Demand Responsive Residential Appliances Interface with the Smart Grid

Statement of the Issues to be Addressed

Historically; smart grid energy management is perceived just for large utility or industrial scale energy distribution; however, demand response-enabled home appliances and equipment will allow residential customers to interact with the grid. There is no single standard approach for how the appliances communicate with the grid. That is, what is the nature and frequency of a utility or price signal and how is it transmitted, received, processed, displayed, 'valued' and managed (e.g., responded to) as part of a demand responsive home appliance network.

This White Paper will identify and address issues central to utility interaction and consumer interaction with home appliances and equipment that are demand response-enabled and thus capable of responding to signals from the electric grid. The focus is to try to anticipate conditions in the smart grid environment 5-10 years down the road

The following outline for the White Paper is suggested:

I. Discussion of markets that make demand response (DR) attractive: wholesale (ISO/RTO) to retail

Many questions arise when what market is to be considered for demand response. Why is demand response at the residential consumer level attractive to consumers? Why is it attractive to utilities? Why is it attractive to the ISO/RTO wholesaler? What about vertically integrated markets (no ISO/RTO)? How quickly and how often will the consumer be alerted to a 'response' and will a signal be sent to the appliances? How often is too often? What time scale is the most profitable for every stakeholder? What role would microgrids play? What is the value of to wind and solar (PV) integration?

A. 5, 10, 15, 60 minute live pricing market (LPM)

5, 10, 15 and 60 minute LMP is where the real time wholesale price is updated every x minutes based on supply within the balancing authority (ISO/RTO). The LPM will not take into account any grid-enabled appliances/frequency controlled signal/events, which may prove to be of value if a blackout is prevented.

B. 24 hour day ahead market

The 24 hour day-ahead market is a prediction of the supply (capacity) based on previous days' loads combined with a forecast and scheduled generation resources.

C. Demand response market

Demand response markets allow the retail utility to respond quickly to grid events and ideally notify consumers to reduce their consumption thereby reducing loads and preserving the system's ability to serve loads, mitigate price peaks and prevent outages.

D. Other market structures

Do other market structures exist or in the planning stages that should be discussed? What about FERC's proposal for an energy imbalance market (EIM[1]) in the Western Electricity Coordinating Council (WECC) that may be a place for these resources to "play".

E. Historic loads vs. potential loads

Historic loads use an analysis of the past to predict the current and immediate needs. Currently, most systems use this method. However, historic loads are prone to over stress and become non-adaptive.

[1]Report can be found at http://www.wecc.biz/committees/BOD/EDTSC/EDTTRS/EDTTRS032411/Lists/Presentations/1/E3_EDT_Phase1_2011-03-24_EDTTRS-FINAL.pdf

The use of historic loads as a pricing basis tends to under bid yielding a loss of revenue. The use of potential loads combines the predicted demand market growth, weather conditions and transmission/generation failures to predict need. Is this a conservative approach in which there is a tendency to over bid? Is this primarily a summer peak situation where after several days of hot weather, the tolerance by consumers for turning down air-conditioning drops off rapidly as temperatures continue to be high or rise and drop out of programs if it interrupted too much?

F. Historic issues with consumers and load control

People typically do not like change, they are creatures of habits. Thus, if notified that high/peak prices are being reached the consumers often will not reduce their consumption. What have been the historical experiences (if any)? What would be a customer response if they have the needed tools? This includes but not limited to internet connected smart appliances or programmable communicating thermostats), access to prices and rate structures, the incentives in place for participation and programmable home energy management (HEM) systems.

G. Direct load control vs. probabilistic modeling of responses

Is the load running and will consumer override? Can the whole home under a HEM be a better source of DR than individual products in the home? What is the value of a HEM accesses to the GreenButton™ site with pricing info unique to consumer. [2]

II. Consumer's current perspective of smart grid

This section will discuss how the consumer perceives the smart grid and how the possible options for the consumer to interface or interact with the smart grid. Does this require a life style change and more complication into their life—unless the response is automated? Consumers need to be educated about the advantages, monetary rewards and how minimally and seamlessly it can impact their life.

A. Options for interface and connections with grid-enabled appliances

What is the network for communicating? This includes displays on the appliances, home (wall) displays, smart phone apps, desktop computer displays, etc. Are appliances with a 'slider' switch or programmable communicating thermostats with a slider for a common interface appropriate? Can the chosen interface be replicated on web pages or a smart phone? What about the value of operations and maintenance information?

III. Economists perspective of smart grid

This section will discuss and economic perspective of the smart grid and in particular issues around dynamic pricing and the market competition that impacts these prices in these markets.

A. Consumer purchase price is tied very closely to cost of generation, transmission and distribution, needing real time rates.
B. Introduction of competition in traditional monopolies. Is there regulatory support for utilities to pay for these resources?
C. What about deregulated states like Texas and Ohio where 3rd party service providers play…what additional functionality is introduced into the market in the future?
D. What is the value for integration of wind and solar (PV)?
E. What is the value proposition for electric vehicles (EV)?

IV. Social/behavioral scientists perspective of consumer reaction to the smart grid

This section will review and discuss studies of how consumers have reacted to the 'smart grid' as well as the possible future implications of the smart grid on human behavior. What experiences can be

[2] http://www.greenbutton.com/

gleaned by the California Energy Commission attempt to add programmable communicating thermostat standard to building codes?

V. Utility perspective of the smart grid

This section will summarize the expected (future) benefits to the utility of a residential-sector based smart grid.

A. Residential renewable (PV) integration, energy storage, load control, microgrids (islanding and/or disaster recovery) and backup generation.
B. Impact and integration of EVs
C. Anticipated role/impact of smart grid-enabled appliances for efficiency, demand response and blackout mitigation.
D. Whole home energy advisor with intelligent learning algorithms that advise consumers on how best to manage energy usages under given circumstances and ultimately adjust automatically.
E. Layers of energy management intelligence and coordination (Whole Home, cul-de-sac, neighborhood, feeder)

VI. Aggregator's perspective and business cases

i. Role of aggregators

What role does an aggregator play? What is the communication strategy for aggregators and the market? What is the value-added of an aggregator?

ii. Utility as aggregator

What is the business case for the utility (efficiency gains vs. lost revenue)? Is this an appropriate role given the utility structure? How does de-coupling impact utility as aggregator

iii. Private sector as aggregator

What is the business case for the private sector? What is the history to date? Historically, the private sector aggregators supply a fraction of the energy consumed, but through effective integration could be relied upon for consistent peak load contributions. What does private sector aggregator think about

i. Whole home energy manager biding into wholesale markets
ii. As more and more residential smart device are introduced how
iii. does that change the market
iv. Which rates work best for aggregators 5 min, 30 min, 1 hour…?

iv. Deregulated service providers

What is the business case for deregulated service providers? What has been the experience in Texas?

VII. Major residential load device manufacturer perspective of the smart grid.

This section will discuss why (or why not) load device manufacturers (e.g., appliance, HVAC, water heating, other equipment manufacturers) see benefits to smart grid-enabled equipment. This will focus primarily on domestic manufacturers, but will include non-U.S. manufacturers and products.

A. What is the business case?

What is the cost-effectiveness for an appliance controller and how quickly can it respond via communications or respond to a downloaded signal?

i. How can each devices load be managed to optimize DR for the whole home?
ii. How might these manageable loads play into structured and non structured wholesale markets?
iii. Advantages in vertically integrated markets?
iv. Thermal energy storage and negawatts—is there a market?

VIII. Features/configuration of home as a participant in smart grid/DR

This section will discuss the loads in the home appropriate for DR/control. Which loads/appliances would be controlled and what is the nature (a display?) of the control setting? Although, most consumers will likely leave the controls set at industry defaults, the consumer ultimately selects which appliances are controlled.

A. Description of the possible loads

This section will discuss home appliance penetration and appropriateness of the electric appliances for DR. The two biggest loads in homes are the HVAC and the water heater. Additionally, most homes have refrigerators and dishwashers. Other significant electric appliances include dryers and possibly clothes washers.

B. Discussion of home communications for DR signals

Residential sector communications (including among appliances, with a display, and with the utility) are limited and there is not a single de-facto standard which would yield a consistent acceptable communications strategy that would serve all needs (including different equipment manufacturers). Should a single communications standard be selected?

C. 'Green Button' initiative

This initiative is the idea/plan that a consumer can view their own energy usage whenever they want over the internet. The plan is being implemented at the start of this year, 2012, with many utilities signing on. How effective will the 'GreenButton' be over time?

IX. Residential sector limitations

This section will describe the barriers to participation in DR.

A. Value proposition

What is the value proposition from the customer perspective? Energy cost savings may not be high enough to pay for the DR technology. What is the marginal cost and what is the payback?

B. Predictability

For real time pricing, how will the consumer be able to respond without a burden? Set and forget? Are water heater demand response programs over the past several years given us some insights into this question?

C. Rewards and rate structures

What rewards and incentives are there to encourage the consumer to purchase a DR appliance and/or retrofit an appliance for DR? Who provides those incentives (if any)? What size of incentive will it take?

D. What's in it for the customer?

Ideally, the consumer will want to be green and save the environment. However, the consumer is going to save money through reduced energy use. Consumers need to see an incentive to this program. What do the consumers have to do in order to get into this program? Is this going to cost the consumer and how much?

E. Do standards play a role?

Are there appropriate standards (building codes or appliance standards) that should be promulgated?

X. Barriers

A. Consumer

i. Too complicated for the consumer to understand?

This system needs to be easy for the consumer to adjust to their personal settings whenever and where ever they want. Should this be configured so the consumer can 'set it and forget it'? There are those that do not want this management system to interfere with any part of their daily life as life is already complicated.

ii. Is privacy a concern?

Privacy would be a concern if the utility has access to individual energy monitoring/control programs. Consumers need to be assured their system only sends total consumption information and that their system in turn receives the information necessary to make predetermined adjustments

iii. How does the consumer get involved?

This needs to be a simple or automatic enrollment. What actions by the consumer will need to take place?

iv. Will there be an additional cost and do the benefits outweigh the costs?

A controller for user interface devices is designed to allow consumers to communicate with smart grid-enabled appliances and assess their function in order to modify and increase their efficiency. However, there is a cost related to each device and specifically the technology each requires to communicate with the system. Is an incentive for such a system appropriate? If so, what level of incentive and who would pay?

B. Aggregators

How does the aggregator engage the customer and how will the customers respond?
What are the advantages to consumer and aggregator/service provider/utility?

C. ISO/RTO

The ISO/RTO requires an assured market, which is easily provided by the utility's need for peak energy. Peak energy needs are more effectively provided through an independent aggregator because they save the utility the need to build more infrastructure (energy producing capacity) for a limited need. Will utilities limit demand response programs in favor of new generation, oftentimes because it is easier to rate base generation?

D. Utility

Does the utility gain overall better response and consumer participation to DR? What are the regulatory barriers in different states and what arguments would have to be made to encourage the necessary changes? How is this different in vertically integrated verses ISO/RTO environments? How differ in de-regulated states vs. not deregulated? How different in de-coupled utility environment vs. not de-coupled? Is DR a net gain or loss to utility? To the consumer? Are the requirements placed on the utility by regulators a barrier (i.e., cost recovery)? What about lost revenue?

E. PUC

Any 'system' has a cost. Will a regulator allow that cost to be recovered? What will be major objections? What will they need to feel 'comfortable'?

F. FERC

There are no published standards for user interface. Will FERC enter into that development? If so, will that be a long and onerous process that creates barriers?

XI. What 'Standard' is needed and where is that standard located (organization)?

Standardization of the home DR 'system' and communication needs to be established. There also needs to be standardization of fast communication between utilities and service providers. Is SEP 2.0 appropriate? openADR? Other?

XII. Next Steps

What are specific next steps to move forward?