Integrating Increased Dispatchable Demand Response and Dynamic Price Response into NYISO Markets

Customer Behavior Dynamics Modeling – Preliminary Findings

Presented to: The FERC Conference on Market Efficiency

June 29, 2011

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Overview

- Project Motivation and Objectives
- Approach to Estimating DDR and DP Potential
- Modeling Demand Side Dynamics in NYISO's Market
- Interesting Preliminary Findings
  - Impact on Price Levels
  - Impact of Not Getting Elasticity Right
  - Impact of Mis-Aligned Prices/Products (time response)
- Next Steps

DDR vs. DP Definitions[1]

- Dispatchable Demand Response (DDR):

  "*Dispatchable demand response" refers to planned changes in consumption that the customer agrees to make in response to direction from someone other than the customer. It includes direct load control of customer appliances such as those for air conditioning and water heating, directed reductions…and a variety of wholesale programs offered by RTOs/ISOs that compensate participants who reduce demand when directed for either reliability or economic reasons…"*

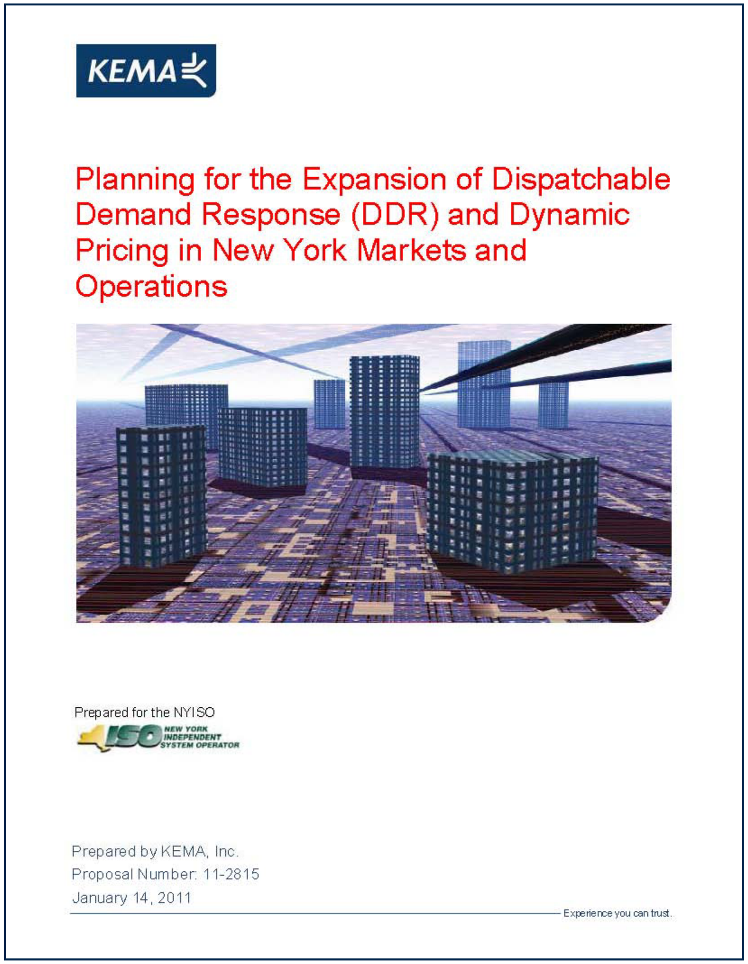
- Dynamic Pricing (DP) response:

  A "customer decides whether and when to reduce consumption based on a retail rate design that changes over time. This is sometimes called retail price-responsive demand and includes dynamic pricing programs that charge higher prices during high-demand hours and lower prices at other times…"

[1] Source: FERC's National Action Plan for Demand Response, June 2010 @ http://www.ferc.gov/legal/staff-reports/06-17-10-demand-response.pdf

Project Motivations

Preparing for dynamic pricing and fully integrating DDR into the markets is a strategic priority for the NYISO


KEMA

Planning for the Expansion of Dispatchable Demand Response (DDR) and Dynamic Pricing in New York Markets and Operations

Prepared for the NYISO

NEW YORK INDEPENDENT SYSTEM OPERATOR

Prepared by KEMA, Inc.
Proposal Number: 11-2815
January 14, 2011

Experience you can trust.

- Explore new entrepreneurial business models that may create opportunities to facilitate growing participation in Dynamic Pricing (DP) programs and Dispatchable Demand Response (DDR) in NYISO markets.

- Understand customer demand side participation in the NYISO wholesale markets through DP and DDR.

Project Objectives

- Identify Dispatchable Demand Response (DDR) potential
  - Determine what load is "controllable" – how, when, and for how long?
  - Create hourly load estimates by NY utility, rate class, and end use
- Identify specific technologies and key attributes - including latency and response duration - that are necessary to realize DDR potential in New York's wholesale markets.
- Integrate DDR potential with Dynamic Pricing (DP) in the markets through system dynamics modeling. Examine impact of demand elasticity on system dispatch under various scenarios.
- Identify market and operations impacts and suggest market, program, or other approaches to enable greater demand side participation in wholesale markets.
- Examine impacts of customer self optimization with participation in the NYISO markets.

What Do We Expect to Learn?

- Understand potential impacts of greater DDR and DP integration
  - Effects on Day-Ahead (DA), Hour-Ahead (HA), and Real Time (RT) markets and prices
  - How to adapt to non-stationary processes on the demand side
  - Where are there robustness issues to manage
  - What are the conditions for preserving DA – HA – RT market convergence
    - Latencies
    - Penetrations of DP and DDR
- Understand where greatest DDR potential lies
  - By end use, performance, technology

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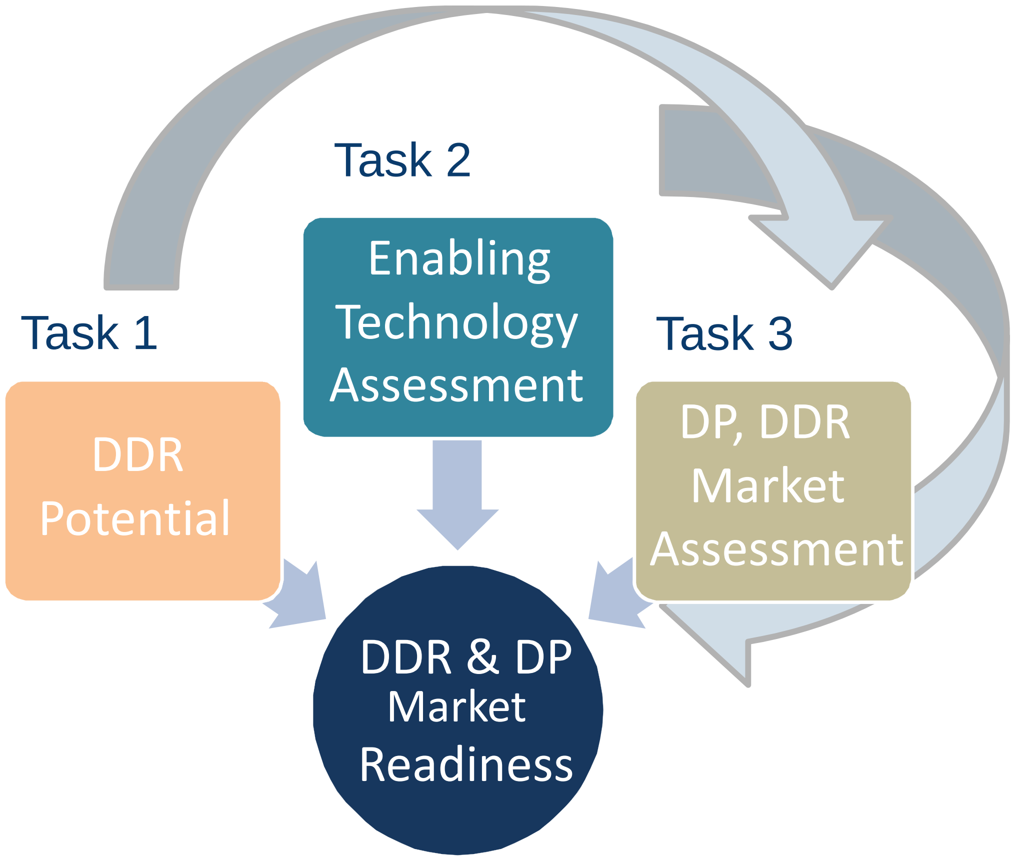
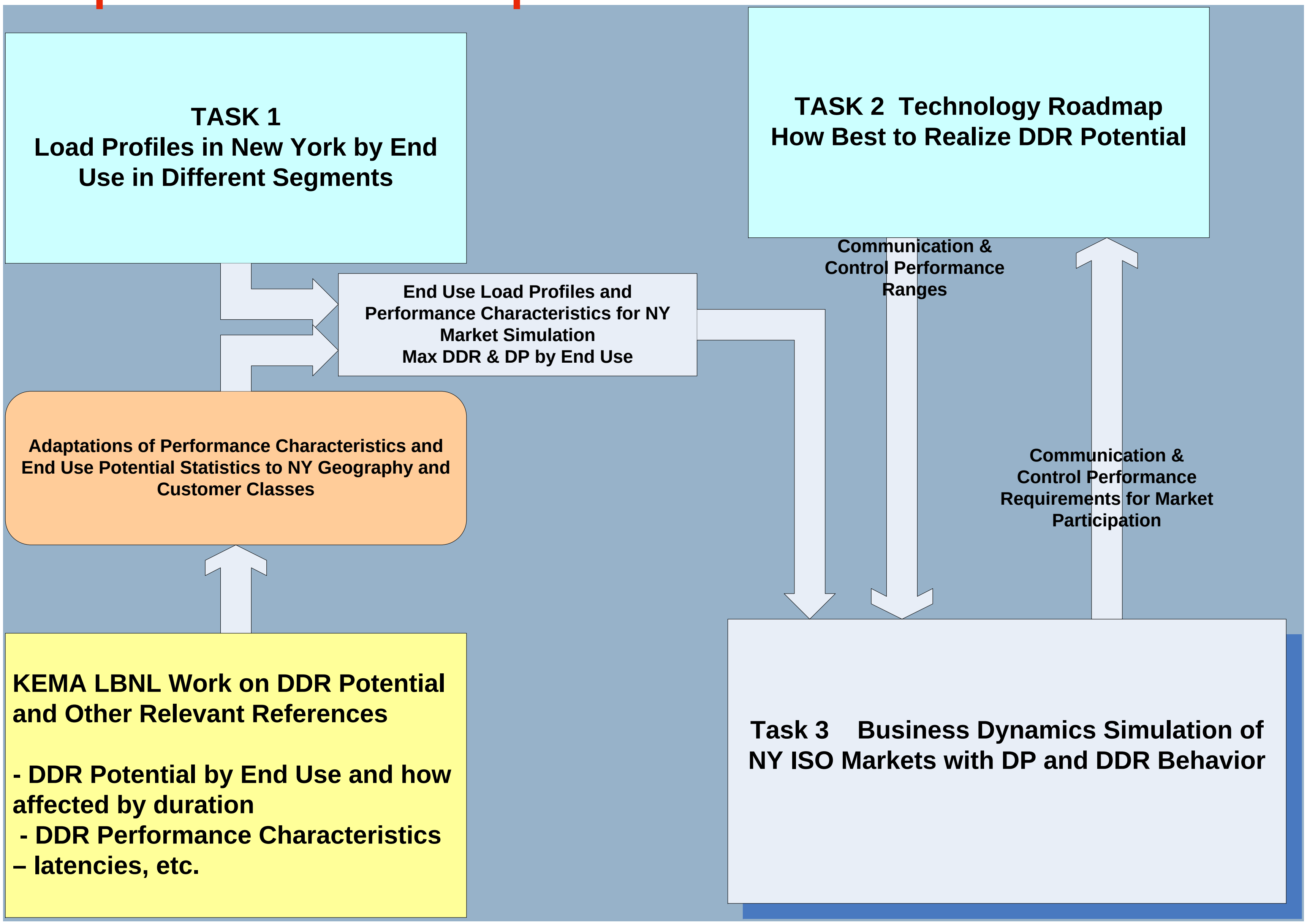
Project Approach – High Level

Building hourly load shed potential by NY utility, rate class, and end use type (Task 1) is an important input to the DP, DDR market simulation model (Task 3).

Developing a technology roadmap to identify and prioritize the key communications and data technologies to enable the identified DDR potential (Task 2) will be essential to realize DDR potential and meet requirements going forward.

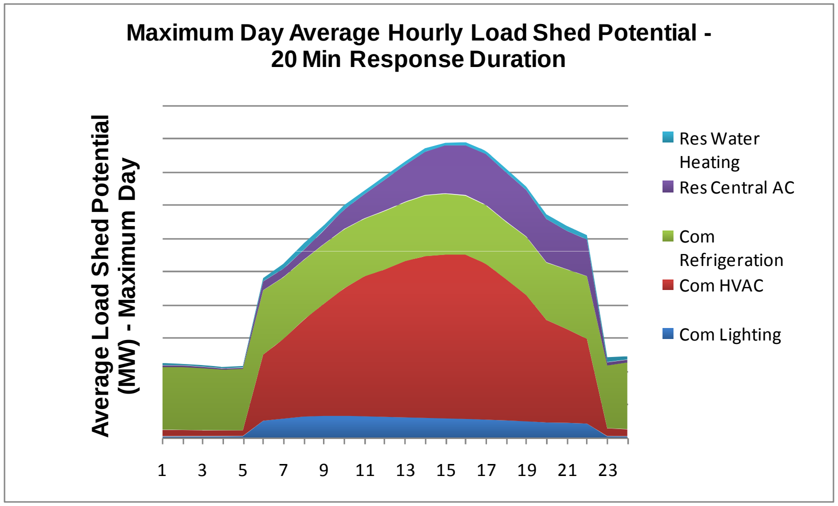


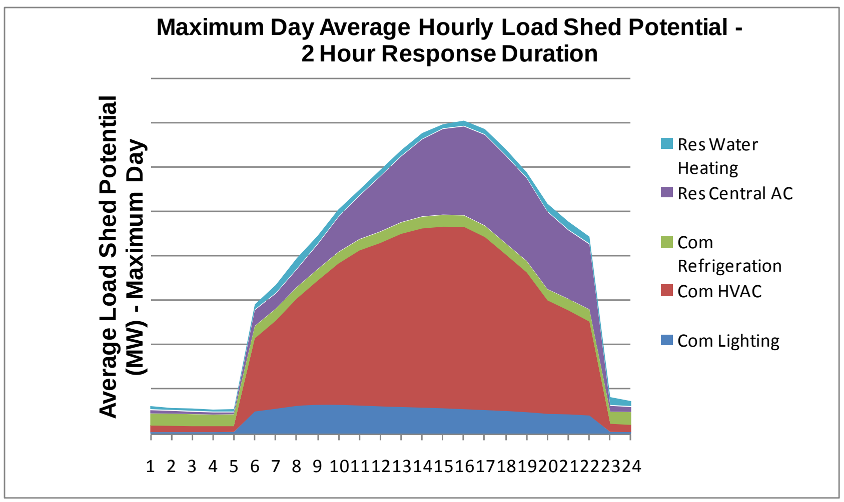
Inputs and Outputs Overview

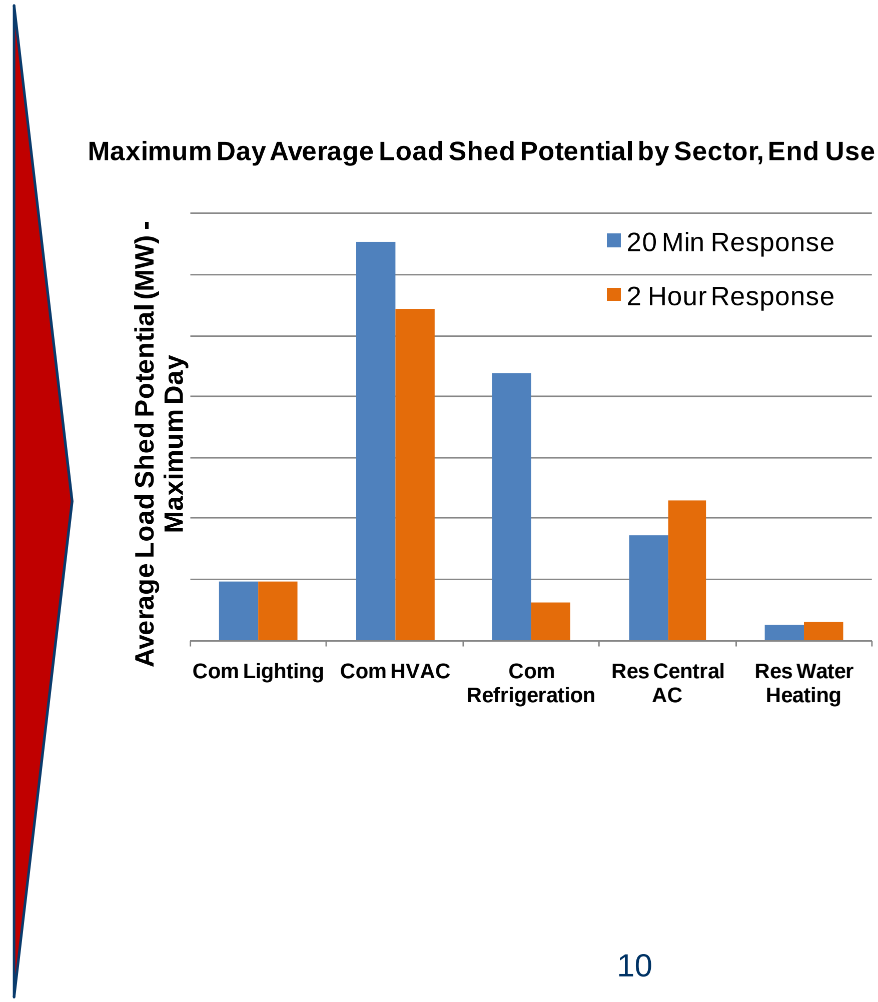


DDR Potential – (Illustrative)

An example of preliminary, relative output of one day (Maximum System Day) load shed potential by sector, end use, and response duration.







Task 1 (DDR Potential) - Approach

- **Objectives**: Link derived load reduction potential data (by end use, customer type, day type, and hour) to pricing assumptions and customer response in Task 3; assess DDR potential against market products and requirements including: latency, duration, fatigue, verifiability, certainty / yield
- **Data available**: NY utility hourly load profiles by rate class, day type; KEMA's ADR work with LBNL for CEC
- **Key challenges**: No NY statewide end use load distributions; utility variation in data and format

Create 8760 hourly average load profiles for key RES, COMM, and IND rate classes

- Identify which utility rate schedules (load profiles) to leverage for each customer type
- Convert day-type loads to 8760 hourly profiles
- Convert 8760 load profiles to 8760 unitized profiles
- Develop 8760 average load profile for most recent year

Estimate hourly average load accounted for by key end uses

- Leverage CEUS, publicly available data
- Estimate portion of load associated with lighting, cooling, ventilation, and refrigeration
- Adjust hourly load by end-use for differences between CA and NYS in the portion of total RES, COMM, IND electric consumption

Estimate load shed capability

- Load shed capability = amt of end-use load that can be shed at various hours; portion that is currently or potentially controllable by the ISO
- Develop rate class and end-use load shapes for typical days with consistent definitions for all utilities
- Estimate load shed duration and MW by end-use and total load class

Task 2 (Technology Roadmap) - Approach

- **Objectives**: Link key characteristics of each key technology to Task 3 model to determine how and when DR can be dispatched, controlled, measured, settled
- **Data available**: KEMA assembling from proprietary and public sources
- **Key challenges**: Screening the categories of technologies, and deployment configurations most relevant to DP, DDR dynamics; including the most relevant data; determining variations of technology application by end use or customer segment

1. Create, Populate Technology Framework
   - Develop a matrix to identify and compare key technical characteristics of DP/DDR enabling technologies
   - Identify relevant technologies by customer segment, end use, and technology type (e.g., communications for information/control; end use control systems; M&V…)
2. Identify Key Technology Variables for Task 3 Model Dynamics
   - e.g. response time, latency, duration of load response by technology
   - Segment technology inputs by end use type and customer class
3. Create DP, DDR Enabling Technology Roadmap based on Task 3 Model Outputs
   - Prioritize enabling technologies (current, potential future) that have the greatest impact on enabling DDR response
   - Identify limitations or opportunities for DDR (by end use, customer class) driven by technology deployments

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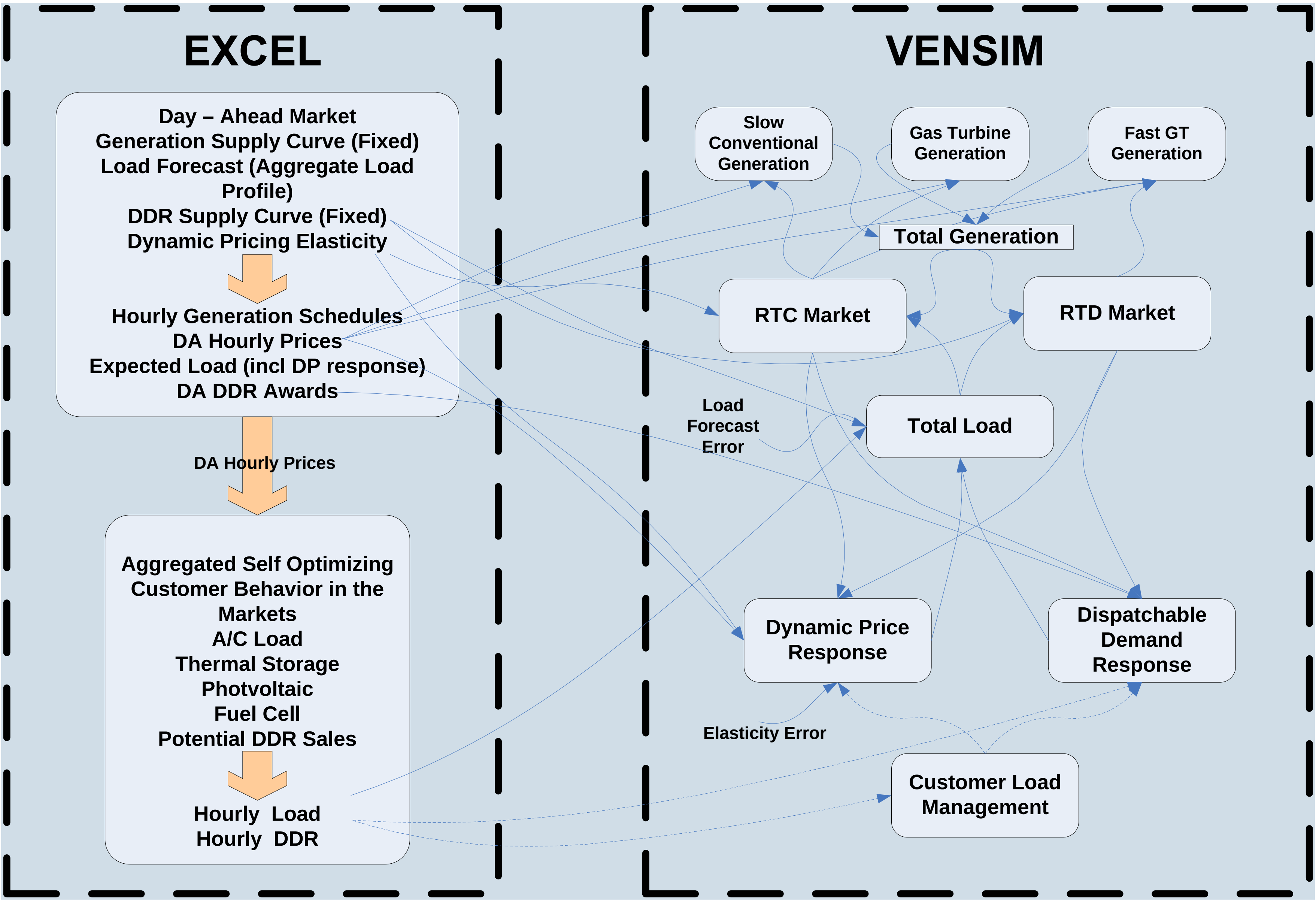
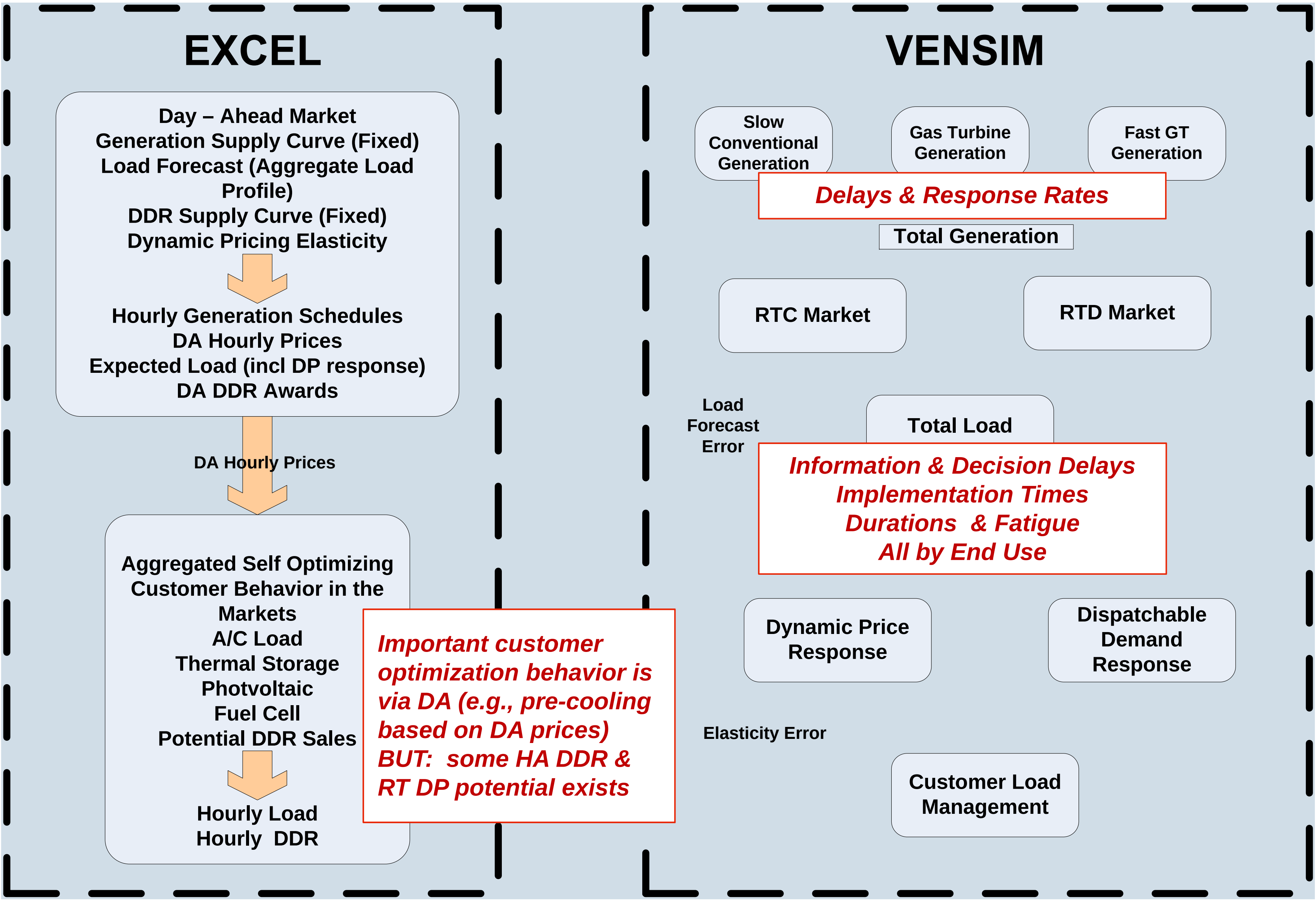
Task 3: Dynamic Pricing, DDR Market Assessment

- Market Impact Assessment – how will DP and DDR “fit” together in markets
  - Interaction between DP and DDR at customer end use
  - Impact of load forecast uncertainty on dispatch optimization
  - Settlements
- Market Simulation (using Vensim® software) to explore interactions and design consequences between all wholesale and retail market participants and DR business processes (supply commitment; dispatch)
- Key challenges to address:
  - Simulating behavior of market participants under specific scenarios
  - Price elasticity
  - Assessing implications on market operations, DR program design

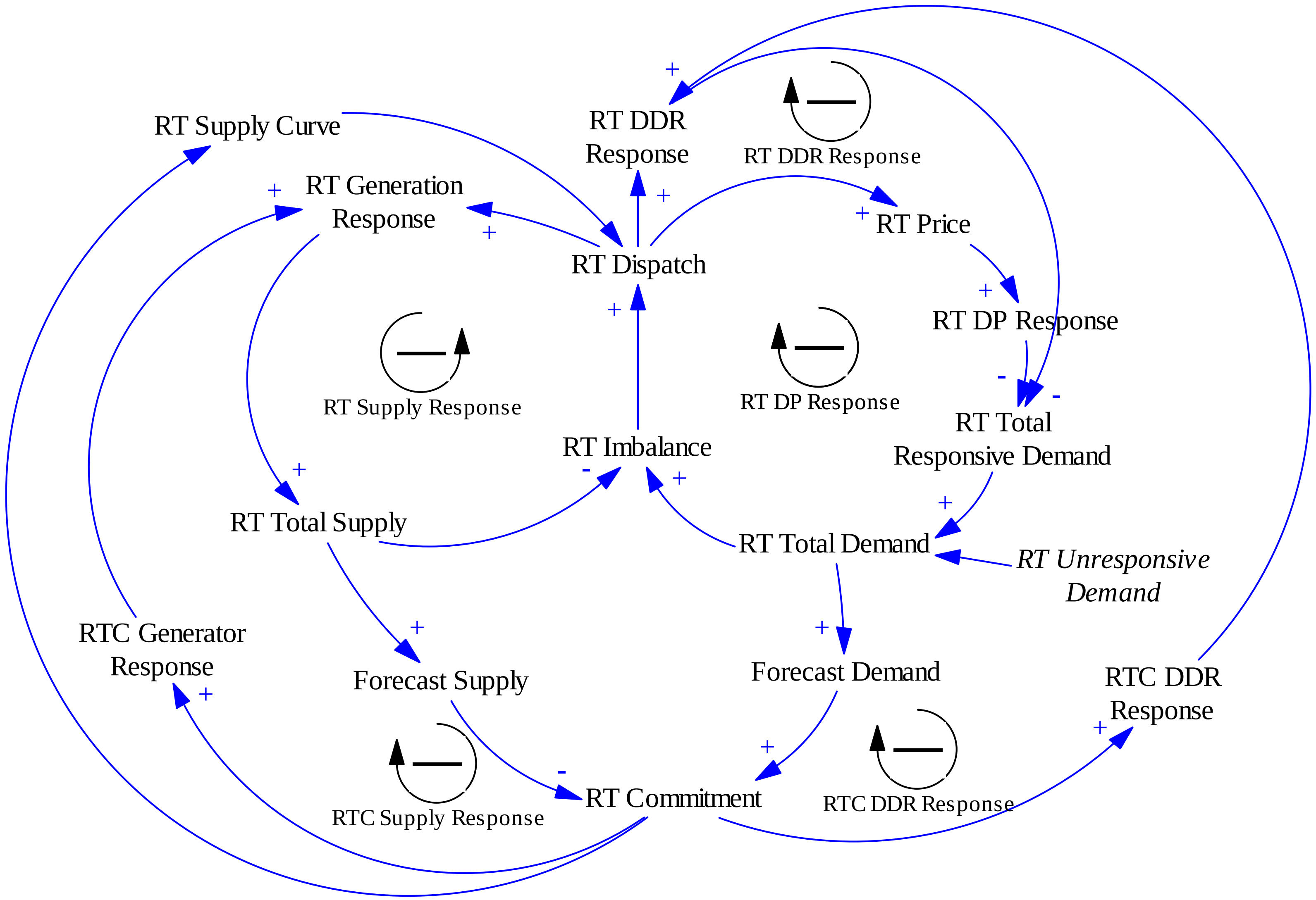
Task 3 Model Overview



Task 3 Model Key Attributes



Real Time Market Model



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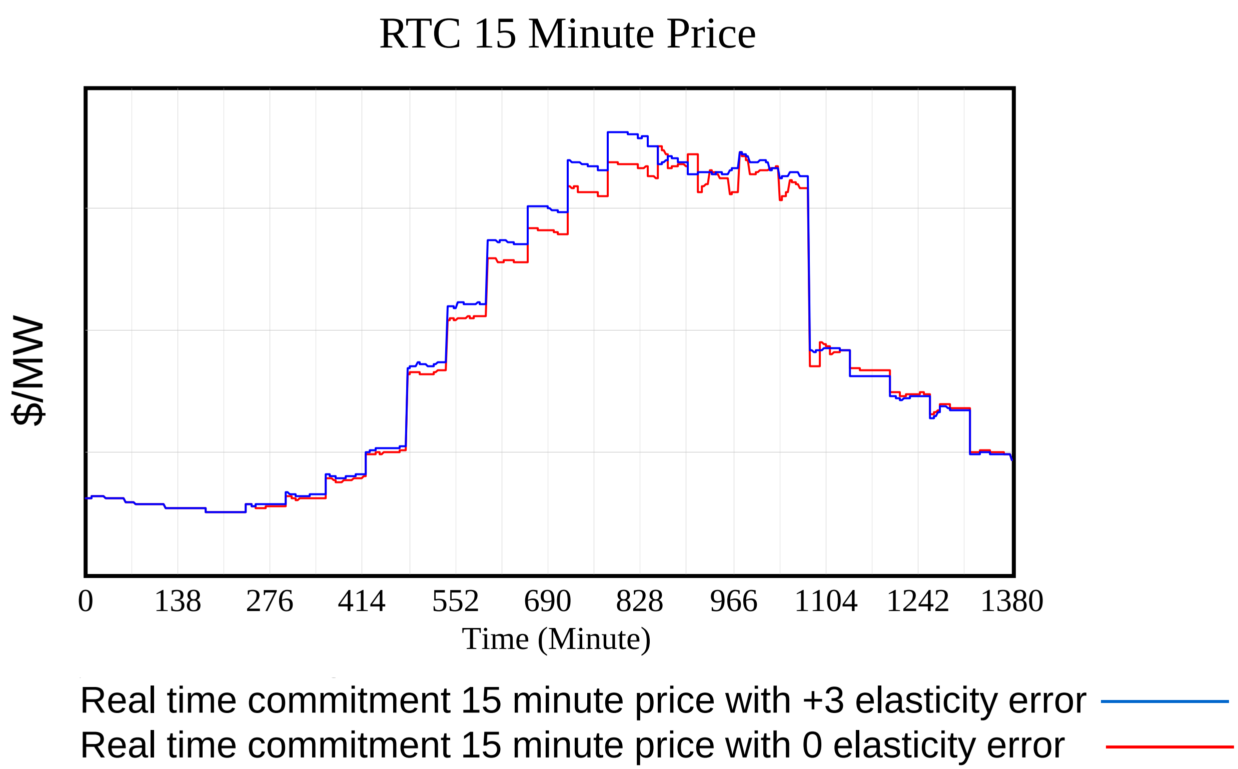
Preliminary Observations

1. Mis-match of price signal time interval (e.g., Real Time Commitment (RTC) Hourly, RTC 15 min, Real Time Dispatch (RTD) 5 min), with DP response performance characteristics causes price overshoot, oscillations, etc. One “market” problem rolls over into the subsequent market.

2. DDR (as modeled) is well behaved.

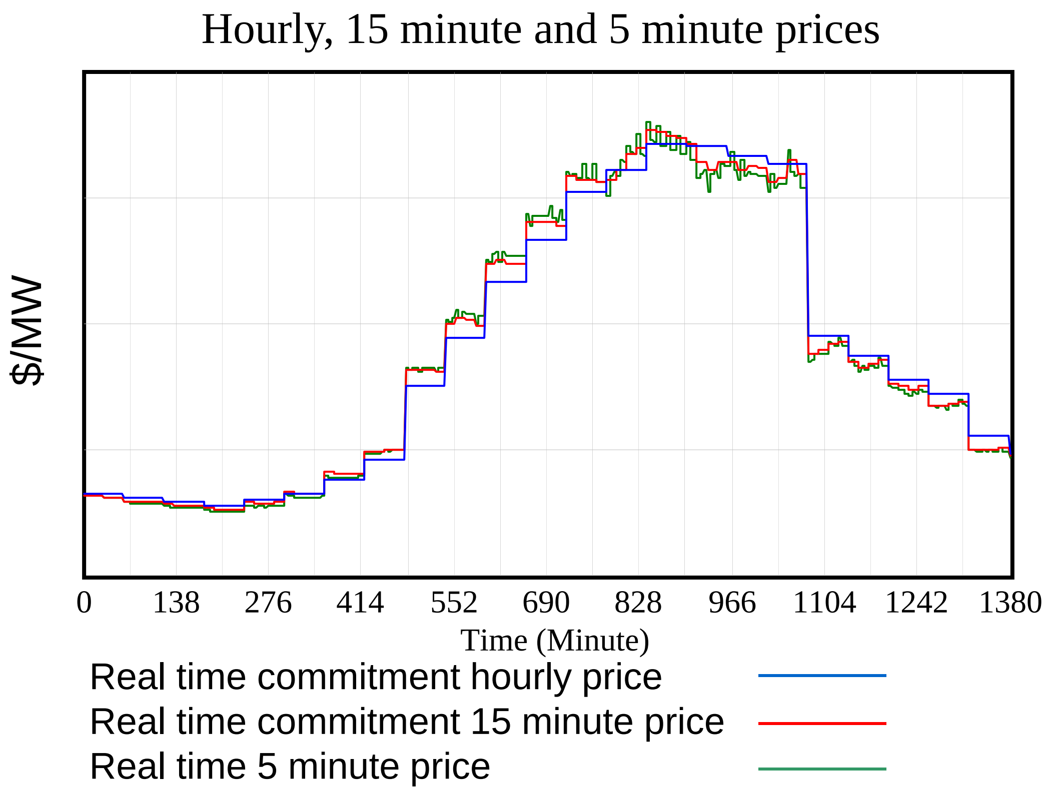
3. Elasticity errors in the DA market will cause problems in the HA, RTC, and RTD markets depending upon the direction and magnitude.

Impact of DP on Real Time Dispatch (RTD) Price



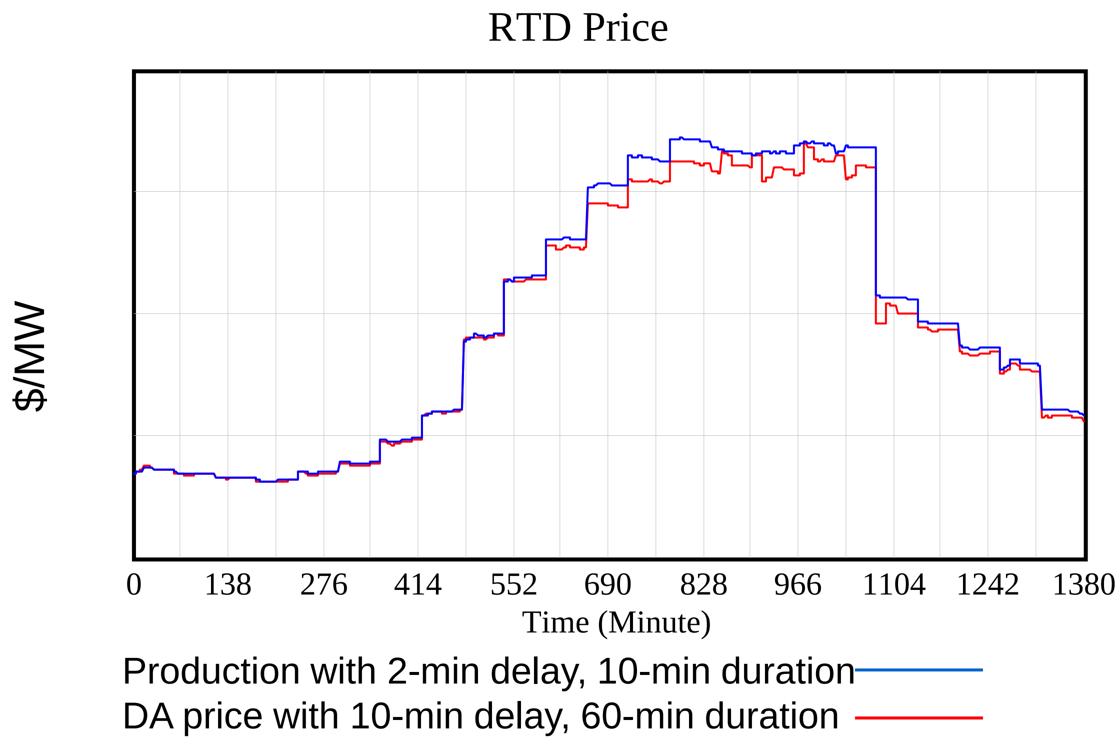
Dynamic pricing is responding to hourly price signal
Delay and duration are 10 and 60 minutes respectively
Real time 5 minute price is plotted for 0-error vs. +3-error
Real time 5 minute price increases due to significant error in elasticity

Price Impacts: Shorter DP Duration & 5-min Signal



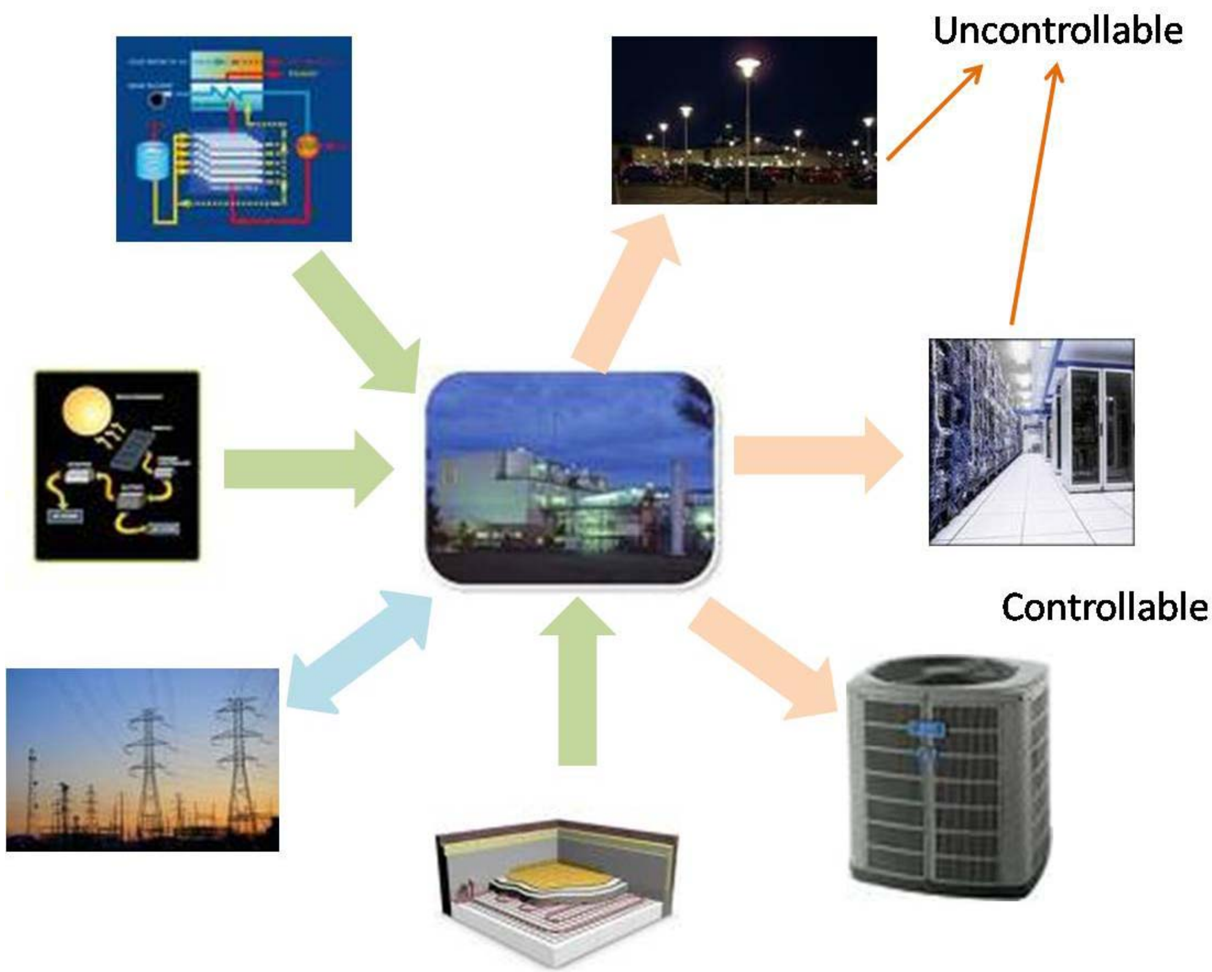
Dynamic pricing is responding to real time 5 minute price signal
Delay and duration are 2 and 10 minutes respectively
All prices are plotted
Real time 5 minute price is not as well-behaved as before because of poor alignment with market price signal. The duration is greater than the price signal period resulting in overshoot and ramping effects

Impact of DDR Duration on RTD Price



Only DDR is present in the market
Real time 5 minute price is plotted for 2-min delay/10-min duration vs. 10-min delay/60-min duration
Longer duration decreases the real time 5 minute price

Commercial Customer Self-Optimization: Model Structure & Components

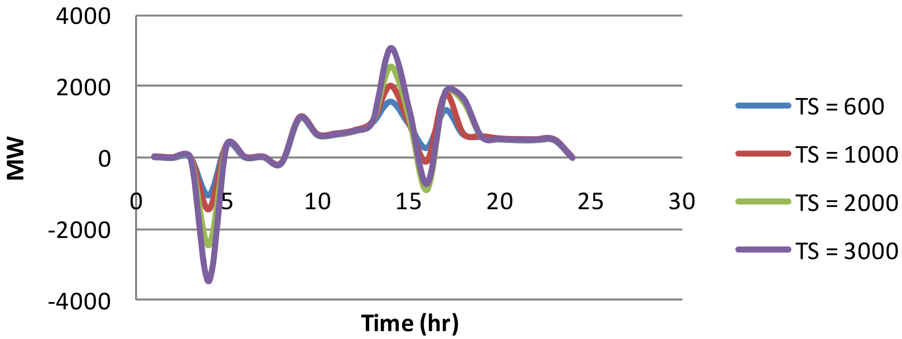


Components

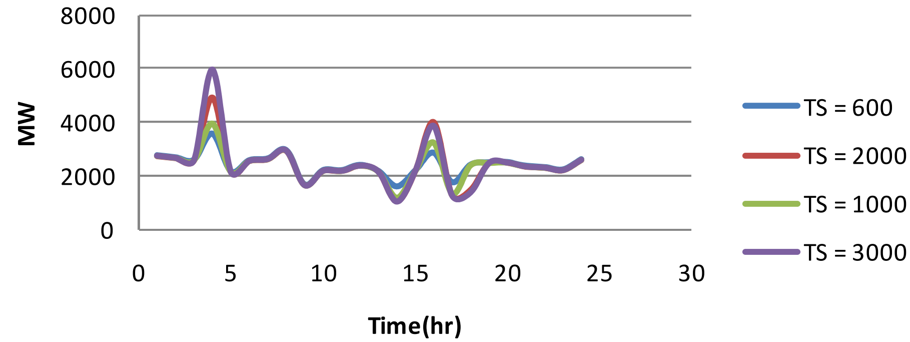
- On-site generation
  - Fuel cell
  - PV cells
- Storage
  - Thermal storage
- Connection to Grid

Self Optimized Load Example

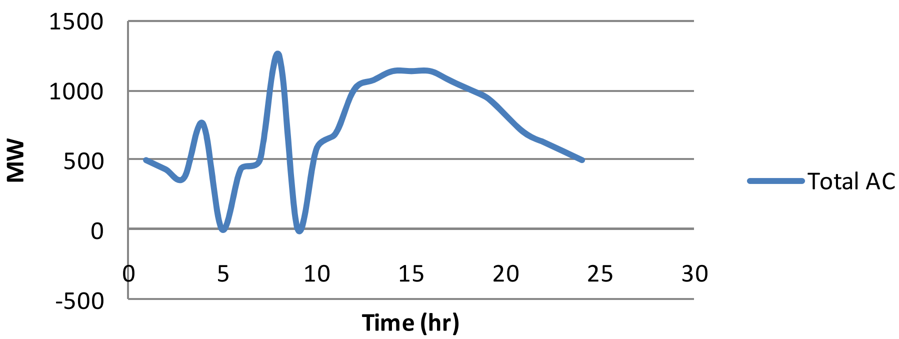
Load reduction



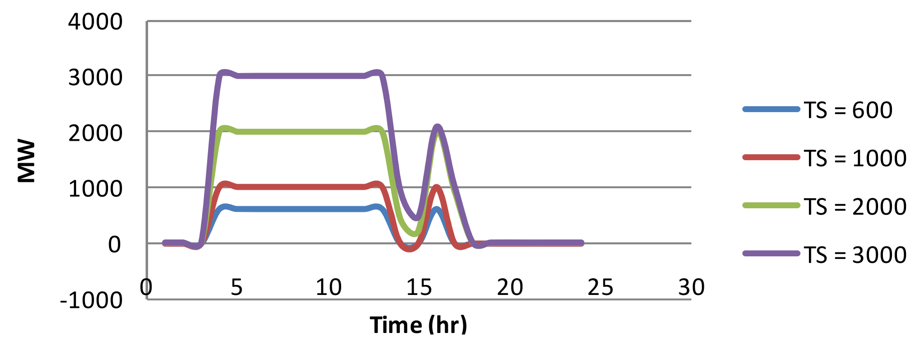
Total Grid purchase



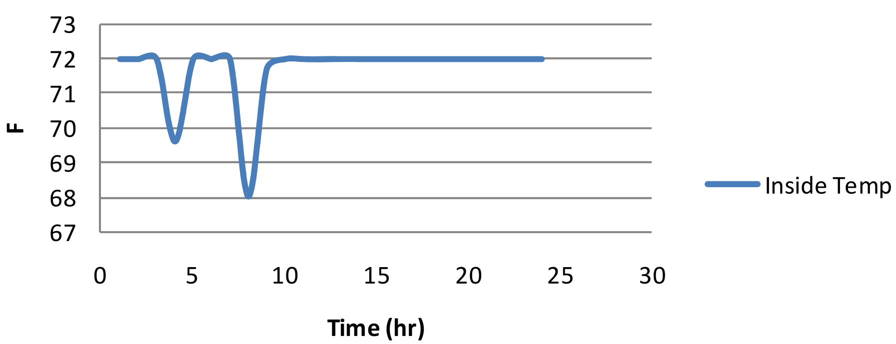
AC load



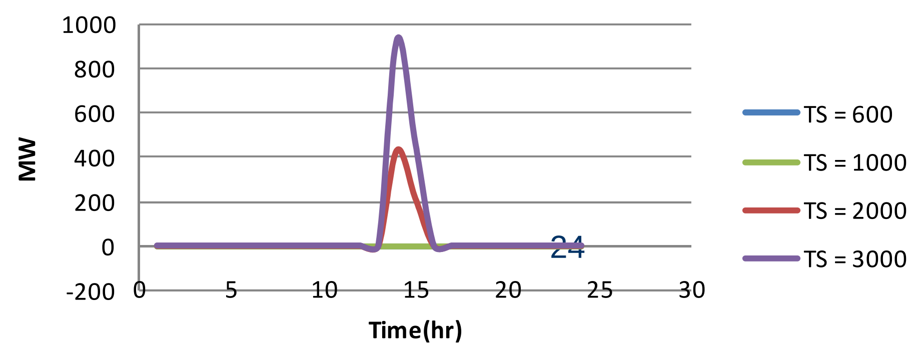
Thermal Storage level



Inside Temp



Amount sent to Grid



Next Steps

- Refine the dynamics of DP and DDR response
  - Different dynamics / penetrations by end use and technologies
- Analyze concurrent penetrations of DP, DDR, and customer optimization. (graphs too complex for this presentation, so far)
- Develop intra-day commercial customer self-optimization
- Explore ranges of elasticities by end use for impact
- Attempt to identify broad conclusions

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