Approach for Grid Responsive End-Use Devices

Introduction
For 100 years, appliances built to serve one master.... the customer/user.

Most appliances have user interfaces that rate among the best ever designed... ingenious simplicity and functionality.

Basic Problem Statement:
How to make appliances grid responsive\(^1\) without losing the utility of appliance and the simplicity of the user interface, while at the same time creating an means to give equitable compensation to the customer/user for the flexibility they provide to the grid.

The problem above is a very complex. Realistically, to get acceptance from stakeholders, this will take several years to reach consensus around a solution to the problem, and even longer to get a standard transaction to support the solution. While the problem below is framed for the home appliance, the technique, to be effect, should be universally applicable to all end-uses. The process, while implemented by energy service providers and end-use device makers, will be beneficial to both the distribution and power operations domains. Accordingly, we need their input as stakeholders.

Assumptions
Over the next ten years, appliance controls will continue to shift from mechanical/analog controls to electronic-based controls.

Moore’s law will continue to lower the cost of powerful computing options available to price-sensitive appliance manufactures.

Solution: (One of many possible)
Define a flexible and extensible logic model inside the appliance controls that meets the following requirements:

- Accepts the current inputs from users
- Adds customer inputs that define their flexibility for appliance operation (none to a lot.)
- Accommodate a standard set of inputs from the “grid” (Besides current price and a near-term forecast of price changes, ideally these inputs would describe the “grid’s need” for

\(^1\) Goals of grid-responsive end-uses: 1) reduce the cost of making electricity, and 2) be responsive to the unpredictable nature of renewable power generation.
the appliance to provide: Voltage regulation services, frequency regulation (very short
term requests for power reduction or power increase\(^2\), and load shifting requests.)

Now consider, based on these inputs, that the appliance defines dynamic short term and long
term operational objective functions. The proposed model is that as the appliance receives
standard grid signals, and using internal, proprietary logic, chooses to modify either the short
term or long term objective functions to accommodate the grid. If and when the appliance (or
any end-use) modifies an objective function, the model proposes a standard way to calculate the
energy changes implemented by the appliance to be “grid responsive.” These changes would be
recorded (in non-volatile electronic memory) as cumulative efforts. These cumulative
contributions would be defined with standardized metrics, for example, one might be a register
that records the watt-hours of frequency regulation service provided.

These standard registers could be read from time-to-time via a variety of automated methods
(even as rarely as once a month), if permitted by the customer. For privacy reasons, the
customer might choose to listen to 1-way grid signals so as to be a good “grid citizen” but forego
the economic compensation. A service provider, after reading these quantified metrics, would
give the customer billing credits (under pre-defined pricing terms) to compensate them for
providing flexibility to the grid.

Next steps

- Agree on the Problem Statement
- Create example of the appliance model logic
- Create example of grid signals
- Create example of conformance testing
- Create example of tariff incentives

Put into a white paper and circulate for comment.

\(^2\) Note that if 50% of connected load (motors on variable speed drives, resistance heating, end uses that can
achieve efficient use of thermal storage, battery chargers) could moderate their power use by +/- 20% then we are
talking about a collective grid control capability of power the 50,000 MW.