Demand Response-Ready End-Use Technologies

Overcoming Barriers to Customer Adoption of DR-Ready Devices

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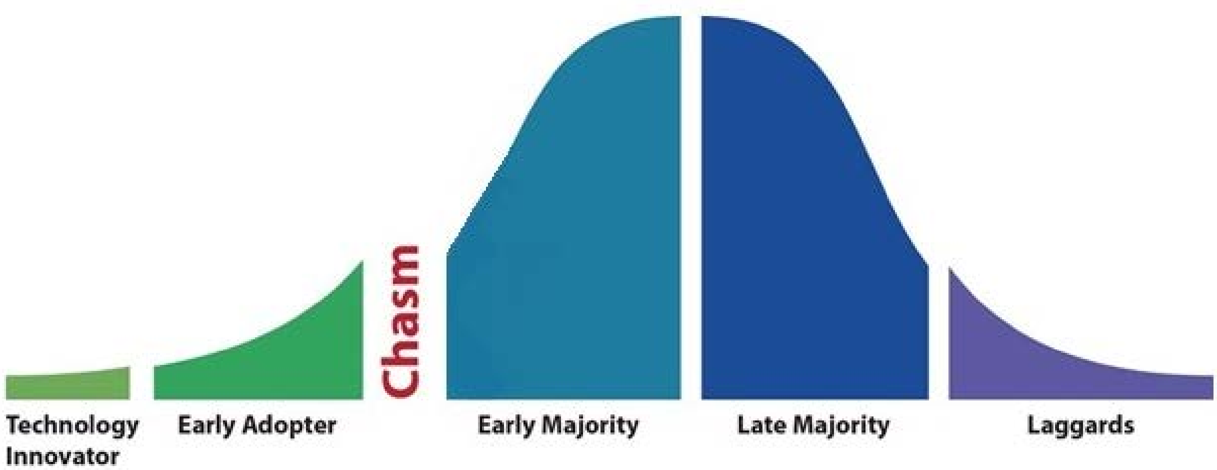

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Technical Update, September 2015

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ABSTRACT

This report describes a methodology for enhancing customer perception of value in order to encourage adoption of connected devices that can be leveraged in demand response (DR) programs. Methodologies that can clearly identify technology and program adoption rationales based on key purchase reasons of customers are critical for generating customer pull for DR-Ready devices. Customer pull for the technologies can in turn support more automated, sophisticated, and ubiquitous demand response.

The report begins by clarifying the meaning of the term "Demand Response–Ready (DR-Ready)" technology and illustrates the DR-Ready concept through examples of industry activities to further connected devices and their utility to the electric power industry. In the DR-Ready vision, consumers receive DR-Ready end-use products at the point of purchase, thus eliminating the need for utility truck service visits to retrofit equipment and thereby significantly reducing the cost of deploying DR-enabling technologies.

The objectives of the project are twofold: 1) develop a methodology for identifying the customer rationale for adoption of connected devices and leveraging them to participate in DR programs; and 2) refine the functional criteria for DR-Ready end-use devices to support grid needs. The report summarizes findings from research conducted under the direction of an industry advisory committee consisting of fourteen representatives across eleven organizations operating in the electric power industry. Through advisory committee meetings, webcasts, workshops, and working group exercises, the project gathered perspectives from a broad base of stakeholders, including utilities, end-use equipment manufacturers, vendors, and researchers.

Utilities, equipment manufacturers, government agencies, and other DR stakeholders can review findings of this report to understand additional perspectives on rationale for customer adoption of DR-Ready devices and programs associated with them. Application of the working group exercise is designed to engage the reader to adopt a customer mindset, with the aim of identifying viable methods of driving customer adoption of DR-Ready devices and programs. By applying the methods outlined in this report, technology vendors and utilities can support enablement of mass market DR through connected devices with built-in capabilities aligned with value perceived by end-use customers.

Keywords

Connected devices
Customer adoption
Customer lifestyle needs
Customer value perception
Demand response modes of operation
Demand Response–Ready (DR-Ready) technologies
Functional capabilities

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Objectives

This report addresses barriers to adoption of Demand Response-Ready (DR-Ready) devices and programs by mass market customers, and proposes methods to overcoming identified barriers. The report summarizes findings from research conducted in 2014 under the direction of an electricity industry advisory committee consisting of over a dozen representatives across eleven organizations operating in the electric power industry. Barriers addressed were identified by the committee as the top three for focus in 2014. These barriers were:

1. Insufficiency of consumer value perception to create customer pull in adopting DR-Ready devices
2. Need for standardized demand response (DR) modes of operation built-into DR-Ready devices and better understanding of kW adjustments would get in each mode
3. Need for understanding DR potential of end-use devices

Consequently, the three project objectives are:

1. Develop a methodology for identifying customer rationale towards adoption of connected devices and application in DR programs;
2. Frame an approach for refining functional criteria for DR-Ready end-use devices to support grid needs;
3. Develop a model for estimating DR potential by end-use category

The project's underlying objective is to provide a basis for future standards development of connected end-use devices. Through advisory committee meetings, webcasts, workshops, and working group exercises, the project gathered perspectives from a broad base of stakeholders, including utilities, end-use equipment manufacturers, vendors, and researchers. This report outlines a methodology for enhancing customer perception of value in order to encourage customer adoption of connected devices and their use in Demand Response (DR) programs. Moreover, an approach to framing DR functional specifications is proposed, along with a method for evaluating DR potential.

Terminology

Demand response is a dynamic change in electricity consumption coordinated with system or market needs [1]. To contribute substantially to providing DR, end-use devices need to be equipped with "intelligence", such as connective and functional capabilities supportive of the physical and/or economic operation of the electric power grid or markets. Intelligence integrated into end-use devices enables mass deployment of demand response ready (DR-Ready) capabilities. Table 1-1 provides a list of examples of industry activities to further connected device capability specifications.

The project advisory committee commenced activities with a discussion to clarify the intended meaning of the term "Demand Response–Ready (DR-Ready)" technology. The key aspects of DR-Ready devices are identified below by committee consensus:

1. Mass market product (for residential and/or small commercial customers)
2. Consumer procurable (through existing retail channels)
3. Connectable device with DR functionality built-in (DR modes, ability to respond to DR signals)

The DR-Ready concept refers to mass market products manufactured with built-in capabilities. The basic capabilities assumed are i) the products are connectable, ii) they have pre-defined modes of DR operation built-in, and iii) they have the ability to automatically receive and respond to a DR signal. That is, the products have the ability to receive and respond to grid or market conditions, by modulating their electricity consumption in support of physical or economic needs of the power or market system.

In the DR-Ready vision, consumers receive DR-Ready end-use products at the point of purchase; that is, through normal consumer retail channels and/or through a professional installer. Enabling mass market customers to directly procure DR-Ready products eliminates the need for utility truck rolls to retrofit equipment, by leveraging the extensive distribution channels of products already in place to deploy DR capabilities. Realization of this vision offers the potential to significantly reduce the cost of deploying DR-enabling technologies and enable other valuable programs to be offered to customers that would have previously not made economic sense.

In short, DR-Ready devices are connective mass market products with built-in capabilities to receive and respond automatically to a DR signal, and that consumers can procure through normal retail sales channels. The first column of Table 1-1 lists examples of distinct categories of DR-Ready devices.

Advancing "Connected" Device Specifications

ENERGYSTAR "Connected" Criteria Development

ENERGYSTAR® is a U.S. government-backed voluntary labeling program that recognizes products that attain higher levels of energy efficiency. The ENERGYSTAR label helps consumers identify products that save energy, money and protect the environment, while offering features and functionality of value to them. As part of ongoing efforts to update ENERGYSTAR specifications, the Environmental Protection Agency (EPA) is engaged with stakeholders on a product-by-product basis to develop a basic set of features for "Connected" capabilities [2]-[8].

Once connected, a product would be able to adjust its electricity consumption by either increasing or decreasing demand on the grid in coordination with power system or market needs. Moreover, connected products would ensure consumers have the final control of their comfort and convenience by supporting an override option for consumers to designate their choice of opting out of demand response events when they do not wish to participate.

EPA's strategy also supports use of open standards, which helps to ensure connected products are compatible with various application needs including smart grid, energy management, and others. EPA plans to recognize product models with connected functionality by listing the products on the ENERGY STAR consumer website. In conjunction, the U.S. Department of Energy (DOE) is developing and validating test methods for verifying a “Connected” device’s demand response functionality.

Table 1-1
ENERGYSTAR Timeline for Addressing "Connected" Criteria

END-USE CATEGORY	DRAFT VERSION (as of June 2015)	EFFECTIVE DATE
Refrigerators, Freezers	Version 5.0 (Final)	September 15, 2014
Clothes Dryers	Version 1.0 (Final)	January 1, 2015
Clothes Washers	Version 7.0 (Final)	March 7, 2015
Pool Pumps	Version 1.1 (Final)	March 30, 2015
Room Air Conditioners	Version 4.0 (Final)	October 26, 2015
Dishwashers	Version 6.0 (Final)	January 29, 2016
Connected Thermostats	Version 1.0, Draft 1	TBD

“Connected” attributes are considered enablers of grid and societal benefits, which can be reached by spurring product and service innovations incorporating communication and DR capabilities. Table 1-1 provides a timeline summarizing end-use categories for which some type of “Connected” feature set is under consideration. Specification development status and expected completion date are also noted, as of the time of report publication.

As indicated in the table, “Connected” criteria have first been completed for refrigerators, and are in process for the other end-use categories listed. A prior EPRI report [16] provides a summary of functional requirements for select end-use product categories and differing perspectives on proposed criteria. The “Connected” specification effort was expanded to pool pumps in 2014, the first end-use category for which additional demand response functionality was explored in support of emerging grid needs (e.g., coordinated increase of electricity demand during DR events). Such capability goes beyond peak load reduction and schedulable load shifting, which other “Connected” product specifications address.

“Connected” Criteria for Pool Pumps

In 2014, EPA released first and second draft versions of “Connected” criteria for pool pumps, outlining proposed approaches for facilitating the deployment of demand response capabilities in this product category. EPRI initiated a process for collecting comments on EPA’s first draft version by bringing the draft to the attention of its membership and project advisory committee, and collecting response through interactive discussions over conference call. EPRI’s compiled comments are captured in Appendix B. In coordination with the Consortium of Energy Efficiency (CEE), the comments were submitted to EPA.

The Connected pool pump specification was subsequently finalized during the spring of 2015. DR functionality found in the specification is summarized below for single, multi-speed, and variable speed pool pumps [2].

- **DR Signal Response**: Capability to receive, interpret, and act upon consumer-authorized signals in a safe manner
- **Consumer Override**: Consumer ability to override, disable, or modify settings at any time including during peak periods and during execution of any DR mode of operation.
- **Demand Response Modes**: Capability to provide the following types of responses in support of DR.
  - ***Type 1 Response***: Capability to respond within 5 minutes of signal receipt by terminating pumping during at least two-thirds of the requested response duration period (for single-speed pumps), limiting pumping to the lowest available speed (for multi-speed pumps), or limiting pumping to within a third of full-motor speed (for variable-speed pumps), for at least a 4-hour duration, and with frequency of at least once every rolling 12-hour period.
  - ***Type 2 Response***: Capability to terminate pumping within 5 minutes of signal receipt for at least a 20-minute duration, and with frequency of at least three occurrences per rolling 24 hour period.
  - ***Type 3 Response***: Capability to initiate pumping, increase motor speed, or extend pumping duration within 5 minutes of signal receipt, for a response period not to exceed the programmed daily pump volume or duration, and with a frequency not to exceed more than one occurrence before the start (12 a.m.) of the following day.

EPRI Comments on Demand Response Criteria for Pool Pumps

The key DR capabilities outlined above have emerged out of EPA's process for developing ENERGYSTAR "Connected" pool pump criteria, based on a series of comments submitted by stakeholders and their respective trade associations. A few issues that were identified by EPRI during the process of facilitation and compilation of comments from EPRI members were resolved in EPA's second draft of proposed criteria released in August 2014. Key issues identified that were addressed in Draft 2 include:

- Including response time (i.e., latency of switching operation upon signal receipt) as part of the response requirement for "Connected" pool pumps
- Specifying relative levels of response (i.e., motor speed) vs. absolute level of demand reduction (e.g., having motor speed adjustment in lieu of demand reduction in the response requirement)
- Relaxing the proposed limit to not exceed daily expected energy consumption under Type 3 Response

Concerns that were resolved in the final specification include:

- Specifying a workable response time (e.g., 5 minutes) for "Connected" pool pumps to respond to upon signal receipt
- Concern over EPA's proposed establishment of default peak period settings, considering the wide range of summer and winter peak periods across electric power service territories and geographic regions.
- Further relaxing the proposed limits on frequency and duration for each response type in order to enable greater usability in support of grid needs. In particular, for greater usability of EPA's proposed Type 1 Response:
  - Have products support a minimum frequency of one Type 1 Response per 12-hour period instead of once every 24-hour period. Such a change would enable a Type 1 Response to be called an hour or so earlier the next day after a Type 1 Response is called the previous day (e.g., after a Type 1 Response is called at 2pm today, a Type 1 Response call still be called at 1pm or so the next day.)

Unlike the preceding recommendation, the following suggestion to enable greater usability of Type 2 Response was not incorporated into the final specification:

- Have products support a minimum frequency of three Type 2 Responses per 12-hour period instead of three every 24-hour period.

Report Organization

Section 1 describes the project objectives and industry context under which EPRI gathered stakeholder input and developed project findings. Section 2 describes a methodology for enhancing customer value perception towards adoption of DR-Ready technologies and programs. Illustrative examples of applying the methodology and key findings from working group application of the methodology are summarized in Section 3. Section 4 frames an approach to developing functional specifications across end-use device categories. Section 5 outlines a method for assessing DR potential, and provides a simple illustration of applying the methodology. The report concludes with summary remarks and recommendation for future work, as described in Section 6. Further details are contained in the appendices, with sources of literature reviewed in Appendix A, compiled comments on Connected Pool Pump Criteria included in Appendix B, and workshop attendees listed in Appendix C.

2
METHODOLOGY FOR ENHANCING CUSTOMER VALUE PERCEPTION

Research Questions

The top priority identified by the project advisory committee in 2014 targeted customer procurement barriers surrounding DR-Ready technology adoption. The problem identified was insufficiency of customer perception of value to create customer pull (i.e., market demand) for DR-Ready device adoption. Two cases were discussed to clarify the target situation the committee was to address.

Case A: Connected devices are deployed but not for DR, for which customer participation is sought (e.g., through DR program incentives)

Case B: Connective end-use devices are not yet deployed, for which device adoption is sought (e.g., through rebates)

Committee discussions determined the need to enhance customer perception of value in both situations. Consequently, the resulting research questions for which a methodology was to be developed to address were identified as follows.

Question i: What are selling points for customer adoption of connected devices?

Question ii: What are selling points that compel customers with connective devices to participate in utility programs?

Question iii: What are selling points and/or workable trade-offs to maintain adoption rates given program obligations imposed on participants?

Step-by-Step Approach

A step-wise methodology devised for enhancing customer perception of value towards DR-Ready device and program adoption is outlined in this subsection. The approach begins with identifying the technology of focus for which customer value perception is to be enhanced. Once the technology is identified, then each step of the approach is conducted with the particular technology in mind (e.g., smart thermostat, home energy management system, connected room air conditioner, smart charging station for electric vehicle, etc.). The step-by-step approach is summarized as follows:

1. Identify target customer segment(s) for the technology in question
2. Prioritize lifestyle needs for each targeted customer segment
3. Map technology features to the segment’s top lifestyle needs

4. Develop messaging with selling points to encourage
   a. customer adoption of the technology
   b. customer participation in a DR program with the technology
   c. customer retention in DR program despite program obligations
5. Reevaluate program parameters to meet higher priority needs of customers to keep customers in DR programs

Each step of the process is explained in more detail in the following subsection.

Step 1: Identify Target Segments

Background: Technology Adoption Lifecycle

Figure 2-1 depicts the five classic stages of new technology adoption [9]. Initially, a new technology is adopted by “technology innovators” before adoption by “early adopters”, who adopt before the “early” and “late majority”, who are finally followed by “laggards”. In addition, author Geoffrey Moore identified a prevalent chasm found in the technology adoption lifecycle that especially pertains to high-tech innovations [10]. The chasm represents the difficult challenge to advance from technology adoption by early adopters to acceptance by mainstream customers, especially for high-tech and other disruptive innovations. Considering the chasm that exists, the proposed approach also considers an additional customer segment labeled “fast followers”, illustrated in Figure 2-1. This segment represents the first customers in the “early majority” to adopt.

The six stages of the augmented technology adoption lifecycle are the customer segments considered in the proposed approach. In summary, the customer segments are:

- Technology innovator
- Early Adopter
- Fast Follower (the first in the Early Majority to adopt)
- Early Majority (the remainder in the Early Majority to adopt)
- Late Majority
- Laggards

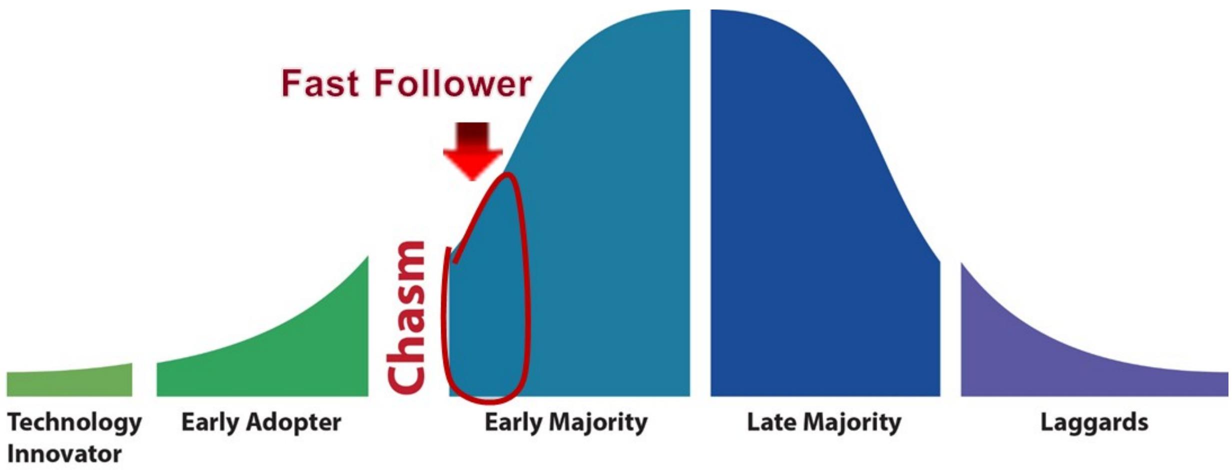

Figure 2-1
Distinct Stages of Technology Adoption

Step Description

The initial step is to identify the customer segments in the current and next stages of the technology's adoption lifecycle. For example, the immediate and next stages of the technology's adoption lifecycle could be:

- Technology Innovator then Early Adopter,
- Early Adopter then Fast Follower, or
- Fast Follower then Early Majority

Step 2: Prioritize Lifestyle Needs

Background: CLASSIFY

The proposed approach leverages prior findings on customer segmentation and prioritization of lifestyle needs conducted by EPRI in the 1980-90s. "Because of the growing trend toward segmentation in the utility industry, EPRI created the CLASSIFY segmentation model in the 1980s to provide utilities with a tool to optimize program participation through targeting markets in both the residential and commercial/industrial sectors."[11] CLASSIFY was primarily intended for applications to develop and deploy customer-driven products and services, although its implementation options were quite extensive.

Under the CLASSIFY effort, "EPRI conducted a survey of over 2,400 customers as well as in-person interviews to determine which factors were important in making energy-related decisions. Approximately 1,200 residential customers were interviewed and presented with a 12-page questionnaire on their attitudes towards purchasing and using technologies for HVAC, lighting, and water heating. These customers also responded to a survey in which they were asked to rate more than 153 attitudinal statements using a six-point scale, from strongly agree to strongly disagree. The application of a conjoint analysis engine to the survey results revealed how residential customers prioritized the following eleven lifestyle needs as factors in shaping their view of electricity service and use."[11] These lifestyle needs are captured in Table 2-1.

Table 2-1
CLASSIFY Residential Lifestyle Needs

Low Energy Bills	Safe Appliances
Increased Comfort	Personal Control
Surge Protection	Attractive Appliances
Time Saving Appliances	Hassle Free Purchases
Resource Conservation	High Tech Appliances
Enhanced Security	

The above residential customer lifestyle needs provide a basis for the prioritization of lifestyle needs to be considered in the next step of the proposed approach. An updated list is formed in Table 2-2, and stems from the original CLASSIFY list of needs for residential customers [12]. However, updated terminology has been employed with simplified wording. Moreover, the need for "trust" has been added, since trust for technology and service providers is very pertinent within the modern context of connected devices enabling seamless and automated transfer of data, including customer data. In the present day, connected technology offerings are also being differentiated by user experience, which includes the overall customer relationship experience for which trust is a pertinent factor or lifestyle need.

Step Description

The second step is to prioritize lifestyle needs for each targeted customer segment. That is, a ranked ordering of lifestyle needs is identified based on the typical priorities of customers in the current stage of technology adoption, and a separate ordering is established for customers in the next stage of technology adoption.

Residential Lifestyle Needs by Category

The residential lifestyle needs considered in the proposed approach are organized by category of need and listed in Table 2-2, along with a description of the meaning of each need. Functional needs include lifestyle needs that are supported by a technology's primary function. Non-functional needs represent additional considerations like the degree of safety, security, reliability, or trust that accommodates a technology while it is performing its primary function. It should be noted that technologies exist with the primary function of enhancing safety or security on the customer's premises; so safety and security represent functional needs in select cases of technologies. However, such technologies with the primary function of enhancing safety or security were not the focus of the workshops conducted, and so safety and security are included under non-functional needs in the table.

Table 2-2
Residential Lifestyle Needs by Category

Category of Lifestyle Need	Meaning of Lifestyle Need
Functional Needs	**Comfort** – increased personal comfort (e.g. indoor environment improvements) **Convenience** – enhanced convenience (e.g., time saving appliance, hassle free operation, or hassle free purchase) **Control** – enhanced control (e.g., remote control capability over connected device using smart app while away)
Non-functional Needs	**Safety** – enhanced operational safety against abnormal operating conditions, resulting in increased personal safety (e.g., safe appliances, surge protection, automated alerts of abnormal operating condition, etc.) **Security** – enhanced security against attack or other hazards induced by third parties, resulting in increased sense of personal security **Reliability** – degree technology performs as per design **Trust** – degree of confidence that consumer privacy will be maintained and data will be protected (e.g., transparency of data use policy)
Beneficial Impacts	**Cost Savings**– Reduction of costs to be borne (e.g., lower energy bills, reduced service fees, etc.) **Environment** – Resource conservation or other environmental concern (e.g., greenhouse gas emission reduction)
Appeal	**Aesthetics** – Visual appeal of products (e.g., attractive appliance or user interface, sleek form factor) **Innovation** – Technology innovation appeal of product (e.g., state-of-the-art capabilities, high-tech appliances)

The final two categories of lifestyle needs in Table 2-2 represent differentiating factors in consumer purchase reasons for technologies that extend beyond needs realized through functional and non-functional product requirements. The beneficial impacts category includes lifestyle needs perceived to be resulting from the outcome of technology adoption, such as cost savings to the consumer or environmental benefits (e.g., reduced greenhouse gas emissions, increased renewable energy production, or enhanced energy efficiency). The appeal category includes lifestyle needs favoring visual or state-of-the-art appeal of technologies being considered for adoption.

Needs under the last two categories may overshadow those in other categories depending on the priorities of the customer in question. Moreover, whether or not a technology actually generates cost savings or other beneficial impacts is less relevant in customer adoption than the consumer's perception of the technology's beneficial impacts, which can be highly influenced through product marketing and customer messaging.

Step 3: Map Technology Features to Top Lifestyle Needs

The third step begins with identifying the technology features that are supportive of the lifestyle needs of the target customer segment. This step commences with brainstorming to identify specific technology features that are demonstrably supportive of particular lifestyle needs for each targeted customer segment. The output of this step is a mapping of technology capabilities or features to top priority needs. The mapping clearly identifies which available features demonstrably support the segment's top lifestyle needs.

Step 4: Develop Messaging with Selling Points

4a. Identify Selling Points for Device Adoption

Step Description

After technology features are associated with top lifestyle needs of a targeted customer segment, it is relatively straight-forward to identify selling points for customer adoption of the technology. Starting with the top needs addressed by the technology, customer messaging can be crafted for each target customer segment by highlighting the lifestyle needs supported by the technology as the main selling points.

Example

For example, the "occupancy sensing" feature of smart thermostats can be messaged as a method of achieving "cost savings" by turning equipment off whenever prolonged lack of occupancy is sensed, so as to eliminate wasteful energy use. Moreover, the "remote app" feature of smart thermostat platforms can be messaged as offering greater customer "control" by enabling adjustments to thermal comfort settings when away from home. Also the ability of smart thermostat systems to "learn and automatically adjust temperature settings" to optimize comfort in the home are features that can be messaged as supporting needs for "comfort and convenience".

4b. Identify Selling Points for DR Program Adoption

Step Description

Based on the understanding established in Step 3 of each target customer segment's prioritized lifestyle needs customer messages with selling points to encourage customer participation in DR programs need to be developed. That is, assuming the customer has adopted the technology in question, the selling points in this step are focused on encouraging customer DR participation by leveraging the technology, while considering various program aids available.

Example

If a targeted customer segment prioritizes convenience and cost savings then compelling messaging could include signing up in the program is as easy as "plug and play to save". Moreover, if "customer override" is a smart thermostat program option and "comfort" is highly prioritized by the targeted customer segment, then messaging on "maintaining comfort and control with the override option" could alleviate concerns over loss of comfort when participating in a program designed to reduce air conditioning grid impacts.

4b. Identify Rationale for Keeping Customers on DR Programs

After customers have adopted a technology and enrolled in a DR program levering the technology, another goal is to maintain customer retention rates. Consequently, the next step in the approach is to identify selling points to keep customers in DR programs, who otherwise may fall out of a program due to onerous program obligations. The task may include adding or adjusting program aids to firmly establish rationale for keeping customers in DR programs, despite program obligations.

Table 2-3 lists typical program obligations to consider in this step. For each relevant program obligation, the task is to identify rationale for keeping customers on the DR program in question. For example, for early adopters who desire the latest technologies, qualifying devices that are perceived as “state of the art” with “high coolness factor” can help establish compelling rationale overcoming the first program obligation listed in the table.

Table 2-3
Program Obligations

Item	Program Obligations
a)	Adopt qualified device
b)	Install device
c)	Sign-up under program on-boarding process
d)	Respond to DR event
e)	Provide consumer data
f)	Participate in post-program season survey

Step 5: Reevaluate Program Parameters to Meet Higher Priority Needs of Customers

The last step in the approach is to iterate by considering tradeoffs that can be made in program design, to identify stronger selling points for keeping customers in DR programs, who otherwise may fall out of a program due to onerous program obligations that outweigh value perceived in technology and program adoption. The task at hand is to consider adjusting program design features to better meet higher priority needs by trading off lower priority needs of the targeted customer segment. Although optional, this step can enhance customer value perception through consideration of key changes to program design (e.g., incentives, constraints) that could better support highly prioritized needs and dispense with program aspects that support lower priority lifestyle needs.

Application through Working Group Exercises

Working Group Exercise

During the summer of 2014, EPRI conducted a series of workshop sessions to apply the proposed approach for enhancing customer value perception and to identify effective rationale for DR-Ready technology and program adoption. Findings are summarized in the next section.

The template in Figure 2-2 below was developed for distribution to working groups. The template serves as a progressive guide for each working group to document consensus findings on one large 11”x17” sheet of paper. A full-sized copy of the worksheet is attached to Appendix C of this report.

Technology of Focus: Group #:

Customer Segment or Stage of Technology Adoption Lifecycle	Time Horizon	Prioritized Lifestyle Needs	Key Capabilities	Rationale for Device Adoption (associate with Lifestyle Needs)	Rationale for DR Program Adoption (given program aids)	Rationale to Stay in Program (despite program obligations)
Customer Segment Name: Description:		Top priority: High priority: A need: Somewhat a need: Not a need:				

Figure 2-2
Template for Working Group Exercise

The instructions below accompanied each exercise, application of which is illustrated in Section 3 of this report.

1. Identify Technology of Focus for particular Working Group
2. Identify technology's main Customer Segments within immediate and next stages of Technology Adoption Lifecycle, such as:
   a. Technology Innovator to Early Adopter
   b. Early Adopter to Fast Follower (first to adopt in Early Majority)
   c. Fast Follower to Early Majority
3. Prioritize Lifestyle Needs of these Customer Segments
4. Identify key capabilities of technology demonstrably supportive of these needs (purchase reasons)
5. Answer Each Research Question through build-up
   a. Map technology capability with lifestyle needs (as selling points for device adoption)
   b. Provide rationale for DR program adoption (given program "aids")
   c. For each Program Obligation, identify workable tradeoffs to maintain adoption rate

3 ILLUSTRATIVE APPLICATION OF EXERCISE

Overview

During the summer of 2014, EPRI conducted several workshop sessions to apply the approach outlined in Section 2 for enhancing customer value perception and to identify effective rationale for DR-Ready technology and program adoption. Working groups were given templates as shown in Figure 2-2 along with instructions to guide their discussions. Each group was asked to document group consensus findings. This section summarizes findings from the working group exercises.

Workshop Venues

The working group exercises were conducted at the following two venues:

1. EPRI's Smart Thermostat Workshop on June 25-26, 2014 in Palo Alto, CA.
2. Active Communication International's Pre-Conference Workshop on August 6, 2014 preceding the "Next Generation of Home Energy Management System" Conference on August 7-8, 2014 in Sacramento, CA.

Working Group Exercise

The following instructions were given to each group.

1. Identify **Technology of Focus** for the working group
2. Identify technology's main **Customer Segments** within immediate and next stages of Technology Adoption Lifecycle, such as:
    a. Technology Innovator to Early Adopter
    b. Early Adopter to Fast Follower (first to adopt in Early Majority)
    c. Fast Follower to Early Majority
3. Prioritize **Lifestyle Needs** of these customer segments
4. Identify **Key Capabilities** of the technology demonstrably supportive of the lifestyle needs or purchase reasons for adopting the technology
5. Answer each research question through a build-up
    a. Map key capability with lifestyle needs, as **selling points for technology adoption**
    b. Provide **rationale for DR program adoption,** given program aids or design options
    c. To maintain adoption rates, identify workable tradeoffs for each **program obligation**

Home Energy Management Systems

One working group at the first workshop session chose to focus on home energy management systems (HEMS), and included smart thermostats in the overall system. Following the exercise, the group quickly identified selling points for home energy management systems. Findings are documented in Table 3-1, with early adopter needs ordered under the first column, and technology capabilities under the second column, as identified by the working group.

As summarized in Table 3-1, aesthetic appeal was identified as the top need for early adopters, followed by comfort and convenience (high-priority needs), and then innovation (a need). The working group perceived aesthetic needs supported by the intuitive design feature of systems offering energy management with latest smart thermostats. Furthermore, the group identified automation capabilities as demonstratively supportive of comfort and convenience needs of early adopters. Moreover, adopting HEMS in the home was identified as a possible conversation starter with acquaintances, which appeals to the need to be recognized as an early adopter of latest technology innovations.

Table 3-1
Selling Points for Early Adopters of Home Energy Management System (Group A)

Early Adopter Needs	Key Capabilities
Top: Aesthetics	Intuitive design
High: Comfort and Convenience	Automation
Need: Innovation	Conversation starter

Smart Thermostats

Selling Points for Technology Adoption

Two working groups at the first workshop conducted the exercise with a focus on smart thermostats. The tables below summarize findings on the rationale identified for technology adoption and DR program participation with smart thermostats.

Working Group B identified comfort and control as the top needs of early majority adopters of smart thermostats, followed by cost savings, and then the environment. Remote access and control capabilities of smart thermostat offerings were perceived by this working group as supportive of comfort and control needs. Smart thermostat platform capabilities supportive of cost savings were also identified; namely, the platform's capability of enhancing certainty and accuracy of electricity consumption and providing this feedback to the customer.

Table 3-2
Selling Points for Early Majority Adopters of Smart Thermostats (Group B)

Early Majority Needs	Key Capabilities
Top: Comfort and Control	Remote access and control
High: Cost savings	Expense certainty and accuracy
Need: Environment	

Working Group C progressed through the exercise rapidly, answering all three research questions identified in Section 2, for both early adopters and fast followers (the first in the early majority to adopt). Table 3-3 summarizes findings on selling points for early adopters of smart thermostats, and Table 3-4 lists findings on selling points for fast followers. Results for top needs of fast followers (as identified by Working Group C) exactly match the top needs of early majority adopters (as identified by Working Group B). Differences in ranking of lower priority needs by these two groups, however, may stem from regional differences as reflected by the makeup of participants in the working groups. For example, impact on environment was not identified as a fast follower need by Working Group C representation from the South of the United States; whereas the environment was identified as a definite need by Working Group B comprised of representatives from the West.

Table 3-3
Selling Points for Early Adopters of Smart Thermostats (Group C)

Early Adopter Needs	Key Capabilities
Top: Innovation	Design features ("Cool factor")
High: Convenience and Control	Smart apps for monitoring and control
Need: Comfort	Learned and automated preferences
Some: Environment	
Not: Cost Savings	

Table 3-4
Selling Points for Fast Followers of Smart Thermostats (Group C)

Fast Follower Needs	Key Capabilities
Top: Comfort and Control	Learned and automated preferences; Smart apps for monitoring and control
High: Cost savings	Occupancy detection to avoid waste
Need: Convenience and Reliability	Smart apps for monitoring and control
Some: Trust	
Not: Environment	

As indicated in Table 3-3, early adopters of smart thermostats tend to seek the latest technology innovations, for which design features impact how "cool" the technology is perceived. Convenience and control are highly prioritized by early adopters, followed by other lifestyle needs like impact on the environment. It is interesting to note that none of the groups that focused on smart thermostats identified cost savings as a need of early adopters. Rather, cost savings was identified as a highly prioritized need of fast followers, as indicated in Table 3-4.

According to the above tables, capabilities of smart apps (that enable monitoring and control of space conditioning systems) are supportive of convenience and control needs of both early adopters and fast followers. Learning and automation capability of smart thermostat systems (to adjust settings based on learned preferences over time) is supportive of occupant comfort. Moreover, occupancy detection capability of smart thermostats (to avoid waste by turning off space conditioning systems when occupancy is not detected) is a source of cost savings.

Selling Points for Program Adoption

Only one working group completed the exercise to identify program adoption rationale for early adopters of smart thermostats. Tables 3-5 and 3-6 summarize findings from Working Group C.

As Table 3-5 indicates, early adopters of smart thermostats can be encouraged to participate in demand response programs with their thermostats using various rationale. Since technology innovation appeal is ranked highest for this segment, utilization of affinity appeal may prove most effective in encouraging early adopters to participate in DR programs, through messaging like "be among the first to employ new technology" by joining the program. Moreover, messaging about program participation as requiring little effort or as easy as "plug and play" supports the early adopter's high priority over maintaining convenience and control. Messaging about "maintaining use" of space conditioning systems under the program, can alleviate concerns over whether comfort will be maintained. Touting program virtues as far as potential environmental impact (e.g., through reducing peak system build-out and enabling a future with more renewables) associates an environmental appeal with program participation, which was identified as somewhat of a need for early adopters.

Table 3-5
Program Adoption Rationale for Early Adopters of Smart Thermostats (Group C)

Early Adopter Needs	Program Adoption Rationale
Top: Innovation	Affinity (be part of the first to adopt new technology)
High: Convenience and Control	Plug and play (requires little effort, if any)
Need: Comfort	Use maintained (can continue to use air conditioner as desired)
Some: Environment	Tout virtues (reduce peak, defer new capacity until future with more renewables)

Table 3-6
Program Adoption Rationale for Fast Followers of Smart Thermostats (Group C)

Fast Follower Needs	Program Adoption Rationale
Top: Comfort and Control	Maintain control (override for comfort)
High: Cost savings	Save money with device setup
Need: Convenience and Reliability	Plug and play (requires little effort to maintain)

As indicated in Table 3-6, fast followers adopting smart thermostats can be encouraged to participate in DR programs by addressing their order of priorities. Since comfort and control are ranked highest, messaging that highlights maintaining control and comfort is important for encouraging customer enrollment. Such messaging can highlight consumer override as an option under the program, enabling the customer to maintain control over their individual comfort. Highlighting overall cost savings that can be achieved upon device setup for program participation addresses a high priority need of the fast follower. Moreover, selling the program as “plug and play” and “easy to maintain” supports the fast follower’s need for convenience and reliability.

Rationale for Staying in DR Program

Only one working group completed the exercise to identify program retention rationale for early adopters of smart thermostats. Tables 3-7 and 3-8 summarize findings from Working Group C.

Table 3-7
Program Retention Rationale for Early Adopters of Smart Thermostats (Group C)

Early Adopter Needs	Rationale to Stay in Program
Top: Innovation	Qualified “cool” devices or enable “bring your own device”
High: Convenience and Control	Trade ally to install device
Need: Comfort	Offer override capability (but don’t incentivize if opt out)
Some: Environment	

Table 3-8
Program Retention Rationale for Fast Followers of Smart Thermostats (Group C)

Fast Follower Needs	Rationale to Stay in Program
Top: Comfort and Control	
High: Cost savings	
Need: Convenience and Reliability	Offer device warranty
Some: Trust	Have transparent policy on use of consumer data, and share results and data with consumer

As indicated in Table 3-7, early adopters of smart thermostats can be encouraged to remain in DR programs by addressing their particular lifestyle needs in order of priority. The DR program administrator can start by qualifying “cool” devices perceived as offering the latest technology innovations, and/or adopt a “bring your own device” policy for the smart thermostat program. Working with trade allies to conveniently install devices for customers can help prevent customer fall-out for lack of successful install. Moreover, offering override capability for customers to opt out of select DR events, can reduce program drop-out rates that event participation obligations may otherwise cause. Furthermore, offering device warranties under the program helps maintain operability of field devices for continual program participation. Finally, establishing and following a transparent program policy on use of consumer data helps build trust, as well as sharing data in a meaningful fashion with consumers.

Home Energy Management Coupled with Solar Photovoltaic System

One working group at the second workshop chose to focus on home energy management systems (HEMS) operated in conjunction with rooftop photovoltaic (PV) systems. Following the exercise, the group quickly identified selling points for such a coupled system.

Broad control over meeting energy needs in the home was identified as the top selling point for current early adopters of HEMS and PV systems. Control was associated with energy independence by the group. The top need for more control and energy independence was followed by convenience, environment, and cost savings. As summarized in Table 3-9, the working group identified these highest priority needs are supported through remote control capability, automated notifications, PV production, and presentation of information on a "slick" graphical user's interfaces (GUIs). GUI displays could make quantified cost savings readily apparent to customers, by showing multiple data streams like local demand and PV production compared against baseline data or what-if scenarios.

Given the large capital investment and/or other commitments to realize a return-on-investment from adopting PV systems, cost savings was a common motivating thread identified across the working group exercise. The group identified the main rationale for PV system adoption as achieving a sense of energy independence from the local utility provider, while achieving a threshold of cost savings. Rationale for DR program adoption leveraging these technologies included cost avoidance and savings through program participation. Rationale identified for customers to stay in programs included continual cost savings and recognition of early adopter status.

Table 3-9
Selling Points for Early Adopters of Home Energy Management Coupled with PV (Group D)

Early Adopter Needs	Key Capabilities
Top: Control	Remote control, local production to support energy independence
High: Convenience and Environment	Notification, PV production
Need: Cost savings	Graphic user's interface and data display

Smart Charging with Electric Vehicle Supply Equipment

One working group at the second workshop chose to focus on smart charging systems for plug-in electric vehicles (PEVs). Following the exercise, the group quickly identified selling points for smart chargers.

As summarized in Table 3-10, convenience while maintaining safety is the top selling point for fast followers who adopt PEV smart chargers (moving up from standard Level 1 charging), followed by control and cost savings. The working group associated faster charging capability of smart chargers as supportive of customer convenience, and automated protection capability of the chargers as a safety assurance feature for the car and home. Enhanced customer control is supported by energy optimization features of smart charging systems that can coordinate charging with grid and local generation conditions (e.g., renewable energy output). Furthermore, the group identified performance reporting as supportive of cost savings. Key rationale for smart charging program participation is "cost savings without inconvenience", while providing "customer override" capability.

Table 3-10
Selling Points for Fast Followers of Electric Vehicle Smart Chargers (Group E)

Fast Follower Needs	Key Capabilities
Top: Convenience and Safety	Faster charging; automatic protection for car and home
High: Control	Energy optimization and coordination
Need: Cost savings	Performance reporting

Common Findings

Common findings from working group exercises conducted across the two workshop venues are listed below.

- For early adopters of smart thermostats and HEMS, purchase reasons center around innovation, and not necessarily cost savings. Given the much greater expense of PV systems, achieving net impact on cost savings is also a critical purchase reason for early adopters of combined HEMS and PV systems.
- For fast followers, it's about cost savings, while maintaining comfort, convenience, and other top lifestyle needs of this segment.
- Residential lifestyle needs (or purchase reasons) now also include Trust and Reliability, beyond the classic lifestyle needs of Comfort, Convenience, Control, Safety, Security, Cost Savings, Environment, Aesthetics, and Innovation.
- Trust as a modern lifestyle need stems from the potential adverse impact of connected devices that enable customer data transfer, which can impact customer relationship experience with technology vendors and service providers.
- Keeping the customer in mind, effective messaging to enhance customer perception associates product features with top lifestyle needs of the targeted customer segment. For example, one may effectively utilize affinity with early adopters as in: "Be among the first to adopt". With fast followers, one may effectively sell based on savings and convenience as in: "Adopt with ease. Plug 'n play to save."

4

FRAMING FUNCTIONAL SPECIFICATIONS

Overview

DR-Ready functional specifications are intended to provide general guidance across multiple end-use categories of how devices can respond to a request for load modulation in a manner that is predictable and can be used by utilities for their planning needs. The vision is to create a framework similar to how energy efficiency measures are evaluated. In energy efficiency evaluation, operating parameters are provided by manufacturers, a test standard is established, and lab testing is conducted by an independent third party laboratory. The purpose of framing functional specifications is to provide generalized criteria for demand response-ready devices that could be applied across end-use categories. The goal is to frame specifications that could then be applied by manufacturers to design and evaluate DR capability of products as well as by utilities to plan for demand response programs.

It is intended that utilities can apply the specified parameters to develop models for program performance, in a manner analogous to energy efficiency programs. For example, energy efficiency HVAC programs use SEER as a rating to qualify products. The SEER rating is derived using a test procedure developed by a Standards Development Organization (SDO) such as ASHRAE, and tested according to an evaluation procedure developed by AHRI, another SDO. Similarly, the DR-Ready specifications outlined in this section could be evaluated at a third party laboratory such as Intertek or UL according to a specified test procedure.

In the case of DR-Ready devices, the actual performance of the device can be verified using data provided by these devices. Consequently, the proposed specifications can provide an understanding of the capability and availability of DR resources for utilities, and provide verification of response and/or performance.

The subsections below frame a set of DR-Ready criteria that can be supported by manufacturers and leveraged by utilities for their DR programs. The target is to allow ample degrees of freedom for manufacturers to innovate while enabling the ability of utilities to predict expected response and/or DR performance. The outlined criteria could make program acceptance of DR-Ready products much easier. Moreover, performance verification and historical event response data delivery capabilities could be very useful for utility and other regional planners to accept demand response contribution from mass markets as a reliable resource.

This section is intended to complement standards' efforts such as OpenADR, SEP 2.0 and CEA-2045. The proposed approach to functional requirements does not specify any commands to be transmitted (although required to trigger DR), but rather focuses on defining how devices are to react. Such a scheme can support a wealth of DR programs (e.g., Bring Your Own Thermostat) with various implementations, such as the Smart Thermostat DR programs being implemented by utilities in California. By defining the expected reaction of the devices and collecting data, the proposed approach can support DR verification of performance and elimination of free-ridership.

Approach

Underlying Principles

The approach to functional specification is based on the following underlying principles:

1. The specification is to be comprehensive as well as high level enough to apply across multiple end-use device categories. This may reduce or eliminate the need for device-specific commands.
2. DR response types are to be supportive of DR programs or future programs and systems where the ability to impact load is beneficial (e.g., DR within the context of a microgrid).
3. DR response types are to be characterized based on capability of devices that could be leveraged, although response types could also be achieved at an aggregate level. The response types described below could be considered a work-in-progress, and are presented with the intention of facilitating an industry dialogue for further discussion and development, including with standards development organizations.
   - Type 1 Response (Schedulable Load Reduction) – Load reduction1 coordinated at least 1 hour in advance (e.g., Day-ahead DR). Applications may include load reduction scheduled according to seasonal needs (e.g., summer and winter peak load reduction) or needs determined day(s)-ahead.
   - Type 2 Response (Fast Load Reduction) - Load reduction coordinated less than one hour in advance. Applications to reduce load quickly may include centrally dispatched services (e.g., ancillary service operating reserves) or coordinated autonomous response (e.g., under-frequency load shedding).
   - Type 3 Response (Flexible Response) – the ability to adjust load during a specified flexibility event by increasing and reducing consumption as coordinated in near real-time. Applications for such balancing resource capabilities include balancing energy, regulating frequency, or ramping up/down to balance intermittent renewable generation.
4. Device capabilities are to be specified in a way that is independent of the communication system technology or architecture.
5. Devices at a minimum need to be capable of load reduction response in order to be considered DR-Ready. Additional response types expand the range of program types that may be supported.
6. Authorities over certification of device capability (e.g. product manufacturers, standards bodies, industry alliances, etc.) may test equipment and publish performance against standardized test procedures. Associated product labeling can be supported by such authorities as well as by organizations such as EPA or DOE.

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[1] Load reduction can be achieved by interrupting (e.g., terminating device operation) or curtailing consumption (e.g., multi and variable-speed pumps, motors, and compressors reducing energy consumption without necessarily turning off completely.)

7. Specified set of functionality is to be kept as simple as possible. Such an approach would simply achieving interoperability and provide for the greatest flexibility and largest adoption by manufacturers, while ensuring they have space to innovate.
8. This functional specification is not a standard. However, it can inform standards-development processes.
9. With respect to customer control preferences, DR-Ready devices are to support responses that self-limit in order to stay within customer-designated comfort boundaries, including customer override of events.

Categories of Demand Response Requirements

Resulting functional specifications for DR-Ready devices are to serve the needs of market operators, utilities, and third-party aggregators that operate DR programs. As depicted in Figure 4-1, utility demand response requirements can generally be classified into four broad areas:

- **Capability** of DR assets to provide a specific type or characteristic of response
- **Availability** of DR assets at the time demand response is required
- **Visibility** to resources that may provide system-level aggregated DR (e.g. knowing the kW and kWh capacity available on the system within a DR program)
- **Verification** of response or performance to support operational requirements

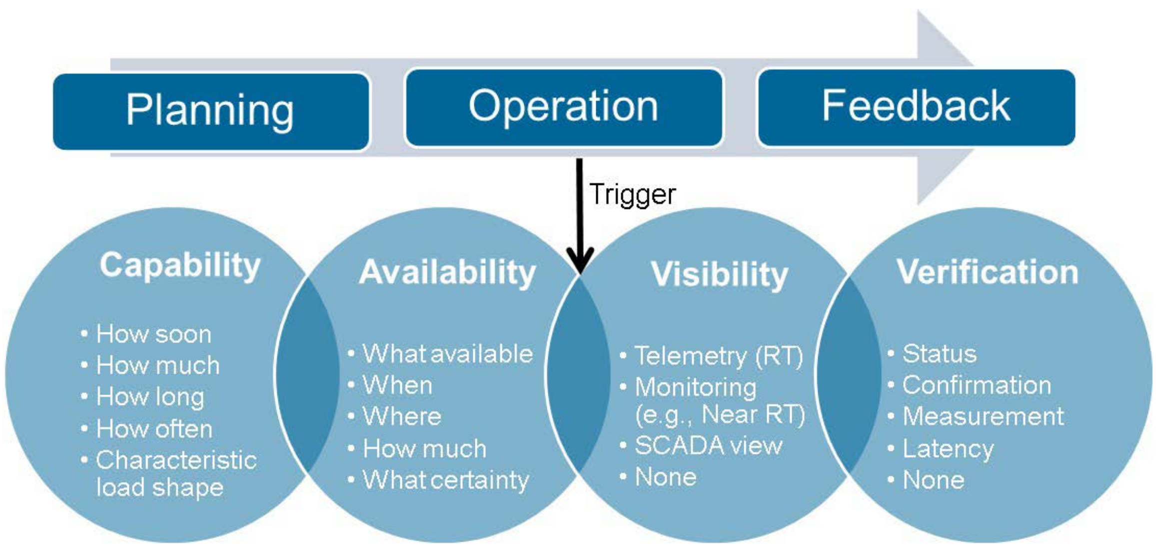

Figure 4-1
Categories of Demand Response Requirements

Figure 4-1 categorizes utility requirements for DR. Within each category, there are a number of parameters that could be fixed by design, measured in real time, or otherwise calculated by system operators, to provide operational assurance, forecasts of expected response characteristics, or indication of availability for performance of a DR resource. These categories of requirements provide insight into the device-level parameters of interest to utilities.

In energy efficiency programs, device performance is verified through an extensive measurement and verification (M&V) process. M&V for DR-Ready devices could be accomplished similarly by employing a standard M&V process as in traditional EE program evaluations. In this way, certain DR capabilities of devices could be characterized during the certification process. However, because the responses of DR-Ready devices are expected to respect customer safety and comfort limitations, as well as event overrides, upfront characterizations generally do not provide specific insight into how individual devices respond to individual events.

Alternatively, another method for M&V could utilize data provided by devices before, during, and/or after each DR event. Operational information could be provided by data originating within a DR-Ready device. Utilizing latest (e.g., real-time) operational information, when possible, offers more flexibility and precision on up-to-date operating parameters that can inform the range of operation specified for DR-Ready device characteristics.

Possible Applications of Functional Specifications

The functional specifications framed in this section are intended to be applicable by product providers, utilities and standards development organizations in defining and employing DR-Ready devices capabilities.

Product Providers: Manufacturers and vendors may clearly define how their devices will operate when specific types of demand response are requested. Functional specifications enable product providers to test their equipment in controlled laboratory conditions using standardized test procedures, and publish results. This enables certainty and consistency in product ratings.

Utilities: For electric power companies, knowing the operating parameters and expected load reductions under different types of customer use and demand response conditions would provide a better tool for program design. For example, knowing that Pool Pump A can reduce load by 1 kW for 4 hours or 2 kW for 1 hour can assist in planning and estimating the number of pool pumps to achieve 1 MW of curtailment either for a 4 hour or 1 hour event.

Standards Development Organizations: These functional specifications can aid SDOs in establishing common ground between stakeholders, including manufacturers and utilities. This can enable a faster and smoother standards development process. One example application is as input into EPA's ENERGYSTAR® Connected specification development.

Consumers: Functional specifications can create awareness and acceptance in the minds of consumers. Knowing that DR specifications have been adopted by well-known standards organizations, and products have been evaluated in a test lab could enable a high adoption rate of DR-Ready products. Product labeling is another key aspect of product acceptance, though labeling is a very broad topic requiring SDO support and not a focus of this report. The energy guide/label placed on products will need considerable focus to appropriately relay meaningful information to the consumer.

Functional Specifications Framework

Parts of Framework

As explained earlier, DR-Ready functional specifications are to be designed to be simple and easy to implement. To better illustrate, an example functional specification is framed in Table 4-1 according to the underlying principles explained above. The columns of the table are as follows:

- Column 1 defines the type of response – whether it is Type 1, Type 2 or Type 3.

  Note that within Type 1 (load shifting) a variable set of modes are possible. This accommodates seasonal differences as well as the issue of certain regions being winter-peaking as opposed to summer-peaking, along with varied durations.
- Column 2 is for parameter enumeration.
- Column 3 identifies the name of the device parameter being specified.
- Column 4 provides an explanation of the operating characteristics of the device parameter.

Table 4-1 identifies functional specifications of devices that addresses various utility DR program requirements. Table 4-2 identifies a set of corresponding operating data required for provision to the DR calling entity (e.g., utility or system operator). The data parameters in Table 4-2 are to be provided at a minimum time interval, to be specified.

The data required can then be collected, warehoused and analyzed by the utility to understand the overall performance of aggregated devices in its service territory. The data can also be used to verify free ridership and if required, baseline performance at the customer level. For some utility programs, such data sets are critical for ensuring proper program participation settlement, and in the long-run, for implementing performance-based incentives.

Functional Specifications for Device Response

The following parameters could be supported by product manufacturers as part of a DR labeling/standards compliance program.

Table 4-1
Functional Specifications of DR-Ready Devices

Device Response Type		Device Function	Meaning
Type 1 Response	1	Device Response Time (e.g., 2 hour)	Maximum time in which the device will provide feedback to "asking entity", including any measurements necessary, measured as time between request received at device to response sent by device
	2	Max Operating Capacity Level (0 – 100):	This is the maximum capacity of overall energy use that the system will operate at when Type 1 DR is called
	3	Min Control Point Offset	Temperature offset for thermostats and water heaters, alternative to specified parameter number 2. (The offset could be positive in summer and negative for winter, and each will need to be published.)
	4	Min Response period (e.g., 4 hour)	The minimum length of time the device will implement the provided command, at the specified capacity level as specified in parameter number 3 or 2. (This could be different for summer and winter, and published separately.)
Type 2 Response	8	Capable – Yes/No	Whether the device can provide Type 2 response for at least 1 hour. For example, thermostats whose mode can be turned to off using software will qualify, but ones where OFF is a hardware switch will not.
	9	Device Response Time (e.g., 10 min)	Maximum time in which the device will provide feedback to "asking entity", including any measurements necessary, measured as time between request received at device to response sent by device
	10	Min Response period (e.g., 1 hour)	The minimum length of time the device will implement the provided command, at the specified capacity level as specified in (4).

Table 4-1 (continued)
Functional Specifications of DR-Ready Devices

Device Response Type		Device Function	Meaning
Types 3 Response	11	Capable – Yes/No	Whether the device can provide Type 3 response for at least 15 min. For example, thermostats whose mode can be turned to off using software will qualify, but ones where OFF is a hardware switch will not.
	12	Min “up” ramp speed	The minimum speed at which it can ramp up, expressed as %capacity/sec
	13	Min “down” ramp speed	The minimum speed at which it can ramp down, expressed as %capacity/sec
	14	Min operating capacity	This is the minimum capacity of overall energy use that the system will operate at when Type 3 DR is called
	15	Max operating capacity	This is the maximum capacity of overall energy use that the system will operate at when Type 3 DR is called
	16	Device Response Time (e.g., 5 min)	Maximum time in which the device will provide feedback to “asking entity”, including any measurements necessary, measured as time between request received at device to response sent by device
	17	Max. Daily event capability	Maximum number of events that can be called in a day for user considerations (e.g., safe device operation, energy usage impact)

Data Requirements for DR-Ready Devices

Data is to be provided from each DR-Ready device at the system interface of the entity requesting load change (the DR manager). Such data may ultimately provide a basis for forecasting, obtaining visibility, and/or verifying response in support of system operations. End device original equipment manufacturers (OEMs) may be required to meet a specific data update time requirement of the DR manager. An end-use device, such as an appliance, would provide data on current readings when requested through available communication channels[2] to the DR manager. Table 4-2 identifies data parameters to be included in the data provision.

Table 4-2
Standardized Data Parameters to be provided by DR-Ready Devices

Data Parameters (Available from a DR-Ready Device every 15 min or less)		Detailed Description
1	Control Point	Average measured control point during time period (e.g., temperature)
2	Control Point Setting	Average control point setting during the time period
3	Capacity %	Average capacity of operation during time period (e.g., for on/off HVAC and water heating, this parameter could be run time %)
4	Availability, for Type 2 and Type 3	Provided as a % of total capacity. If for safety or comfort reasons the system cannot be operated, then availability will be zero.
5	Power Level, kW	If kW is measured, then actual measurement is delivered. If not, an estimate is delivered (e.g., via manufacturer scheme using capacity correlation curves).

[2] For products supporting an open interface port, standards such as CEA-2045 do not define how messages are sent to and from a DR manager.

Mapping Functional Specifications

Table 4-3 below illustrates how the functional parameters outlined in Table 4-1 satisfy utility needs for understanding capabilities of DR-Ready devices as categorized in Figure 4-1.

Table 4-3
Mapping DR-Ready Functional Specifications

Utility DR Requirement		DR-Ready Functional Specification Aspect	Comments and Future Accommodation
Capability	How soon	Defined by Type (1,2,3)	
	How much	Max/Min Capacity Level	
	How long	Min Response Period	
	How often	As requested, but with built-in protections to prevent damage or premature aging of the device.	Alternatively, two per 12-hour period or one per 24-hour period.
	Load shape	(Not specified)	Device load shape is influenced by building characteristics
Availability	What available	Defined by Type (1,2,3)	
	When	(Not specified)	
	Where	(Not specified)	A more advanced feature for future accommodation especially for network uses, and generally not yet available
	How much	Max. operating capacity – Type 1 and 2; Availability Type 3	
	What certainty	(Not specified)	
Visibility	Telemetry	(Not specified)	Can be capable
	Monitoring	Yes, via Data	
	SCADA view	N/A	
Verification (Table 3)	Status	Feedback Response Time	Feedback includes whether the device is available or not
	Confirmation	Control Point setting or Capacity %	Data on current operation
	Measurement	Capacity % or Power level	
	Latency	Min time period	

5
EVALUATING DEMAND RESPONSE POTENTIAL

Overview

The potential for Demand Response from residential devices in a utility's service territory is dependent on many factors including fuel distribution in residential homes (e.g., gas vs. electric water heating), weather, customer adoption rates, controls technology availability, and occupancy. A missing piece of information in many cases, when evaluating DR-Ready equipment is the potential of a particular device to provide load reduction in a utility's service territory.

This section of the project intends to develop a straw man approach for conducting this analysis and provide a methodology that utility members can incorporate into their decision making for projects and programs. The load shed potentials are quantified by end use with additional DR-Ready control elements for each end use that can be separately controlled. It uses building models to develop load shapes that are then put through filters of device penetration, operating strategies and load coincidence factors. These factors can be adjusted by the utilities as they see appropriate for their service territory.

These possible load reduction measures are evaluated individually with the assumption that these loads are fully controllable (i.e., DR-ready) for load shed during DR events. The penetration levels of these devices is less than 100%, reflecting the fact that not all the devices will have DR-Ready controls installed. The potential will also change depending on the time of day during which DR is called as different end uses operate at different times of day. In the example analysis, the time period used for DR analysis is Noon to 6 PM during the summer months (i.e., May to September). The approach estimates DR potential as the potential energy (kWh) shed within a specified time period of DR, from each load type. Thus, the effectiveness of these load types can be compared to develop a sense of their performance in actual buildings; thus, provides a reference for field demonstration.

Estimating hourly energy use in residential buildings

Ideally, the analysis would utilize measured loads over a large random sample of residential customers in a utility's service territory. However, that level of detailed data is rarely available, and is very expensive to procure. An alternate option is to use modeling software, which has become more accurate with significant funding from DOE. The energy use of a typical residential building is generated using the BeOpt simulation engine [15]. BeOpt is a residential simulation engine developed and maintained by National Renewable Energy Labs (NREL) and is widely regarded to be the best available research tool.

The output from BeOpt is simulated energy use for a typical home, by load. The time period can be varied, but for this analysis is set at 15 minutes. This output can then be moved to an analysis engine such as Excel for further analysis.

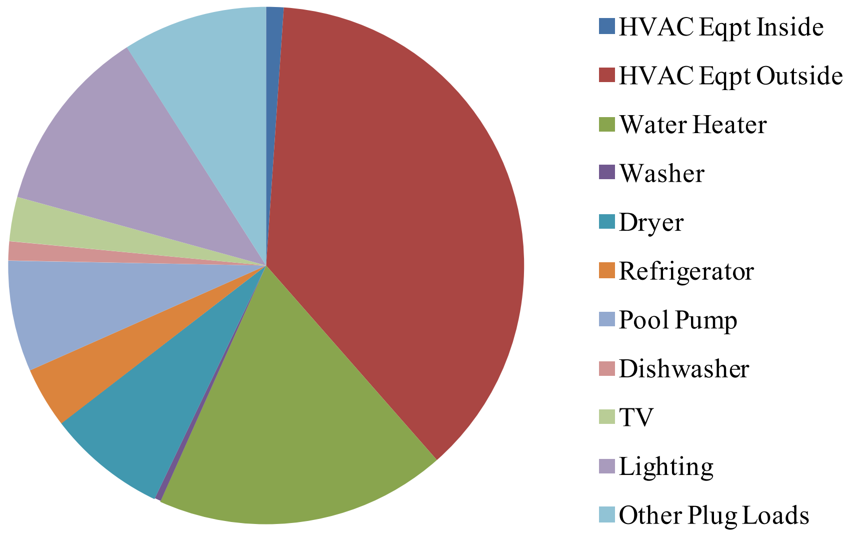

Figure 5-1
Annual Energy Use by End-use Load from BeOpt Simulation

To understand the DR impacts for peak load reduction, the data is filtered for energy use by the end loads in the summer peak periods – noon to 6 PM during the summer months (i.e., May to September) and is compared with the total annual energy use to evaluate the significance of energy consumption in those peak-hours. This provides a measure of the potential contribution of each end use load. Figure 5-3 shows the percentage of peak-hour load which can be used as an indicator for potentially effective load sheds from single DR-ready device.

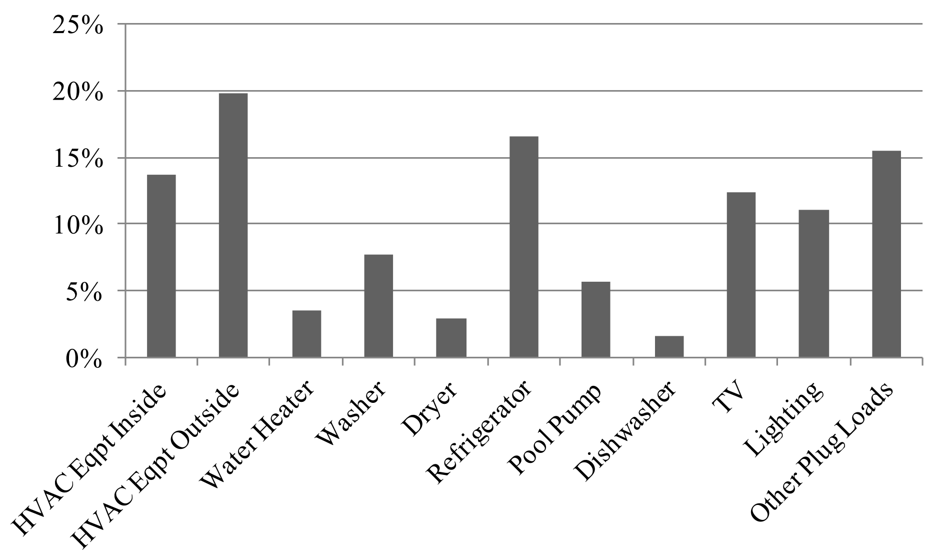

Figure 5-2
Summer Peak Contribution of End-use Loads

Methodology for Energy Saving Potentials Estimation of DR-Ready Devices

The estimation of potential energy savings during DR events take a three-step process:

1. The estimated energy use of the different end uses as developed in the previous section
2. Parameters such as load reduction factors are assumed to estimate the amount of load shed with full penetration of DR event. (denoted as β) Refer to Table 5-1, each load type and their control actions for DR is provided with a parameter. These parameters fill in the gaps between the expected load shed and what reductions are mostly likely achieved in reality. For instance, the outside HVAC equipment can usually shed loads for 25% cycle, 50% cycle and 100% cycle (i.e., the percentage of time in which the equipment is forced to reduce energy consumption below the previous hour's baseline runtime during the one hour DR event). However, field measurements usually indicate reductions are less than expected, due to controls latency. For example, when a 50% cycling event is implemented, and if the baseline operation during that hour was ½ hour, then the air-conditioner can catch up in the remaining ½ hour and the net load shed could be zero. These parameters should be multiplied with the total energy consumption of the summer peak hours to calculate the actual attainable reductions of each load type with full penetration of DR event.
3. Thirdly, penetration levels (denoted as β) of each load type are provided to calculate the practical load shed with the consideration of maintaining their basic functionalities. Refer to Table 5-2: these parameters should be multiplied with the attainable load sheds found from Step 2 above and thus yields the practical load sheds from each load type.

Table 5-1
Applied Load Shed Correction Factors for DR-Ready Devices

DR-Ready Devices			Parameters (α)		
			Non-HVAC Devices	HVAC Eqpt In	HVAC Eqpt Out
HVAC Equipment	Load Control Relays	25% cycle		0	0.1
		50% cycle		0	0.25
		100% cycle		0	1
	Thermostats	2 °F offset		1/3	1/3
		4 °F offset		7/12	7/12
		4 °F offset with 2 °F precool		5/6	5/6
	Variable Capacity Air Conditioner	2 °F offset		1-(2/3)^2.8	1-(2/3)^1.3
		4 °F offset		1-(1/3)^2.8	1-(1/3)^1.3
Water Heating			1		
Washer			2/3		
Dryer			2/3		
Refrigerator			0.2		
Pool Pump			0.8		
Dishwasher			1/3		
TV			0.2		
Lighting			0.7		

Table 5-2
Penetration Level of Each Type of DR-Ready Device

Parameter	HVAC In	HVAC Out	Water Heater	Washer	Dryer	Refrigerator	Pool Pump	Dishwasher	TV	Lighting
β	85%	85%	4%	75%	75%	95%	15%	50%	95%	95%

The methodology of potential energy savings estimation is summarized in a flow chart in Figure 5-3. Thus, the 15-min interval energy consumption data obtained from the BeOpt model needs to be multiplied by both parameters α and β and then the summation yields the full potential of the entire summer in Table 5-3. This calculation is conducted by Equation 5-1. Here, the total energy saving potentials of the HVAC equipment, both inside and outside, are counted together in Table 5-1 with Equation 5-2.

$$\Delta \boldsymbol{E}_{\boldsymbol{total}} = \sum \boldsymbol{\alpha} \cdot \boldsymbol{\beta} \cdot \boldsymbol{E}_{\boldsymbol{interval}} \qquad \textbf{Eq. 5-1}$$

$$\Delta \boldsymbol{E}_{\boldsymbol{HVAC,total}} = \Delta \boldsymbol{E}_{\boldsymbol{HVAC,inside,total}} + \Delta \boldsymbol{E}_{\boldsymbol{HVAC,outside,total}} \qquad \textbf{Eq. 5-2}$$

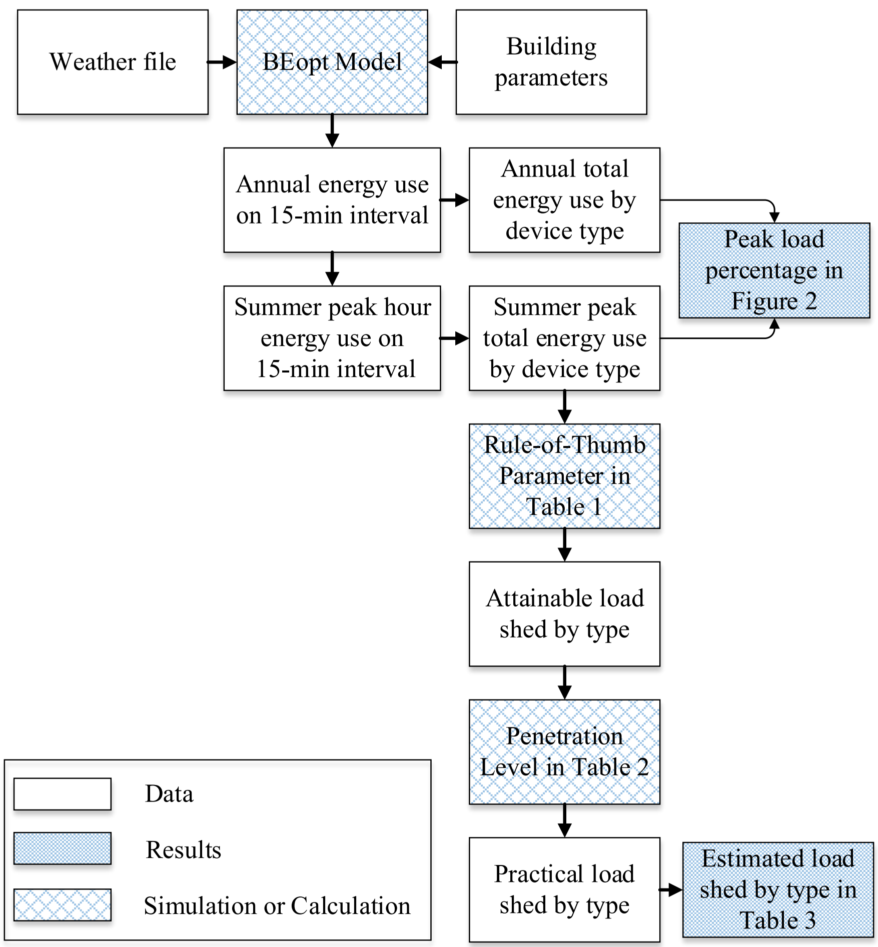

Figure 5-3
Flow Chart of the Potential Energy Savings Calculation

Results and Summary

Table 5-3 summarizes the energy use reduction potentials of each load type. DR-ready HVAC equipment and light dimming devices reach the most effective load shed through DR participations. Thus, the installation of data communication devices and associated control upgrades should be focused on these two load types for the most effective results and faster investment payback.

Table 5-3
Energy Saving Potential of Each DR-Ready Device

<table>
<tr><th colspan="3">DR-Ready Devices</th><th>Energy Saving Potential per Summer [kWh]</th><th>Energy Saving Potential per Day [kWh]</th></tr>
<tr><td rowspan="8">HVAC Equipment</td><td rowspan="3">Load Control Relays</td><td>25% cycle</td><td>81</td><td>1</td></tr>
<tr><td>50% cycle</td><td>201</td><td>1</td></tr>
<tr><td>100% cycle</td><td>805</td><td>5</td></tr>
<tr><td rowspan="3">Thermostats</td><td>2 °F offset</td><td>274</td><td>2</td></tr>
<tr><td>4 °F offset</td><td>479</td><td>3</td></tr>
<tr><td>4 °F offset with 2 °F precool</td><td>685</td><td>4</td></tr>
<tr><td rowspan="2">Variable Capacity Air Conditioner</td><td>2 °F offset</td><td>341</td><td>2</td></tr>
<tr><td>4 °F offset</td><td>628</td><td>4</td></tr>
<tr><td colspan="3">Water Heating</td><td>3</td><td>0</td></tr>
<tr><td colspan="3">Washer</td><td>2</td><td>0</td></tr>
<tr><td colspan="3">Dryer</td><td>14</td><td>0</td></tr>
<tr><td colspan="3">Refrigerator</td><td>15</td><td>0</td></tr>
<tr><td colspan="3">Pool Pump</td><td>6</td><td>0</td></tr>
<tr><td colspan="3">Dishwasher</td><td>0</td><td>0</td></tr>
<tr><td colspan="3">TV</td><td>8</td><td>0</td></tr>
<tr><td colspan="3">Lighting</td><td>110</td><td>1</td></tr>
</table>

6 CONCLUSIONS

In 2014 an industry advisory committee met regularly to help guide project activities summarized in this report. This section summarizes key findings from addressing the top three barriers identified by the committee. Recommendations for future work are also identified in this section.

DR-Ready Concept

DR-Ready devices are connective products that mass market customers can purchase with DR functionality built-in. These products can support DR programs by providing 1) pre-defined DR modes of operation governing device behavior during a DR event, and 2) ability to respond to DR signals.

Advancement of DR-Ready devices can reduce DR deployment costs by mitigating the need for utility truck rolls to retrofit end-use products in homes and small commercial settings. That is, DR-Ready devices can enable ubiquitous demand response by reducing deployment costs and increasing customer engagement.

Enhancing Customer Perception of Value for Adopting DR-Ready Devices

The success of the DR-Ready concept, in which customers procure DR-Ready devices at local retail and home improvement stores, relies heavily on customer perception of value in adopting devices with built-in DR capability. Unlike traditional DR programs that the utility industry pushes to consumers, under the DR-Ready vision consumers create market pull for DR-Ready products through retail purchases. Recognizing the importance of generating market pull, the project advisory committee identified the primary need for methods to improve consumer perception of value from DR-Ready devices.

The approach for advancing customer perception of value recognizes differences in customer segments and their prioritization of lifestyle needs. A methodology was developed to associate specific product features with prioritized lifestyle needs, to inform consumer messaging based on the highest priority needs of targeted customer segments. A structured working group exercise was devised and applied at two workshop venues in 2014 to identify customer rationale for adopting a connective product, leveraging it for participating in a DR program, and staying in the DR program. The final step in the exercise focused on iteratively examining tradeoffs between product features and program obligations to fine-tune DR capabilities and program design towards addressing the highest prioritized lifestyle needs. Such a methodology can be further applied for successful messaging to mass market customers towards driving customer adoption of DR-Ready devices and programs.

Refining Functional Specifications for DR-Ready Devices

Research was conducted to advance functional specifications of DR-Ready devices for meeting electric power industry objectives. Functional specifications enable manufacturers to quantify the response of devices against specified DR requirements. They enable utilities to plan for predictable DR with program adoption.

EPRI reviewed EPA's proposed "Connected" criteria for pool pumps released in 2014, gathered member feedback, and coordinated submission of a collective response with CEE. Moreover, EPRI considered EPA's proposed "Connected" criteria per end-use category and developed recommendations for refining functional requirements across end-use categories.

A simplified set of DR response types were proposed to support a wide range of grid and market needs for employing DR. The three basic types of responses proposed are: 1) scheduled load reduction, 2) fast load reduction, and 3) flexible DR. Moreover, functional requirements supportive of program needs for DR verification and reporting are also addressed in this report. Data parameters were identified that could be provided by DR-Ready devices to entities calling DR events. Product support for such a basic set of response types and data transfer requirements has potential applicability for a wide range of utility and market objectives for DR.

Estimating Demand Response Potential by End-Use Category

Beyond examining functional requirements for DR-Ready devices, the project advisory committee identified the importance of understanding DR potential by end-use category. For example, if smart appliances like dishwashers with load reduction capabilities are not normally operating during system peak, then the lack of availability of this category of end-use compels prioritization of other categories with higher DR potential to support peak load reduction.

Research was conducted to develop an approach for estimating DR potential based on assumed availability by end-use category across different time frames. Results can be applied to identify low-hanging fruit among end-use categories to specify DR-Ready criteria for, based on DR potential for supporting system objectives.

Future Work and Collaboration

This report describes methods for overcoming barriers to DR-Ready device and program adoption and a method for evaluating DR potential. It proposes a simplified set of technical requirements that are supportive of a broad range of system objectives for employing DR. In addition to detailing the developed approaches, the report illustrates their applications.

Beyond existing work, continued broad-based industry collaboration is needed to advance DR-Ready device capability and availability. A collaborative effort involving consumer product manufacturers and the electric power industry can serve to validate DR-Ready capabilities that are valued by utilities and system operators and also readily achievable by consumer products industries. Collaboration is useful to inform how commercially available end-use products can be readily adapted to become flexible resources to support utility needs for DR. The functional specifications framework summarized in this report for establishing DR-Ready criteria is designed to support such collaborative efforts, towards speeding the proliferation of products with capabilities useful to consumers as well as to the electric power industry.

Further developments and collaborative steps are needed to inform and guide the specification and demonstration of valuable capabilities that are supportive of industry needs for flexible electricity consumption. Moreover, research is needed to frame associations between technology capabilities and system or market needs, which may vary by time horizon and geographic region. A structured mapping is needed between DR-Ready product capabilities and the system objectives they can support. Results could be applied to identify and demonstrate low-hanging fruit among end-use categories based on technology capabilities and DR potential. Future work could also include addressing risks to grid security, developing guidelines for application of functional requirements or helping utilities develop plans to utilize forthcoming DR-Ready capabilities.

Through such broad-based efforts and collaboration considering diverse perspectives, the electric power industry can support enablement of mass market DR aligned with manufacturer product direction and customer acceptance, to derive compelling value from employing DR-Ready technologies.

A
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B
COMPILED COMMENTS ON CONNECTED POOL PUMP CRITERIA

Background

Shortly after EPA released the first draft of its proposed criteria for connect pool pumps, EPRI brought the draft to the attention of its members during an Energy Efficiency and Demand Response Program Advisory meeting in February 2014. Following the face-to-face meeting, EPRI quickly organized a conference call to review initial suggested feedback with members as well as compile collective remarks on the criteria. The compiled comments were submitted to EPA in coordination with CEE.

Compiled Comments

EPRI's compiled response to Draft 1 of EPA's Connected Pool Pump Criteria is found below.

Comments on EPA's Connected Pool Pump Specification

Compiled by EPRI on 2/26/14

4.2 Definitions

Figure 1 (line 74): For balance, we suggest including a long-range communication example in the list to the right side of the diagram, such as "cellular network, AMI, or SCADA system"

Figure 1 (line 75): It is not clear from the diagram that a pool pump with a physical port interface (all standards based) meets the criteria. Specifically, the rendering in the drawing resembles a communication module (shown mounted on the pump), but shows this inside the CPPS boundary. The concern here is that a module should not be required, if the physical port itself is an open standard. The following note (lines 76-78), furthers this lack of clarity by listing "external communication module" as being inside the CPPS.

We agree that if a physical port on a product were proprietary, then a communication module that converts to an open standard should be required.

Figure 1 (Line 77): Suggest clarification of wording to the following for Note 1 under Figure 1.

These elements "either individually or together" could be within the pump controller, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

Figure 1 (Line 78): Suggest adding: "Note: An open standard interface is always required at the premises, even in the event that an Internet/Cloud system is provided."

It is our view that open access at the premises should be required, regardless of whether or not the manufacturer is also offering cloud services. This ensures availability for all parties in the future, enables local uses (e.g. compensating for renewables variability), provides for consumer choice of apps and systems, and encourages competition in the marketplace.

(Lines 81-89) EPRI recognizes that there are a number of non-standard protocols that are in wide use in the marketplace. While not being dejure standards, some of these are available to any interested party (although sometimes at a cost) and have been useful in creating a degree of open access.

4.3 Communications (Line 108)

EPRI applauds the commitment to open standards that is reflected in this section. The overarching goals of the "connected" specifications involve ensuring interoperability and access for consumers, which needs successful connectivity of devices in the field, and without standards these goals cannot be realized. It is recognized that standards development processes may be slow and that, as a result, the capabilities of standards may lag behind the emergence of new functional interests in the marketplace. To address this, manufacturers and vendor groups often develop "extensions" to standards so that they can continue forward in an interoperable way. Specifications like this document from the EPA stimulate the development of content of this kind and accelerate the completing and maturing of standards.

(Lines 114 to 116): Suggest clarifying these lines to say:

"B. In addition to A, an Interface Control Document (ICD), Application Programming Interface (API), or other documentation shall be made available to interested parties that, at a minimum, allows access to the following functionality:"

(Lines 122 to 123): Suggest solidifying as a requirement "economical and direct communications that complies with 4.3A and 4.3B" without the allowance for alternative approaches. As stated, this could be mistakenly interpreted to imply that none of the communications requirements in 4.3A and B are mandatory.

4.6 Operational Status, User Settings & Messages

A) Minimum information to consumers or authorized third party (Line 212). Suggest also including information for supporting determination of availability of DR as well as verification of DR, besides device status. For example:

2. DR status information in preparation for, performance of, and completion of DR modes of response to include: % of full speed, any consumer override, and kw usage as available. For example, status information may consist of 15 minute data across the hours before, during, and after a DR event.

4.8 Demand Response

a) Include response time with minimum delay as a requirement. For example, the Australian/New Zealand standard specifies response within 5 minutes of signal receipt. Shorter response time is potentially useful for more applications supporting the grid.

b) Recommend manufacturer provide information to inform consumer and utility on pump behavior after a DR event (e.g., run-time adjustment to maintain pool health).

c) Type 1 Response (Line 281). Suggest changing to the following:

Multi-Speed: Pumping shall be "reduced (i.e., interrupted or curtailed)" to the lowest available speed

Variable Speed: Pumping shall be "reduced (i.e., interrupted or curtailed)" to no greater than a third of full speed

d) Type 3 Response (Line 295-6). Suggest changing to the following:

The response shall be limited such that the pumped volume is not decreased and energy consumption is not increased compared to the scheduled operation for that "month or billing cycle. This limitation shall be subject to consumer override."

Comments in Response to EPA's Questions on DR Functionality

EPA Question 1 (Line 332): Will the proposed Type 1 responses per pump type, default 4-hour minimum duration, and 1x per 24 hour minimum response frequency provide tangible grid benefits while limiting consumer impacts?

Comments: For greater usability of Type 1 response for more use cases EPRI recommends

a) dropping "1x per 24 hour" limitation. (Alternatively, though less desirable, change to "1x per 12 hour".)

b) eliminating the "4-hour minimum duration" and/or providing the ability to specify a minimum duration ranging from one hour to 12 hours.

EPA Question 2 (Line 334): Will the proposed Type 2 response, default 20-minute duration, and 3x per 24-hour response frequency provide tangible grid benefits while limiting consumer impacts?

Comments: For greater usability of Type 2 response for more use cases EPRI recommends

a) dropping "3x per 24 hour" limitation. (Alternatively, though less desirable, recommend changing to "3x per 12 hour").

b) eliminating the "20-minute duration" and/or providing the ability to specify a minimum duration ranging from one minute to 60 minutes.

EPA Question 3 (line 336): Will the proposed Type 3 response provide grid benefits while effectively guarding consumers against the potential for responses that increase overall consumption or decrease the daily pumped volume? What is the impact to pool pump manufacturers relative to this additional proposed layer of consumer protection?

Comment: For greater usability of Type 3 response for more uses cases EPRI recommends

a) require energizing or increasing pumping to a specified percentage or maximum power.

EPA Questions 4 (line 339): What changes, if any, do stakeholders recommend in order to provide increased grid benefits, or conversely to limit consumer impacts?

Address functionality to maintain integrity of pool (e.g., freeze protection). Pool pump operation in subfreezing temperatures requires running of the pump to prevent freezing. Additional functionality is needed to accommodate short-run considerations (e.g., freeze protect pool by running pump for 5 minutes every hour) in order for the pool pump to support DR.

C WORKSHOP ATTENDEES AND EXERCISE

EPRI Smart Thermostat Workshop

The list of participants below registered to participate in the EPRI Smart Thermostat Workshop on June 25-26, 2014, for which a subset (shown in italics) participated in the working group exercise on enhancing customer value.

First Name	Last Name	Company
Ammi	Amarnath	Electric Power Research Institute (EPRI)
Mangesh	Basarkar	Pacific Gas & Electric Co.
Mike	Bates	EnergyHub
Robin	Bedilion	Electric Power Research Institute (EPRI)
John	Bosse	Earth Networks, Inc.
Mike	Bourton	Grid2Home, Inc.
Melissa	Buchler	Salt River Project Agricultural Improvement and Power District
Jonathan	Burrows	Pacific Gas & Electric Co.
Jack	Callahan	Bonneville Power Administration (BPA)
Sunil	Chhaya	Electric Power Research Institute (EPRI)
Albert	Chiu	Pacific Gas & Electric Co.
Dane	Chouristensen	NREL National Renewable Energy Laboratory
Angela	*Chuang*	*Electric Power Research Institute (EPRI)*
Bienvenido	*Clarin*	*Electric Power Research Institute (EPRI)*
Hilen	*Cruz*	*Salt River Project Agricultural Improvement and Power District*
Abigail	Daken	U.S. Environmental Protection Agency
Tyler	Dillavou	Bonneville Power Administration (BPA)
David	Dinse	Tennessee Valley Authority (TVA)
Ronald	Domitrovic	Electric Power Research Institute (EPRI)
Bob	Donaldson	Duke Energy Corp.
Lieko	Earle	NREL National Renewable Energy Laboratory
Ryan	Egly	Schneider Electric
Erin	Erben	Eugene Water & Electric Board
Ilan	Frank	Opower
Douglas	Frazee	ICF International, Inc.
Ethan	Goldman	Vermont Energy Investment Corporation

First Name	Last Name	Company
Christopher	Gray	Southern Company Services, Inc.
Prachi	*Gupta*	*Oncor Electric Delivery Co.*
Justin	Hill	Southern Company Services, Inc.
Denver	Hinds	Sacramento Municipal Util. Dist.
Christopher	*Holmes*	*Electric Power Research Institute (EPRI)*
Sherry	*Hubbard*	*Ohio Power Co.*
Earle	Ifuku	Hawaiian Electric
Walt	Johnson	Electric Power Research Institute (EPRI)
Ashley	Kelley-Cox	Electric Power Research Institute (EPRI)
Tyner	Kincade	Honeywell, Inc.
Ivan	Kustec	Emerson Motor Co.
Serena	*Lee*	*Consolidated Edison Co. of New York, Inc.*
Michael	Li	U.S. Dept. of Energy
Scott	McGaraghan	Nest Labs
Alan	Meier	Lawrence Berkeley Laboratory
Lucy	Morris	Pacific Gas & Electric Co.
Ram	Narayanamurthy	Electric Power Research Institute (EPRI)
Bernard	Neenan	Electric Power Research Institute (EPRI)
Joseph	O'Donnell	Kansas City Power & Light
Emanuele	Pasca	ENEL Ingegneria e Ricerca S.p.A.
Ann	Perreault	Ecobee
Ellen	*Petrill*	*Electric Power Research Institute (EPRI)*
Jonathan	Powell	Avista Corporation
Marco	Pritoni	University of California
Venki	Ramachandran	AutoGrid
Jennifer	Robinson	Electric Power Research Institute (EPRI)
Bob	*Ruskamp*	*Lincoln Electric System*
David	Schourock	EcoFactor
Joe	*Shiau*	*Southern California Gas Co.*
Terry	*Shire*	*EcoFactor*
Marc	*Shkolnick*	*Lincoln Electric System*
Jarrett	Simon	CenterPoint Energy Houston Electric, LLC
Christopher	Smith	Ingersoll-Rand Co.
Karen	Smith	Electric Power Research Institute (EPRI)

First Name	Last Name	Company
John	Steinberg	EcoFactor
Bertrand	Texier	Total New Energies USA, Inc.
Oriana	Tiell	Pacific Gas & Electric Co.
Harshal	Upadhye	Electric Power Research Institute (EPRI)
Piotr	*Urbanski*	*Southern California Edison Co.*
Robert	Warden	Comverge, Inc.

ACI Home Energy Management Pre-conference Workshop

The following individuals participated in the working group exercise on enhancing customer value at the pre-conference workshop co-located with ACI's HEMS workshop in Sacramento, CA on August 6, 2014.

First Name	Last Name	Company
Vikki	Wood	Sacramento Municipal Utility District
Kris	Bowring	Lowe's Home Improvement Companies, Inc.
Ricky	Buch	GE Power & Water
Jelynne	Burley	CPS Energy
Akinori	Inagaki	Nomura Research Institute Ltd.
Esther	Kent	Centerpoint Energy
Hojong	Kang	Missouri Public Service Commission
Chris	Kotting	USNAP Alliance
Carlos	Soriano	CPS Energy
Pei-Yuan	Peng	LG Electronics China R&D Center
Ron	Russell	Frontier Associates
Hiroyuki	Sato	Nomura Research Institute Ltd.
Angela	Chuang	Electric Power Research Institute (EPRI)
Don	Stevens	Panasonic
Reiko	Takemasa	NRG Energy

Workshop Exercise

Each working group was given one copy of the worksheet on page C-5 to conduct the workshop exercise. The worksheet served as a template for each working group to document consensus findings.

Technology of Focus: **Group #:**

Customer Segment or Stage of Technology Adoption Lifecycle	Time Horizon	Prioritized Lifestyle Needs	Key Capabilities	Rationale for Device Adoption (associate with Lifestyle Needs)	Rationale for DR Program Adoption (given program aids)	Rationale to Stay in Program (despite program obligations)	Comments (e.g., limits of workable trade-offs)
Customer Segment **Name:** **Description:**		Top priority: High priority: A need: Somewhat a need: Not a need:					
Customer Segment **Name:** **Description:**		Top priority: High priority: A need: Somewhat a need: Not a need:					
Customer Segment **Name:** **Description:**							

Stage of Technology Adoption Lifecycle

1. Technology
2. Early Adopter
3. Fast Follower (first in Early Majority)
4. Early Majority
5. Late Majority
6. Laggards

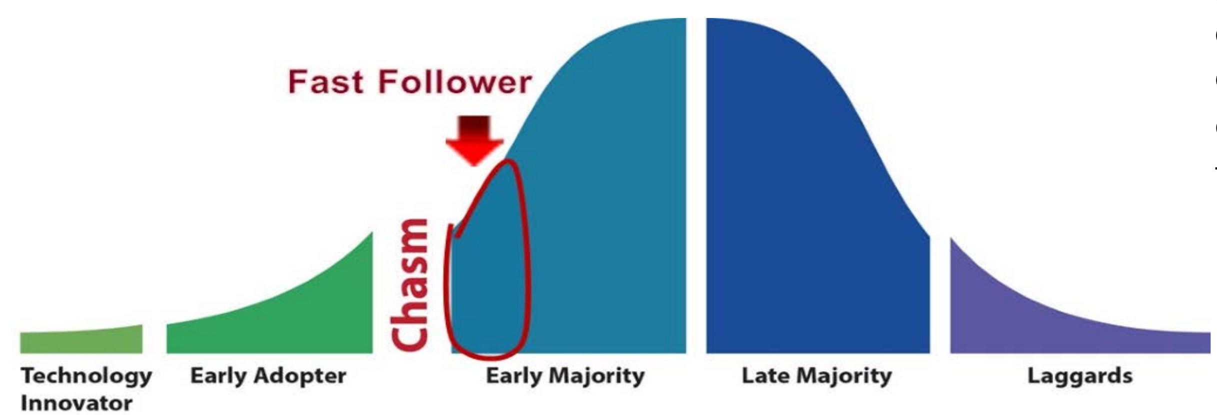
Lifestyle Needs

A. Comfort
B. Convenience
C. Control
D. Safety
E. Security
F. Cost Savings
G. Environment
H. Aesthetics
I. Innovation
J. Other 1
K. Other 2
L. Other 3

Priority Levels for lifestyle needs

5 = Top Priority Need
4 = A high priority need
3 = A lifestyle need
2 = Somewhat a need
1 = Not a lifestyle need

Priority Rank



Program Obligations

a. Adopt qualified device
b. Install device
c. Sign-up under program on-boarding process
d. Respond to DR event
e. Provide consumer data
f. Participate in post-program season survey

Assumptions

i. Vendors and Utilities actively work together to speed customer adoption.
ii. Technology Lifecyle Time Horizon is the soonest the customer segment identified will be the primary focus for targetted marketing of the technology listed.
iii.

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