SMART GRID INTEROPERABILITY PANEL

Barriers to Responsive Appliances at Scale

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Executive Summary

Numerous papers and discussions have identified the nature and extent of the potential for consumer appliances to enhance the reliability, stability, and security of the electric grid, provided such appliances were capable of responding to grid conditions. In addition, many of the technical issues involved in designing and building such appliances have been, or are being resolved, as is demonstrated by the availability of high-end appliances of various kinds that are capable of communicating and responding to information from the external environment. Such appliances are called “responsive appliances.”

The purpose of this paper is to identify at least some of the various social and economic barriers to the widespread acceptance and adoption of responsive appliances in the marketplace, and based on these identified barriers, propose reasonable approaches to resolving them.

This paper identifies 18 barriers, observed from the perspective of the consumer, the appliance manufacturer, the utility, the electricity retailer, which may be a different entity from the Utility, and the various groups responsible for regulatory and public policy.

The observed barriers are then categorized by common implied resolutions.

From these categories of resolutions, a set of next steps towards mitigating or eliminating the identified barriers is proposed for consideration.

1 Introduction

For the purpose of this paper, the term "responsive appliances" is defined as residential devices that (a) represent a meaningful[1] load that can be reduced, increased or shifted in time and/or can otherwise change operations to provide useful benefit to the electric grid, (b) where the change in operations is acceptable to the customer, if not unnoticeable, and (c) are capable of responding to price, demand, grid condition, or other automated signals.[2]

Numerous papers and discussions have identified the nature and extent of the ability of responsive appliances to enhance the reliability, stability, and security of the electric grid. In addition, many of the technical issues involved in designing and building such appliances have been, or are being resolved, as is demonstrated by the availability of high-end appliances of various kinds that are capable of communicating and responding to information from the external environment.

However, barriers to the widespread availability, acceptance, and adoption at scale, meaning large-volume deployment, of responsive appliances do still exist. The purpose of this paper is to identify at least some of the various social, policy and economic barriers to the widespread acceptance and adoption of "responsive appliances" in the marketplace, and based on these identified barriers, propose reasonable approaches to resolving them.

While this white paper may not contain a complete or exhaustive list of potential barriers to responsive appliances, the authors have sought to identify the most prominent barriers from different perspectives of residential customers, utilities, electricity retailers and service providers, appliance manufacturers, state and federal regulators, and other policy makers. It is worth noting that, of the identified barriers, most are not technical barriers but rather social, economic, regulatory or policy barriers, though they may have a technological solution. In fact, the technical barriers have been resolved in a number of different ways, which itself imposes a barrier (as noted below). At the conclusion of this white paper, the authors propose a set of actions and policies that lower, remove, or otherwise mitigate the identified barriers.

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1 While "meaningful" will ultimately be defined by the market, here meaningful refers to loads that have a size and nature such that their response, or lack thereof, can impact grid stability or efficiency. Traditionally this includes loads that 1) in the aggregate total at least 50 MW, and where 2) aggregate load reduction has a measurable impact on the grid. Not meaningful loads would include devices of low current draw or intermittent usage, such as radios, smoke detectors, electric power tools, and so forth.

2 It is assumed here that responsive appliances are, by definition, "connected appliances" in that an appliance must have a communications connection of some description in order to receive automated signals. Connections may be implemented in many ways, including those identified in ISO/IEC 15067-3, "Model of a Demand-Response Energy Management System". In the rest of this document, we simply use the terms "appliances" and "responsive appliances" interchangeably.

1.1 Abbreviations

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
AHAM	Association of Home Appliance Manufacturers
APPA	American Public Power Association
CEA	Consumer Electronics Association
DR	Demand Response, a technology or system in which devices owned and operated by the consumer respond to an external signal by increasing, reducing, or otherwise changing their energy demand
DoE	Department of Energy
EPA	Environmental Protection Agency
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FERC	Federal Energy Regulatory Commission
HAN	Home Area Network, a local area network within a house that provides communications between Responsive Appliances, and between Responsive Appliances and the electric grid, usually via a gateway
HVAC	Heating, Ventilation, and Air Conditioning
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LAN	Local Area Network
NARUC	National Association of Regulatory Utility Commissioners, an organization representing the PUCs (which see) of the 50 states, the territories and the District of Columbia
NASUCA	National Association of State Regulatory Consumer Advocates, an organization representing the government agencies charged with representing residential consumer interest before PUCs (which see) in the 50 states, the territories and the District of Columbia
WAN	Wide Area Network

2 Identified Potential Barriers to Responsive Appliances

2.1 Consumer Perspective

Barrier 1: Understanding and Meaningfulness of Value Proposition
The cumulative value-proposition for the U.S.A. and the utility industry of at-scale deployment of responsive appliances is expected to be significant. However the value proposition to the individual consumer is less compelling. For example, a back-of-the-envelope calculation yields an $11 billion-per-year net national benefit[3] when responsive appliances are applied to the residential energy market. However, these savings amount to less than $2/appliance/month in the average home of 5 major appliances[4]. This level of savings on a bill is generally considered insufficient to motivate customer demand for responsive appliances. The fact that having responsive appliances represents a real savings over the life of the appliance is generally not a factor for the consumer at the point of appliance purchase decision.

Barrier 2: Customer Awareness of Impact on Energy Savings
For most residential customers, involvement in energy management has, for last 120 years, largely meant minimizing the amount charged on electricity bills and paying bills on time. Relatively few customers know what their tariff rate or rate structure is on a bill, and even fewer begin to understand the day-to-day and hour-to hour variations in the actual cost of power.

To a great extent the lack of understanding by residential customers is a historical legacy of the way electricity has been regulated. The customer is generally insulated from the actual generating cost of electricity and its volatility. Electricity differs from other commodities whose price varies, such as produce, where the price for specific items varies seasonally or vehicle fuels, where the price varies with upstream supply conditions as it does with electricity.

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3 Note that this calculation includes the effect of avoided costs resulting from power plants that may not be required to be built, but does not include energy cost savings resulting from shifts in demand to lower-cost periods, or costs/benefits related to incorporating variable generation.
http://www.gridwiseac.org/pdfs/forum_papers/103_106_paper_final.pdf

4 Approximately 115,000,000 US households x 5 Responsive Appliances per household = 575,000,000 devices. 11,500,000,000 / 575,000,000 = $20 per device/year. $20/12= $1.67 / month

Research done by the Smart Grid Consumer Collaborative has indicated that simple customer awareness of grid operations is a significant barrier to acceptance of Smart Grid concepts such as demand response, of which responsive appliances are a part.[5]

Barrier 3: Unique Characteristic of Regulated Utilities Market
In most industries, particularly in technology markets, early adopters help build consumer confidence and comfort with product offerings. Similarly, mechanisms used in other markets to attract customers are not available to regulated utilities. The traditional regulatory approach to utilities limits both marketing opportunities and the effect of this early adopter phenomena, by expecting, indeed often requiring, that all customers in a given class or category be treated identically.

Barrier 4: Expectations of Simplicity and Convenience
Consumers have come to expect simplicity, convenience, and transparency from appliances. Indeed the word "appliance" has been adopted in other fields to denote a system or device that can be installed and largely ignored. Responsive appliances must, to the extent possible, match this expectation of simplicity and transparency, or invisibility, of operation, by avoiding disruption to the consumer's lifestyle, while at the same time protecting consumer choice and privacy.

2.2 Perspective of Appliance Manufacturer

Barrier 5: Cost of Implementation vs. Market Considerations
The appliance business is extremely competitive and manufacturers therefore typically operate on relatively small profit margins. Given this characteristic of the appliance industry, adding capabilities such as communications hardware, does not make economic sense for manufacturers unless driven by either market demand or regulatory requirements. Absent a regulatory requirement, the question in the mind of the manufacturer is "Does the consumer of the product demand such a feature?" In the case of responsive appliances there must be market demand for manufacturers to justify adding this capability to a product. Currently, many appliance makers provide connectivity towards satisfying customer desire for remote monitoring, automation, comfort, and convenience, yet provide no energy management or grid responsive features. For the manufacturer, the value proposition today in providing a connected appliance is not at all related to demand response, energy management, or minimizing the cost of the electric bill for customers. While appliances with communication features are starting to appear in the marketplace, these appeal predominantly to upper income households

[5] Studies are available from:
http://smartgridcc.org/sgccs-consumer-pulse-and-market-segmentation-study-summary
http://smartgridcc.org/research/sgcc-research/sgccs-consumer-pulse-wave-3-study-summary
http://smartgridcc.org/sgccs-2013-state-of-the-consumer-report

and those with an interest in the technology for its own sake such as smart phone / appliance interactions. As a group, the high-income customers are generally less interested in participating in energy management programs for economic or financial reasons compared to renters and lower income household where a lower electric bill allows more expenditures on essentials such as food and medicine. However, the previously mentioned average $2 per month per appliance savings is not significant even in the case for the low-income consumer. Aside from technology interests, available research shows the interest in responsive appliances among higher-income customers appears to be more aligned with ecological impacts and the sense that it is the "right thing to do".[6]

In addition, while appliance makers may include energy management as a value-added feature, the implementation may not conform to standards suitable for grid-responsive energy management such as demand response, storage, or distributed generation. For example, communication standards for grid-responsive energy management would likely be more stringent in terms of data security and privacy than may be necessary for marketable convenience or cost savings features. The more stringent requirements required for grid-responsive systems would likely be more costly to implement, which are a further disincentive given the narrow profit margins noted above.

Finally, as is discussed under Barrier 7 below, different utilities may develop different systems and architectures for communications with consumer devices. The cost to the appliance manufacturer of developing and supporting multiple communication systems in different utility service areas would be significant.

In summary, the barriers to vendors manufacturing responsive appliances are:

1) Consumers are not demanding them, so there is no current justified business case,

2) No regulatory agency is requiring them, and

3) Manufacturers economically cannot absorb the cost of implementation absent either market demand or regulatory requirements.

2.3 Perspective of Utility

Barrier 6: Industry Diversity and Market Fragmentation
Unlike many other countries, the utility market in the United States has more than 3,000 unique entities with different operational requirements,

6 Ibid.

legal and regulatory restrictions, and management objectives. Each of these entities has influence in only a portion of the United States[7].

Together with issues relating to state jurisdiction over retail electricity and competition between appliance manufacturers, these characteristics could create a "market fragmentation" barrier. The existence of differing architectures to support communications for demand response among utilities, while it may not be considered a barrier in any given utility, remains a barrier to responsive appliance manufacturing and implementation at scale. (See also Barrier # 14.)

In addition, the development of systems capable of communicating with consumer devices has proceeded in an inconsistent manner even within individual utilities. Multiple communication systems and architectures may be in place in the service territory of a single utility due to mergers, acquisitions, or practical engineering solutions available.

Barrier 7: Resource Constraints
With a diversity of appliance manufacturers, each developing their own proprietary communication systems as discussed above in Barrier 5, utilities lack the resources to develop multiple communication methods and protocols to suit.

Barrier 8: Regulatory Constraints
As regulated entities, utilities have relatively stable, but limited, rates of return. As a result of this constraint, utilities taken as a whole tend to be risk-averse, since greater risk may not carry the potential upside of greater reward. Furthermore, each utility may prefer to look to others who have faced and successfully overcome regulatory and technology challenges, so they have a precedent before embarking on a risky venture.

A related issue is that utilities generally are required to stand ready to provide essentially equivalent service to any and all who request it within a customer class. Utilities are generally prohibited by law or regulation from recommending, let alone requiring, customers to purchase a specific type or brand of equipment. Because of these restrictions, any solution chosen for utility communications to responsive appliances has to be able to communicate with 100% of the potential market for those appliances, regardless of manufacturer or technology.

2.4 Perspective of Electricity Retailer

Barrier 9: Dynamic Pricing Resistance
Dynamic pricing of some description such as peak-time rebate, Real-time pricing, and transactive energy, is a significant driver for whatever financial benefit consumers may see from responsive appliances. However,

[7] http://www.eia.gov/electricity/data/eia861/index.html

whether the electricity retailer is a utility or a competitive provider, there is limited incentive or opportunity to provide dynamic pricing. Where the regulated utility is the energy retailer, there is generally a desire on the part of both regulators and consumers to maintain existing non-dynamic rate structures and designs. In markets with competitive service providers, marketing is focused on the simplest possible comparison to the incumbent utility, which usually offers a flat rate tariff. In either case, even where there is the potential of a price or rate advantage, the perceived complexity of marketing on price or rate limits dynamic pricing to large commercial and industrial accounts.

2.5 Perspective of State Regulator

Barrier 10: State Jurisdiction
A given PUC or board has jurisdiction only over utilities in one state, and may have no jurisdictional authority over municipals and co-ops. This factor, combined with the limited federal jurisdiction over retail electric tariffs, policies, and procedures, reduces the likelihood that all 53 of these jurisdictions[8] will agree on a common implementation or communications protocol for responsive appliances.

Barrier 11: Legal Constraints
In much the same way that the utilities are constrained by law, rule, or precedent, the various state regulators, though they may have broad powers over the corporations they regulate, are constrained in what they can require of retail service providers and certainly of customers. In many states, these limitations are reinforced by political or related issues.

Barrier 12: Resource Limitations
In many states, there are few or no specific, legislated, requirements in place regarding the qualifications or background of commissioners.[9] In addition to this, because of selection processes, term limitations, or other factors, commissioners may not remain in office for a sufficient time to gain a broad range of experience, or to guide a longer transition process. This, in some cases, leaves the commissioners heavily dependent on the agency staff to develop and maintain the required expertise. Here too

[8] In addition to the 50 state agencies, each Territory and the District of Columbia also have independent retail regulation of electricity.

[9] In 23 jurisdictions there are no qualifications required for commissioners, and 44 states have no academic requirements. Only 10 states require both academic and experiential qualifications. Source: Institute of Public Utilities, Michigan State University, Database of Commission Structure, available at: http://ipu.msu.edu/research/pdfs/IPU%20Database%20on%20Commssion%20Structure%20(2013).xlsx

there may be resource limitations, as agency staffing levels vary widely, from as few as 3 positions to nearly 1,000.[10]

Barrier 13: Expectations of Consistency
Traditionally, regulation tends to view consumers as relatively monolithic blocks of consumers, and approves tariff designs accordingly. However, one size does not fit all market designs, all consumers, or even all those in a given customer or tariff classification in a single market. Among residential consumers, early technology adopters often help build confidence among skeptical consumers. However, as PUCs are generally required to make decisions that are in the interest of every consumer in a market segment, PUC decisions tend to favor those where there is clear evidence that all consumers will benefit under "status quo" conditions. This tendency by PUCs limits the opportunity for those consumers who would be early adopters.

Barrier 14: Realizing Utility HAN Investment
Sizable investments now exist in the smart meters in many states in the form of HAN communications capability in the meter, which was added with the expectation of making residential demand response much more cost effective. The incremental investment to add HAN capabilities to communicating meters is now in the hundreds of millions of dollars. Regulators in most states want to see the benefits of the investment realized; however, the process of firmware maintenance of the meter function has led to unforeseen technical difficulties in maintaining robust communications linkage with demand-responsive devices in the home. These types of interoperability problems are recognized in both California[11] and Texas[12]. Regulators in many states feel a responsibility to pursue policy that makes use of the significant investment made in HAN infrastructure already incurred, which may be in conflict with other policy goals such as security.

2.6 Perspective of Federal Level Regulator

Barrier 15: Federal Jurisdiction
The federal agencies that have authority relative to some aspect of responsive appliances, notably Federal Energy Regulatory Commission (FERC), Department of Energy (DOE), and Environmental Protection Agency (EPA) each have specific, limited, jurisdiction defined by law. While FERC has broad jurisdiction over power grid reliability, this

10 Ibid.

11 PG&E Opening Testimony, CPUC proceeding to Increase Revenue Requirements to Recover Costs to Upgrade Its SmartMeter™ Program, Application No.07-12-009, pages 7-9, August 29, 2008

12 See: http://interchange.puc.state.tx.us/WebApp/Interchange/application/dbapps/filings/pgSearch.asp

jurisdiction is limited to the bulk generation and transmission level. In addition, these different agencies have different legislative mandates. As a result, there may be legislative gaps and/or overlaps to be considered when examining developing demand responsive appliances. However, identifying the extent and nature of these gaps and overlaps would be a significant effort, beyond the scope of this paper.

2.7 Perspective of Policy Maker

Barrier 16: Energy Efficiency Emphasis
While most policy makers are knowledgeable about both energy efficiency and demand response, there appears to be a tendency by policymakers to lean towards focusing on energy efficiency rather than a balanced approach of considering both energy efficiency and demand response. Over the past 25 years, there has been as much as a fourfold increase in appliance energy efficiency through the market effects of the ENERGY STAR® program. However, as appliances have become more efficient, the benefit of further efficiency gains decreases relative to the cost of obtaining them. As a result, increasing energy efficiency beyond current levels may yield less improvement in grid efficiency than a similar investment in enabling responsive appliances.

For example, today's average refrigerator uses less energy in normal operation than a 60-watt light bulb. Another 10 percent improvement in refrigerator machine efficiency would achieve less than a 6-watt savings in power.[13] However, a refrigerator that is aware of grid conditions, resources, and pricing, and could shift its peak demand (500watts of power used during the defrost cycle) to periods when electrical demand, and therefore prices may be lower, or energy from intermittent sources that may be more plentiful. This shift in demand may do a great deal more to improve the energy efficiency of the grid, even though the efficiency of the refrigerator operation is unchanged. While energy efficiency is always beneficial, policies that unduly favor efficiency of individual devices over the potential responsiveness of those devices may undervalue the contribution that responsiveness can make to the efficiency of the grid as a whole, thereby delaying acceptance and adoption.

Barrier 17: Limited Experience and Knowledge with Alternatives
Closely related to the historical emphasis on energy efficiency, policy makers may not be aware of the magnitude of the benefits available from responsive appliances and distributed energy storage to aid the incorporation of intermittent generation, such as wind and solar.

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13 Messner/Sastry, 6th International Conference on Energy Efficiency in Domestic Appliances and Lighting, 2011.

Barrier 18: Narrow Scope of Approach
Policy makers tend to focus on demand response via direct control or price/transactive responsiveness in a mutually exclusive manner. Given the variety of operating conditions and jurisdictional issues noted in this paper, there is a need for policies that favor appliances that can handle either or both.

3 Analysis & Recommendations

Many of these barriers represent chicken-and-egg issues, for example:

- Consumers are unfamiliar and uncomfortable with dynamic pricing for electricity because they have not been exposed to it.
- Consumers have not been exposed to dynamic pricing in large part because regulators and service providers have not been comfortable with requiring or offering them.
- Regulators and service providers cite consumer discomfort with dynamic pricing as a reason for not requiring or implementing it.
- The lack of widespread availability in the marketplace of responsive appliances limits consumer comfort with dynamic pricing.

This is not to say that the cycles cannot be broken. However, it does indicate that some barriers will fall as a direct result of others being overcome, and more importantly that some sets of barriers may have common resolutions.

The following discussion on Implied Resolutions groups the above 18 barriers, and presents proposals for common resolution. While there is a degree of overlap in the groupings, the resolutions address the barriers presented above through the following four discrete categories:

- Economic and Markets
- Regulatory Reform
- Education
- Managing Diversity

Summary of Barriers Identified

Perspective of Consumer	
Barrier 1	Understanding and Meaningfulness of Value Proposition
Barrier 2	Customer Awareness of Impact on Energy Savings
Barrier 3	Unique Characteristic of Regulated Utilities Market
Barrier 4	Expectations of Simplicity, Convenience and Privacy
Perspective of Utility	
Barrier 5	Cost of Implementation vs. Market Considerations
Barrier 6	Industry Diversity and Market Fragmentation
Barrier 7	Resource Constraints
Barrier 8	Regulatory Constraints
Perspective of Electric Retailer	
Barrier 9	Dynamic Pricing Resistance
Perspective of State Regulator	
Barrier 10	State Jurisdiction
Barrier 11	Legal Constraints
Barrier 12	Resource Limitations
Barrier 13	Expectations of Consistency
Barrier 14	Realizing Utility HAN Investment
Perspective of Federal Regulator	
Barrier 15	Federal Jurisdiction
Perspective of Policy Maker	
Barrier 16	Energy Efficiency Emphasis
Barrier 17	Limited Experience and Knowledge with Alternatives
Barrier 18	Narrow Scope of Approach

4 Implied Resolutions

4.1 Economic and Markets

Barriers 1, 4, 5, 7, and 8 argue for solutions that limit the implementation cost of responsive appliances for one or more market participants.

- There is considerable value in demand response aggregated at the utility scale, but no business model has emerged to transfer the energy market benefits to appliance manufacturers in order to fund the costs of manufacturing connected devices at scale. While such a purely market-based solution is preferable, and a number of different market mechanisms have been tried since the passage of the Energy Independence and Security Act, no such solution has yet proven effective.

- Explicit subsidies to consumers, utilities and/or appliance manufacturers may be necessary in order to demonstrate the economic value of responsive appliances, but such subsidies need not be excessive.

- Industry and regulatory consensus around common messaging structures, and unified but flexible hardware platforms and protocols for communicating those common messages will reduce implementation costs.

- Consumers' perceived costs, which include loss of convenience and flexibility in addition to economic costs, must be minimized. Responsive appliances should:

    - Require very little or no consumer interaction once installed,

    - Inform consumers, while preserving privacy,

    - Enable consumer override capability at any time, and

    - Provide ease of implementation and consistency in operation and coverage.

4.2 Regulatory Reform

Barriers 3, 8, 9, 11, 13, 15 imply that some degree of regulatory reform will be required in order to

(a) Expose the market incentives and societal benefits that current regulation and rate setting structures tend to conceal, and

(b) Provide more coherence in regulatory structures between the wholesale markets, regulated at the federal level, and the retail markets, regulated at the state level or below.

Such reforms, while beyond the scope of this white paper, will likely require legislative action at both the federal and state level and will require cogent analysis by the appropriate bodies.

4.3 Education

Barriers 2, 3, 9, 12, 16, and 17 indicate that education and familiarization will be required at every level. Residential consumers need to understand the benefits in order to be motivated to purchase responsive appliances. Regulators and policy makers need to have a greater understanding of the benefits as well, in order to consider appropriate regulatory and other structural reforms required.

- While existing research by the Smart Grid Consumer Collaborative and other bodies indicates the nature of the education required for the residential consumer, more work can and should be done in the development of consumer education programs.

- A comprehensive analysis of the value proposition for various market participants (particularly consumers) needs to be conducted. While there will be variations in the exact value for the individual market participant, an analysis similar to PNNL-19083, "Use of Residential Smart Appliances for Peak-Load Shifting and Spinning Reserves" by Sastry et al, but larger in scope, would provide valuable indicators of the true value proposition.
- Societal pressure and consumer education / awareness may be more significant drivers than cost savings in the decision to purchase responsive appliances. Looking at the experience of recycling as a cultural phenomenon, there is indication that the desire to "do the right thing" provides motivation, even where there is a cost to do so.
- To a great extent, the availability of responsive appliances at any scale will assist with the educational process (see the discussion of early adopters under Barrier 13).

4.4 Managing Diversity

While Barriers 6, 7, 10, 11, 12, 14, and 18 indicate that diversity in implementations is a functional necessity, simply because the operating characteristics and conditions of the provision of electric service are not monolithic. Barriers 1, 4, 7 and 8 appear to argue for nationwide unification around a single technology so as to minimize per unit costs. Diversity cannot, and indeed should not be eliminated, but careful selection of flexible and modular technological solutions, such as ANSI/CEA-2045, "Modular Communications Interface for Energy Management",[14] can allow needed diversity, while providing common benefits and cost reductions.

- Technology solutions should allow for different communication platforms, with sufficient commonality in messaging to allow for application at scale.
- Solutions should not preclude differing architectural arrangements for responsiveness (utility control, aggregation, customer owned management, etc.)[15]

[14] A summary of ANSI/CEA-2045 is available at: http://www.ce.org/CorporateSite/media/Standards-Media/Standards%20Listings/ANSI-CEA-2045-Preview.pdf and http://docs.caba.org/documents/ihomesandbuildings/CABA_iHomes_Autumn_2013_web.pdf (pp. 15-17).

[15] A number of the possible options for demand response energy management are specified in ISO/IEC 15067-3, "Model of a Demand-Response Energy Management System."

The widespread availability and installation of responsive devices[16] that are capable of supporting communication for grid-aware energy management represent a classic public good—there is significant societal value, but no obvious entity can front the cost to create the public good.

Where limited customer demand increases manufacturer risk beyond an acceptable level, and limited retail presence of responsive appliances limits customer awareness, and demand is a circular problem, the question becomes how to resolve the circular problem of scale in a timely fashion.

As noted in Barriers 1, 2, and 3, consumer demand is not currently present at any significant level. Even after considerable public education, it seems likely that the early adopters will not represent a sufficient market for manufacturers to risk creating and manufacturing connected devices for the value-based product lines. The authors do not believe that education alone will achieve scale for responsive appliances in a timely fashion. Thus, an incentive-based approach is recommended.

At a high level, there are two possible solutions:

- A purely private sector business model where utilities provide financial incentive to appliance manufacturers; or
- Some form of government-sponsored incentive to appliance manufacturers.

Given the diversity of appliance manufacturers (as noted in Barrier 5), utilities (as discussed in Barrier 6), and state regulatory constraints (Barriers 10 - 13), the development of a consistent approach for utilities to provide a common incentive to appliance manufacturers seems unlikely in the short term.

Some form of government-sponsored incentive might be a financial incentive to manufacturers and/or customers, or a direct requirement. Given the identified benefits of more rapid implementation, and the slow turnover of installed appliances, a direct requirement may be most beneficial.

Barrier 14 requires a different action plan, which is addressed below. Standardization of the responsive appliance will ultimately be the key to reducing cost of the consumer connecting to the appliance, and more importantly the key to creating scale of responsive devices over time as appliances are replaced. Nonetheless, it does not solve the problem that many stakeholders need access to many responsive appliances. Barrier 14 is the current manifestation of this problem, but the general problem is that a robust architecture is needed to allow many stakeholders to reach many responsive appliances within a single

[16] While this paper focuses on devices that are traditionally considered “loads,” the availability of a common platform for communications with distributed generation resources has nearly identical impediments and benefits.

customer premises. Utility operated communications networks are but one example of the many stakeholders that have a legitimate need to access responsive appliances. Other stakeholders include manufacturers of responsive appliances, balancing authorities, and mostly important the tenants of a premises. Each stakeholder could have a different preferred access tool such as a smart phone, web portal, on-premises desktop control tool, etc. An electronic gateway is frequently cited as the solution for the tool to facilitate the many-to-many transactions required in the end-state.

The authors recommend the following 3 steps.

- Single Standard Required at the Appliance
- Process to Achieve a Standard at the Appliance
- Create Technology to Solve the Many-to-Many Transactions

These steps can be executed in parallel, whereas the sub steps listed are usually expected to be executed sequentially.

1. Single Standard Required at the Appliance

Under federal oversight and timelines by an entity with statutory ability to enforce (see Steps 2.a and c below), but not decision making authority, create a technical body with decision making representation from manufacturers, utilities, and balancing authorities; customer and regulatory needs and concerns must also be represented. The body will evaluate existing standards appropriate for implementation, nationally, under a federal requirement. Existing standards are preferable, but gaps, if any, can be identified and solutions to solve the gaps recommended.

2. Process to Achieve a Standard at the Appliance

a. Research legal authority of federal entities to impose a requirement to add grid-compatible communications capability to new electric consuming/generation devices.[17]

b. Find co-sponsors to support the implementation of the requirement: utilities, manufacturers, environmental organizations, and other stakeholder organizations.

c. If legal authority does not exist or is insufficient, solicit one of the federal entities to join the co-sponsor one of the groups identified above. Jointly the co-sponsors should propose legislation to give the federal entity legal authority.

[17] Highest priorities would be HVAC, hot water tanks; EV/EVSE, and solar inverter devices.

d. Promote the identified standards defined in Step 1 above as a requirement.

e. Together with Step 2d, or with legislation if required, develop a national-level customer education program, similar to that supported by ENERGY STAR®, to increase awareness of benefits and expectation of effects if a customer participates.

3. **Create Structures and Technology to Solve the Many-to-Many Interactions**

a. Regulator Education – references, instructional material, webinars, and technical outreach should be developed to address basic educational issues highlighted in this paper.

i. AHAM, CEA, and a number of other commercial organizations provide a potential resource for much of this material.

ii. There are a number of utility pilots that have tested the gateway, device connectivity, communication, and other issues that should also be presented.

iii. Finally, DOE has previously funded Smart Grid technical training for state commissions, NARUC, NRECA, APPA and NASUCA that could be expanded to address smart appliances and devices specifically. The Smart Grid Technical Advisory project at Lawrence Berkeley National Laboratory might represent a useful approach for this type of effort.

b. Demonstration Projects Modeled After the Green Button Initiative – the Green Button initiative was successful for two primary reasons: (1) it started with a clear set of objectives to standardize data access, and (2) it instituted an open competitive process that did not require direct utility participation. The key elements of a Green Button approach to smart appliances/connected devices would include:

i. Work with federal agencies to establish grants with matching dollars to fund a select number of state commission competitively awarded demonstration projects that meet specific smart appliance project criteria:

1. Use of gateways, addressing multiple physical and communication protocols for in-premise devices,

2. Customer control,

3. Could also include specific standards for utility signals (OpenADR), customer devices (ANSI/CEA-2045), etc.

4. Integration of multiple WAN and, LAN options,

5. Matching federal dollars would include requirements for specific engineering studies, evaluation measures, and reporting.

ii. Instead of regulatory commissions funding utility pilots, regulators would establish utility-funded grant pools that would be used to match federal funds to support competitively awarded demonstrations.

iii. Multiple demonstration projects would facilitate regulator, public, and industry education and would provide real examples to illustrate technology, standards, and innovative marketing tools.

5 Conclusion

As has been noted elsewhere within this white paper, there is a great deal of commonality and overlap among the social, economic, regulatory and policy barriers to the development of a robust widespread market for consumer appliances capable of responding to grid signals and conditions.

The opportunity that responsive appliances represent in the aggregate is significant, even as the incentive associated with making any individual appliance responsive is small. Because of the disparity between the aggregate benefit to the grid and the limited benefit to the consumer (or manufacturer) of an individual appliance, the opportunity may not be sufficiently understood or appreciated by those responsible for decision-making, whether the manufacturer, service provider, regulator, or consumer. In addition, the diversity and sheer number of items involved creates an environment where the decision making required is broadly spread at many levels. As a result, policy and regulatory decisions required are delayed.

This white paper proposes a series of steps intended to:

- Narrow the gap between the aggregate benefit and the individual cost
- Make the opportunity more broadly known and appreciated
- Clarify the needed decisions and processes

While other, possibly better, paths to a robust market for responsive appliances certainly exist, it is the hope of the authors that this white paper serves as a focal point and basis for discussion and identification of a common path to a goal that clearly benefits society as a whole.