently not stated where this override can be initiated – by using the CT or through some other channel. Comverge would caution that easily initiated overrides can significantly cause an increase in the use of this function and limit the value of the DR asset. We have seen the use of overrides increase over 30% when the function could be initiated by simply pushing a button on a communicating thermostat. As it is critical that the DR capability be reliable, we would suggest that it be impermissible to initiate an override at the CT. Programs will often limit a customer's ability to override by denying the incentive if overrides exceed a certain level. Also they will limit the number of overrides by requiring a different channel to request an override (*e.g.,* calling a customer service representative or going to the program website). Participants that would use the override function regularly would be better served by opting out of the program altogether.

The CT should be remotely configurable to either allow for local overrides or not. Whether or not to allow for opt outs should strictly be a program design consideration and not an end device requirement one way or the other.

Price Response

Comverge has been involved in Price Responsive DR programs for many years. In the Comverge programs, there are typically three price tiers. Customers define a base schedule and then a temperature to implement at each price level. There is often also a critical price tier that is implemented in emergencies or very high market price periods for which the customer has also defined another temperature. There may be additional DR devices that respond to price, such as water heater switches and pool pump switches.

Comverge suggests that such a model be considered for implementation of Price Responsive DR in the ENERGY STAR CTs whereby the customer can specify a temperature setting/price relationship for the HVAC system for both heating and cooling.

The CT system should focus on communications of price information and schedules via the CT. Certainly the DR Program Administrator should have the ability to implement other communications mechanisms through other channels. However, these capabilities should be considered outside of the scope of this set of this discussion, since their implementation would not be portable if the CT is separated from the server system.