Evolving Integration of Demand Response

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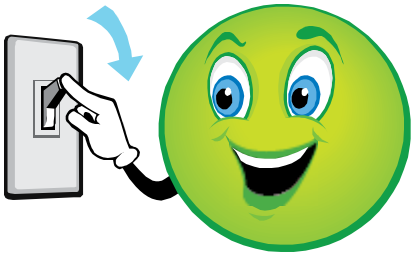
DR dispatches essentially request a deviation from the normal usage of electricity. This can range from a minor or even unnoticeable inconvenience, such as dimming lighting and adjusting thermostat set points, to deferring and industrial process.



DR as a Reliability Resource

- Dispatched when capacity or supply is constrained.
- Programs included interruptible programs dispatched through broadcast signals to DR program participants.
- Offered little in the way of feedback to estimate the performance of the event in order to manage real time operations.
- Limited capabilities for targeted dispatch to direct the DR resources in the areas that needed them most.

Wholesale Market Integration

- Wholesale electricity markets have been working for several years to integrate DR resources as competitive alternatives to generation resources.
- Aggregated or large DR resources can now be bid into Independent System Operator (ISO) and Regional Transmission Organization (RTO) markets
  - Dispatch is triggered by market prices & conditions
- Catalyzed by FERC orders
  - 719 (Wholesale Competition in Regions with Organized Electric Markets, 2008)
  - 745 (Demand Response Compensation in Organized Wholesale Energy Markets, 2011)

Distributed Energy Resources & Renewable Generation

- Distributed and renewable generation resources are proliferating as the cost of solar and wind generation decrease.
- The variability of the renewable generation resources present a challenge
  - for power procurement roles at electric utilities
  - for ISOs and RTOs that must balance electricity supply and demand in real time.
- The intermittent aspect of renewable resources can be addressed in part by utilizing DR as contingent resources

Grid Modernization

- Initiatives including Advanced Metering Infrastructure (AMI), Distribution Automation (DA) and Outage Management are drastically expanding grid monitoring, command and control capabilities.
  - Note: AMI does not include real-time feedback to grid operators, but does provide a metering source for potential settlement
- DR cannot be considered in isolation
  - DR is a component in an evolving portfolio of resources including energy storage

Business Case for DR

- The business need and context for the DR programs must be understood.
- DR as a competitive resource with generation resources depends upon the investment required for enabling DR for participating customers.
  - The economic overlay of Locational Marginal Pricing (LMP) can help determine the economic viability of investment.

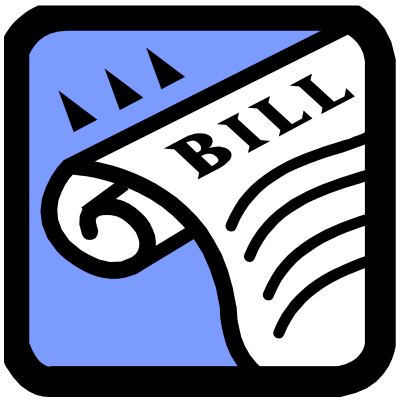
- DR program implementation and administration costs as well as the customer compensation can determine the bid price for DR participation in the electricity market.
  - The total of these costs may or may not result in a competitive resource

Electricity as a Commodity

- Fundamentally, the need for DR relates to the fact that electricity demand today is inelastic.
  - The price of electricity consumption is known to be relatively constant by consumers
  - Electricity use is not influenced by the actual cost of supply (generation).
- The reality for both utilities and balancing authorities like ISOs and RTOs is that the electricity demand by consumers must be met in near real time by generation resources.

Electricity Rates & Tariffs

- Alternative rate structures attempt to align the cost of electricity with the retail rate:
  - Time of Use (TOU)
  - Critical Peak Pricing (CPP)
  - Peak Time Rebate (PTR)
  - Real Time Pricing (RTP)



- These rates either charge more for electricity or incentivize conservation during periods of higher demand and associated higher energy costs.

Technologies, Communications & Protocols

- Modern DR is further enabled by utilizing demand response standards that respond to DR dispatch or price signals
  - OpenADR (Automated Demand Response)
    - Translates DR instructions into BACS languages such as BACNet (ASHRAE 135-2010) and C-Bus, Modbus, X10 and other protocols.
  - Smart Energy Profile (SEP)
    - Embedded in many Advanced Metering Infrastructure (AMI) systems with ZigBee telecommunication protocol
    - Communicates energy usage, messages and DR signals from the meter to a premise or Home Area Network (HAN).

Conclusion

- Demand Response is evolving from a reliability resource to a price responsive and wholesale market integrated resource through the use of technologies and the developing need for a diverse portfolio of resources to meet electricity demand.
- In the longer term, DR becomes a component of Transactive Energy where information communicated between interoperable devices and market participants can balance supply and demand based on cost to better optimize the economics of electricity.