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The Opportunity for Immediate Action Leveraging FM Networks to Enable Demand Flexibility

The costs and complexity of various technologies and standards comprising 2-way network technology are a major impediment to wide scale implementation of demand flexibility for pool pumps and other devices.

Just as the last-mile was a significant bottleneck to broadband build-out, all homes and devices needing 2-way communication capability is throttling smart grid deployment. The technical difficulties of this approach are essentially insurmountable, thus smart meters have yielded little benefit in realizing demand response and transactive pricing (DR/TP).
Fortunately, the asymmetry of front-channel â€œbidâ€ and back-channel â€œaskâ€ data requirements that are inherent in the nature of the grid offer a solution. The existent national FM radio network combined with RDS-based Utility Message Channel (UMC) technology provides the missing link and can scale quickly starting now. This technology has been tested extensively with major utilities over the last 5 years and is currently deploying its first large-scale rollout.

Additional submitted attachment is included below.

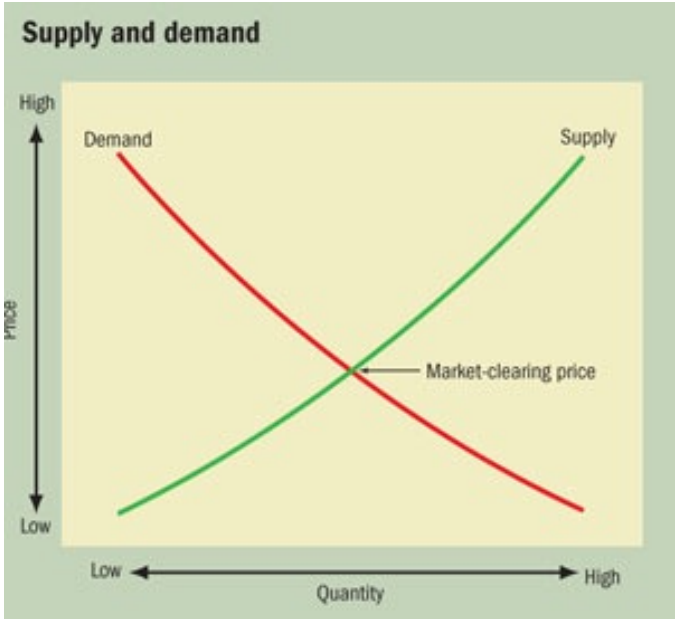
e-Radio technology you can use USA tm

Optimizing the Efficiency of Electricity Markets and Demand Flexibility through Standards for FM Reception in Appliances

For Economic Efficiency to be Optimized in a Free Market Three Fundamental Requirements Must be Met

1) Supply must be variable across a range encompassing targeted demand variation
2) Demand must be calculable as a function of price (the Demand Curve)
3) Supply must be calculable as a function of price (the Supply Curve)

The price at which supply and demand are equal is defined as the market clearing price



Supply and Demand can then be Balanced Minimizing the Cost to Satisfy Demand

Using a Double-Auction Retail Market Price clearing mechanism or equivalent

- to calculate an instantaneous clearing price
- ensuring all demand is met at the least possible supply

The only impediment is the ability to satisfy the three basic requirements

The ability to do so is available now

Only the Second Requirement is Currently Unavailable… This can be be Remedied Over a Short Time Horizon

1) Supply must be variable across a range encompassing targeted demand variation
2) ***Demand must be calculable as a function of price***
3) Supply must be calculable as a function of price

Let's Consider the Difficulties we Face Trying to Meet this Requirement and Examine Two Solution Approaches

Demand must be calculable as a function of price

- Every device controlled by every customer connected to the grid will have its own demand curve as a function of time and price
- From which rooms you want to light to how warm to keep each sector of your house to when to wash clothes etc. will all depend on the time of day, month, year, the price of the needed electricity at each time and your own trade-off decisions
- Demand at each moment from each customer will be the sum of the demand from each device at each moment
- Demand at each substation will be the sum of demand from each customer at each moment

There are Two Ways to Satisfy this Requirement, One is Very Hard, One is Easy… First the Hard way

- We could add the instantaneous demands of each device at each possible price point at each customer to create a demand curve for power at each substation node as a function of all device node demand curves
- Every device demand curve would be different based on device characteristics, home characteristics, and customer usage decisions as a function of price
- If we could track each device's usage as a function of time and price we could aggregate all the demand curves into a substation demand curve
- We could then calculate the instantaneous clearing price and the related supply needed to optimally meet the clearing demand at each instant (or clearing cycle, generally envisioned as approximately 5 minutes)
- That clearing price would need to be communicated back to each device (node) each cycle so that each device could modify its usage according to its demand curve

This Bottoms Up Approach is not Only Very Hard it is Practically Impossible

- It would require two-way communication ability at every device affected (at each demand node)
- Every home meter would aggregate the demand signals from every device and communicate the aggregated demand to the substation every cycle
- It would require the substation to aggregate and communicate the total demand each cycle to generation nodes
- A clearing price calculation mechanism would combine total supply and demand data to calculate and communicate the instantaneous clearing price to every device which would adjust its usage accordingly

Just as the Last-Mile was a Significant Bottleneck to Broadband Build-Out, all Homes and Devices Needing 2-way Communication Capability is Throttling Smart Grid Deployment

- Technology competition
  - Many competing technologies with different advantages/disadvantages
  - Appliance/vehicle makers, commercial/residential builders, and others are delaying adoption and rollout until the potential options narrow
  - Rapidly emerging technical option variations
- Protocol contention
  - Regulatory agencies, hardware/software makers, appliance/vehicle mfgs, etc. struggling
  - All-encompassing protocols trying to anticipate any tech market competition winners are difficult to write and by definition weaker and hard to build consensus around
- Cost and time to install, uncertainty about the feasibility of solutions
  - Each available 2-way communication technology has constraints to rapid scaling to outer nodes – costly per appliance, costly to install, time/resource intensive to install/setup
  - All have significant but poorly modeled network congestion problems
  - All have significant but poorly modeled phantom power problems
  - Beyond the challenges of ubiquitous installation of communication devices at nodes, no specific network technology can feasibly scale to cover 95% plus of US homes in the near term

The Technical Difficulties of this Approach are Essentially Insurmountable thus Smart Meters have Yielded Little Benefit in Realizing Demand Response/Transactive Pricing (DR/TP)

- Adding two-way communication capability to every electrical device on the grid is infeasible for many reasons
- The cost to add such capability to most devices would increase the cost of the devices significantly
- A single communication technology and standard would have to be agreed upon before manufacturers could begin to plan such sweeping design and manufacturing investments to enable all of their products
- The capacity capability of the communications network would be congested significantly from messages sent back and forth from/to tens of billions of devices every 5 minutes (or any useful cycle period)
- The reliability and penetration range of two-way communication technologies is nowhere near sufficient: interruption and rebooting of every device in a customer's home at any frequency is a nonstarter; critical devices such as water heaters frequently reside in generally poorly penetrable basements

Fortunately, Asymmetry of Bid and Ask Aggregation Level Requirements by Node-Level is Inherent in the Nature of the Grid

- 5-minute price clearing requires bid and ask data on that time period
- The Auction mechanism can only take place with aggregated demand curve data at a node level that has the capability to manage supply – i.e. at the Feeder Level or higher – since changing the market price based on a single home or device demand obviously makes no sense
- Therefore, disaggregating Feeder Level demand by home or appliance node adds no value to the Double-Auction Retail Market Pricing mechanism. In fact, such disaggregated bid data must be re-aggregated in order to use it
- However, for the low-level nodes to moderate their consumption based on the (Feeder Level) cleared Market Price data (as it is cleared every 5-minutes or at some other interval) this data must be communicated to those nodes frequently. Ideally at the same frequency as the market clearing activity.

These Asymmetric Node Level Requirements for Front Channel and Back Channel Communication Offer a Solution

- As noted, sufficient back-channel demand aggregation and communication capability already exists at the feeder station node level and above to enable price clearing and Demand Response/Transactive pricing
- Therefore the only missing hinge factor element is a ubiquitous, inexpensive, reliable, single adopted standards-based, front channel network
- This element already exists and can be implemented nationwide in a matter of years not decades

The Existent National FM Radio Network Combined with FM Technology Provides the Missing Link and Can Scale Now

- The use of easily scalable 1-way FM-based communication to low-level nodes
- Obviating the cost, difficulty, inefficiency, unreliability, and time-to-market challenges inherent in trying to connect all appliances to a set of competing, two-way, incomplete network technologies

A Ubiquitous Signal Solution can Enable DR/TP Now

- We can deliver continuous cleared price information to all node level devices (much faster than 5 minutes with national signal latency under 5 seconds and delivery with complete redundancy and security overhead in less than 30 seconds)
- Avoidance of 2-way communication at low-level nodes eliminates privacy issues
- We cover 94% of US homes with less than 5 seconds of latency now. We can have 100% of homes very quickly whenever needed
- Feeder nodes automatically aggregate all lower-level node demand. The actual aggregated demand will supply aggregated bid data to the rest of their grid section in real-time enabling the Double-Auction Market mechanism to clear prices
- All lower nodes will get real-time cleared price data from feeder-level market clearing process by way of the FM-based signal and adjust their individual usage accordingly
- Relatedly, building-based Double-Auction pricing control markets using BAS systems such as described in Battelle's *Transactive Controls: Market-Based GridWiseTM Controls for Building Systems* can be executed with e-RadioUSA's proxy signal as well. The building node only needs the cleared price data from the feeder node. The internal Double-Auction market mechanism employs the BAS itself for internal communication across internal building nodes

Utility Message Channel (UMC) Technology has been Tested Extensively with Major Utilities Over the Last 5 Years and is Currently Deploying its First Large Scale Rollout

- Extensive testing with major utility partners has demonstrated the reliability of signal coverage, penetration, and device control signal efficacy
- Testing on the most challenging and valuable device type – load shaping on electric water heaters
- This load shaping on the 50 million residential electric water heaters in the US can reduce peak US electrical generation requirements by 50 to 200 GW (5%-20% of current total US electrical generating capacity}
- Similar shaping on residential air conditioners, pools, and hot tubs, plus commercial hot water heaters air conditioners, could further reduce future peak requirements by a greater amount
- This capability would obviate much of the current financial hurdles for economic integration of the alternative power generation capacity investment
- The ubiquitous coverage and long wavelength penetration capability of FM signals obviate the major insurmountable hurdles gating 2-way implementation of DR/TP
- Dual-mode capabilities include Wi-Fi capability for the small percentage of applications that really require at least an intermittent low node backchannel but still need the reliability and security of the clearing price delivery