The Brattle Group

FUNDAMENTALS OF PRICE RESPONSIVE DEMAND

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Introduction

- Many utilities, state commissions, ISOs/RTOs are investigating ways to reduce energy costs for end-use customers while preserving system reliability
- An attractive option for achieving this goal is to pass through real-time pricing costs to end-use customers and to let the load serving entities bid in price-responsive demand curves into the energy market
- This presentation shows how that task can be accomplished

We simulate the impact of real-time pricing (RTP) rates on a Midwestern utility

- For the simulations, we use the architecture of the Pricing Impact Simulation Model (PRISM) which grew out of California's statewide pricing pilot (SPP)
- We tailor PRISM for this application by first converting it from a two-period pricing model to an hourly pricing model and by replacing California price elasticities with those derived from an experiment in northern Illinois that was carried out by ComEd
- We then simulate the impact of RTP on several variables for the average customer:
  - Percent change in average critical hour consumption
  - Percent change in average monthly consumption
  - Percent change in average monthly bill

For demonstration purposes, we have forecasted price responsive demand for 36 different scenarios

Scenarios are driven by:

- Level of RTP series
- Value of price elasticity
- Existence of enabling technology
- Market penetration of dynamic pricing

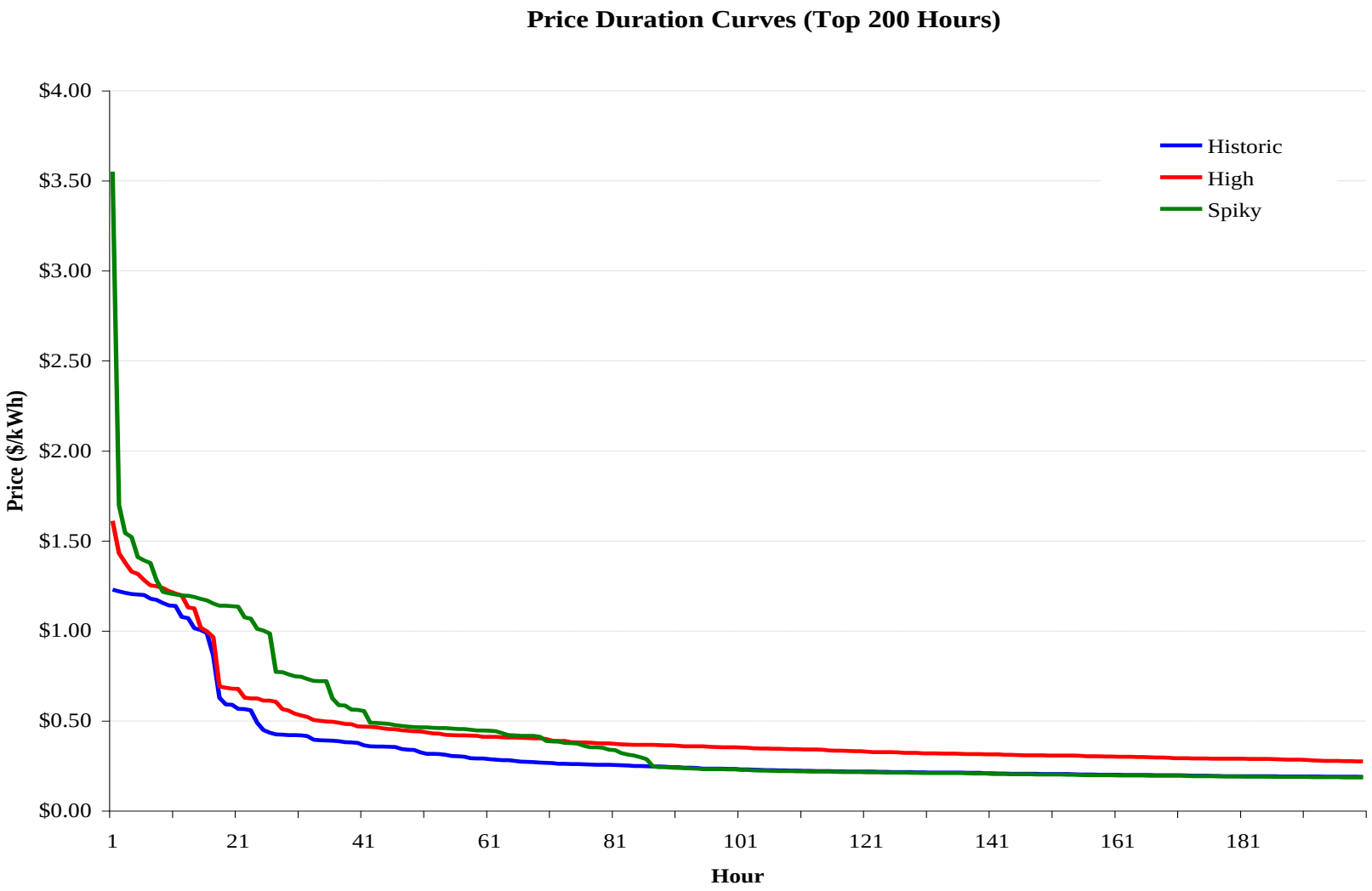
Scenario Driver	Number of Sensitivities	Detail
Price	3	Historic, High, Spiky
Technology	2	w/ and w/o Technology
Elasticity	3	Low, Base, High
Market Penetration	2	Universal, Opt-in
Total Number of Scenarios	**36**	

Driver 1: Level of RTP series

We simulated the impact of three price series:

1. Historic Prices
   - A Midwest utility's RTPs between January 1, 2007- December 31, 2007
2. High Prices
   - 2 x Historic prices
3. Spiky Prices
   - We developed this series based on the historic RTPs
   - Prices for the top 40 hours of the historic RTP duration were increased dramatically to illustrate a crisis year

Price Duration Curves



Driver 2: Value of price elasticity

We simulated the impacts under three assumptions:

1. Base elasticity
   - ComEd RTP 2006 elasticities
2. Low elasticity
   - Base elasticities reduced by 30 percent
3. High elasticity
   - Base elasticities increased by 30 percent

Elasticity Assumptions

	Low	Base	High
Normal Day (Price <$0.13)	-0.033	-0.047	-0.061
High Day (Price >$0.13)	-0.057	-0.082	-0.107
High Day (Price>$0.13) w/ TECH	-0.069	-0.098	-0.127

Driver 3: Existence of enabling technology

We simulated the impacts under 2 enabling technology assumptions:

1. Without enabling technologies
2. With enabling technologies

Technology impacts are modeled through higher elasticities that are shown in the elasticity assumptions table

Driver 4: Market penetration of dynamic pricing

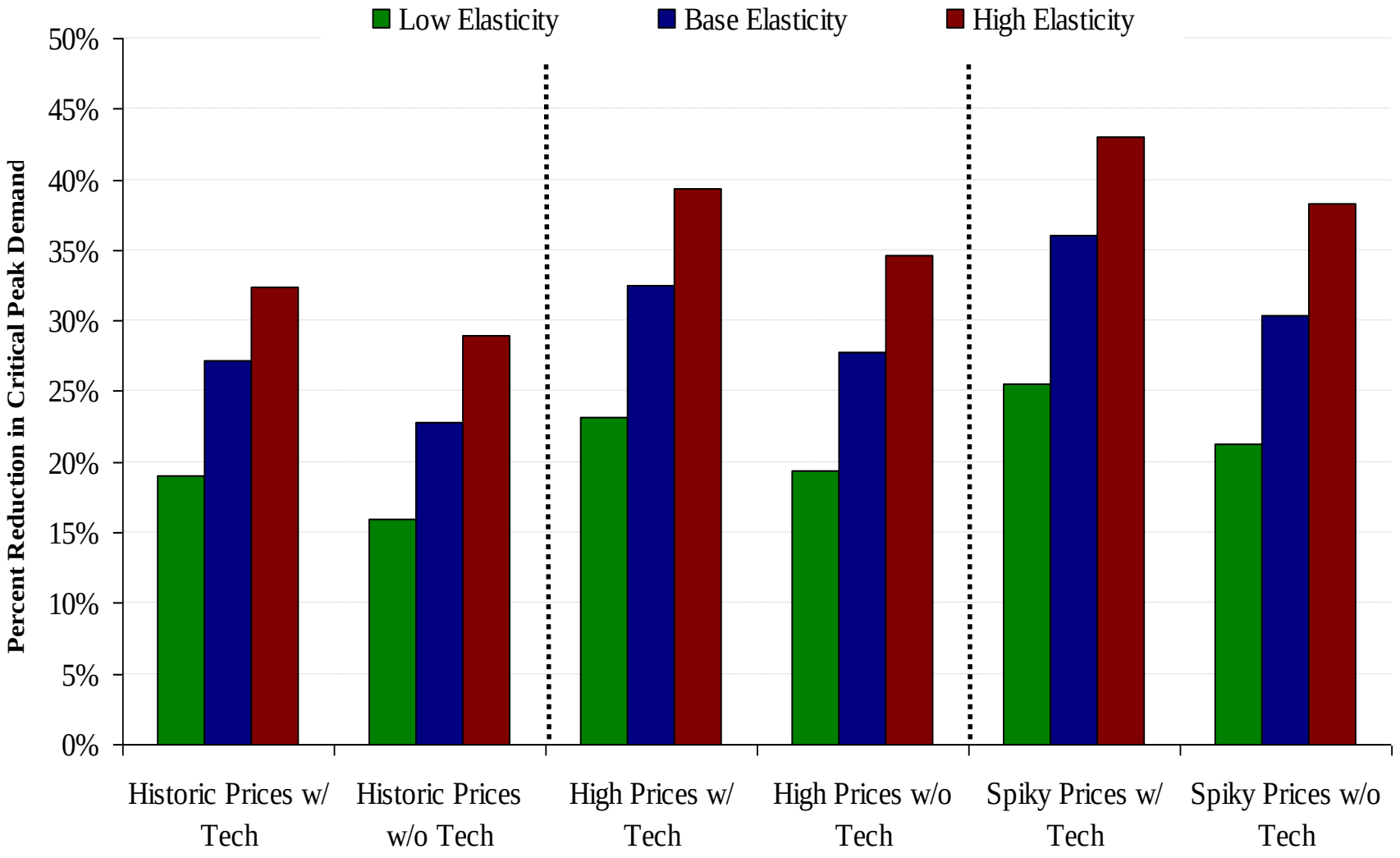
We constructed price responsive demand curves under 2 market penetration assumptions:

1. Universal deployment (High Penetration)
   - 100 percent of customers are subject to RTP prices
2. Opt-in deployment (Low Penetration)
   - 20 percent of customers volunteer for RTP prices

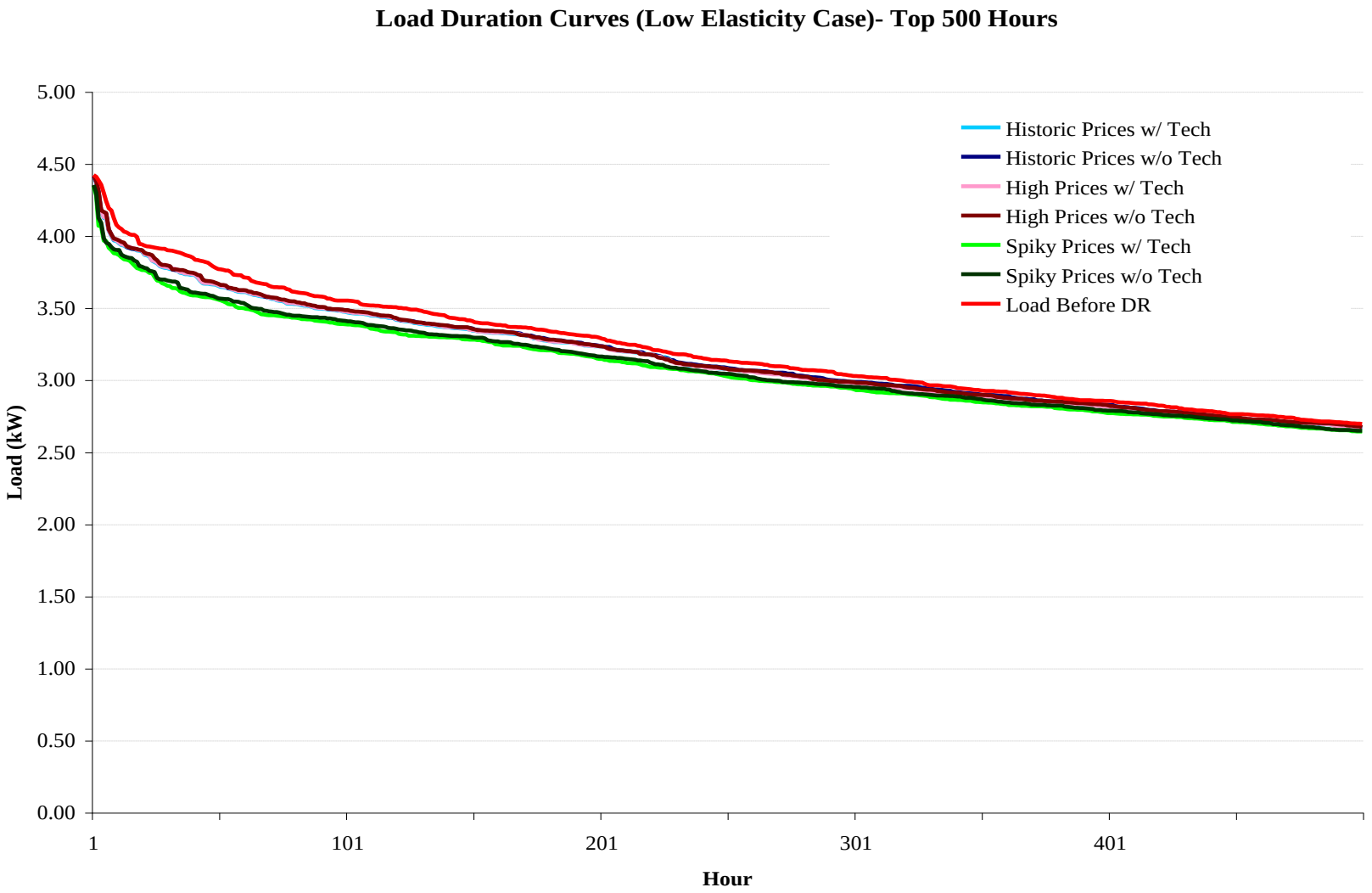
Implementation

- We used illustrative data from the Midwest
  - Load profile of an average non-space heat customer
  - Existing (non-RTP) prices
- We ran our simulation under the specified scenarios
  - Obtain percentage demand reduction in average critical period load (kWh/hour)
  - Critical period is defined as top 100 hours in terms of the prices
- We constructed price responsive demand (PRD) curves
  - Total number of residential customers is used to construct market demand curves- 370,294 customers in 2007 corresponds to:
    - 370,294 residential customers under "Universal Deployment Scenario"
    - 74,059 residential customers under "Opt-in Scenario"

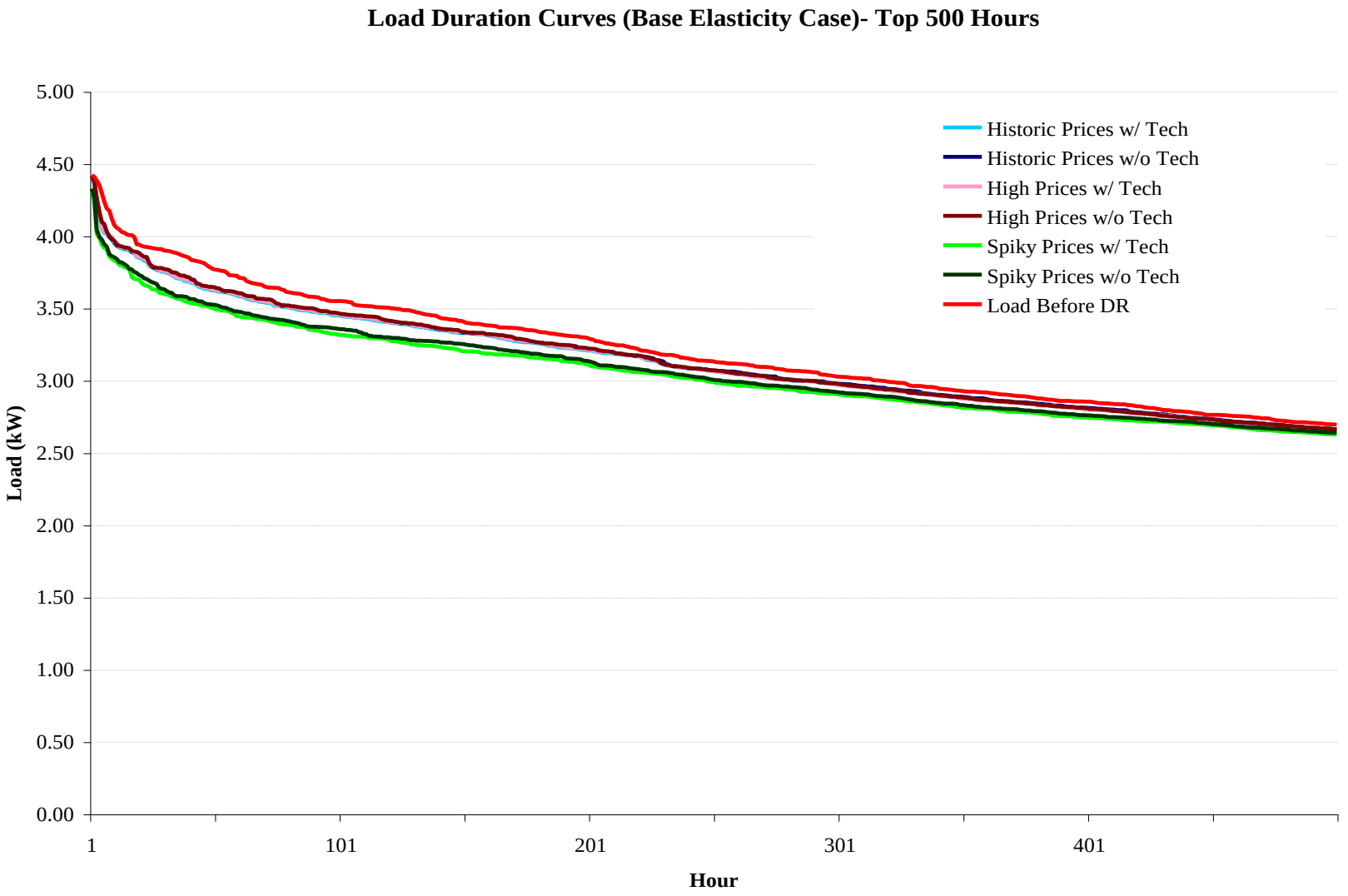
Forecast demand response impacts



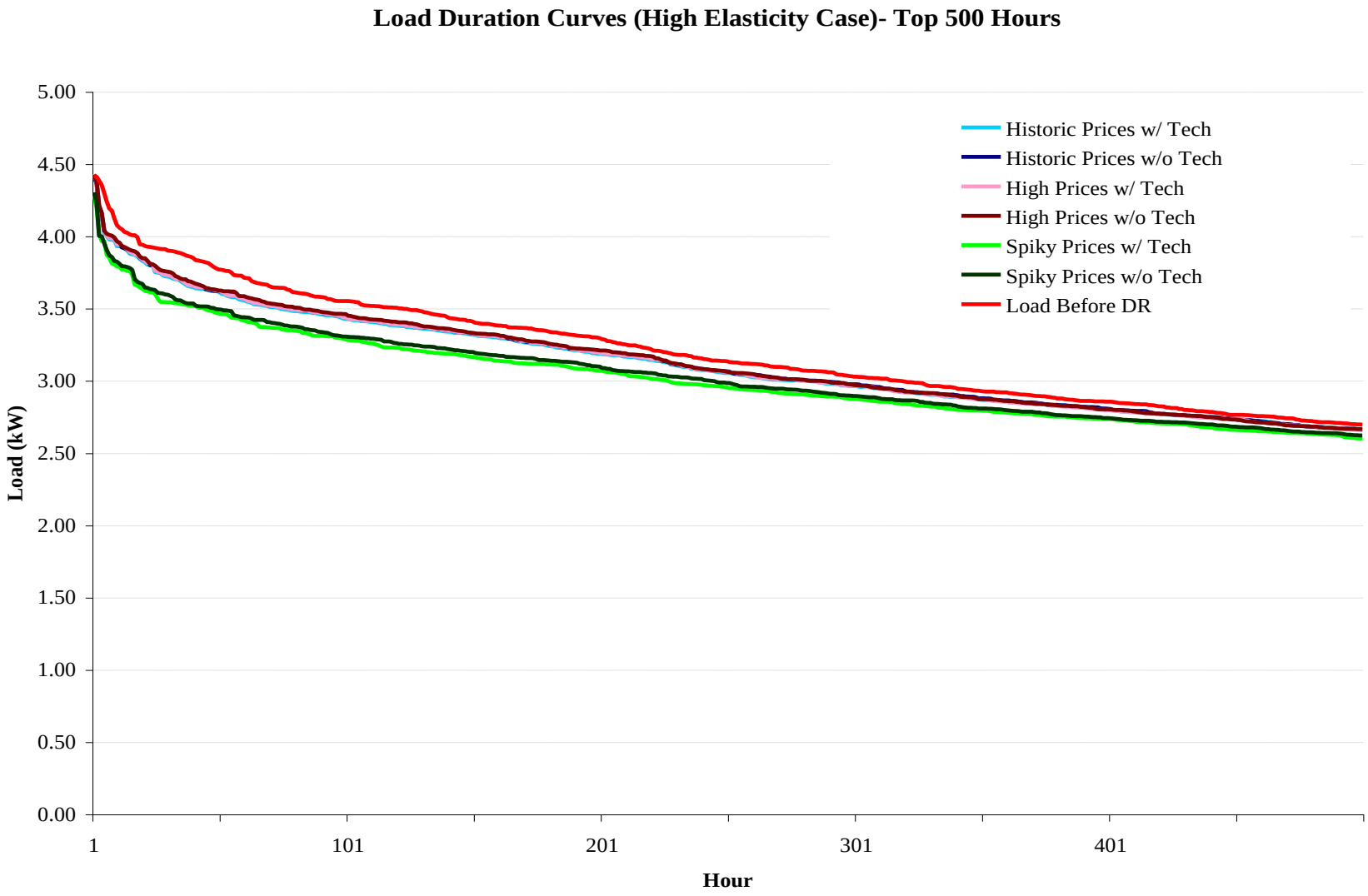
Load Duration Curve for the Average Customer (Low Elasticity Case)



Load Duration Curve for the Average Customer (Base Elasticity Case)



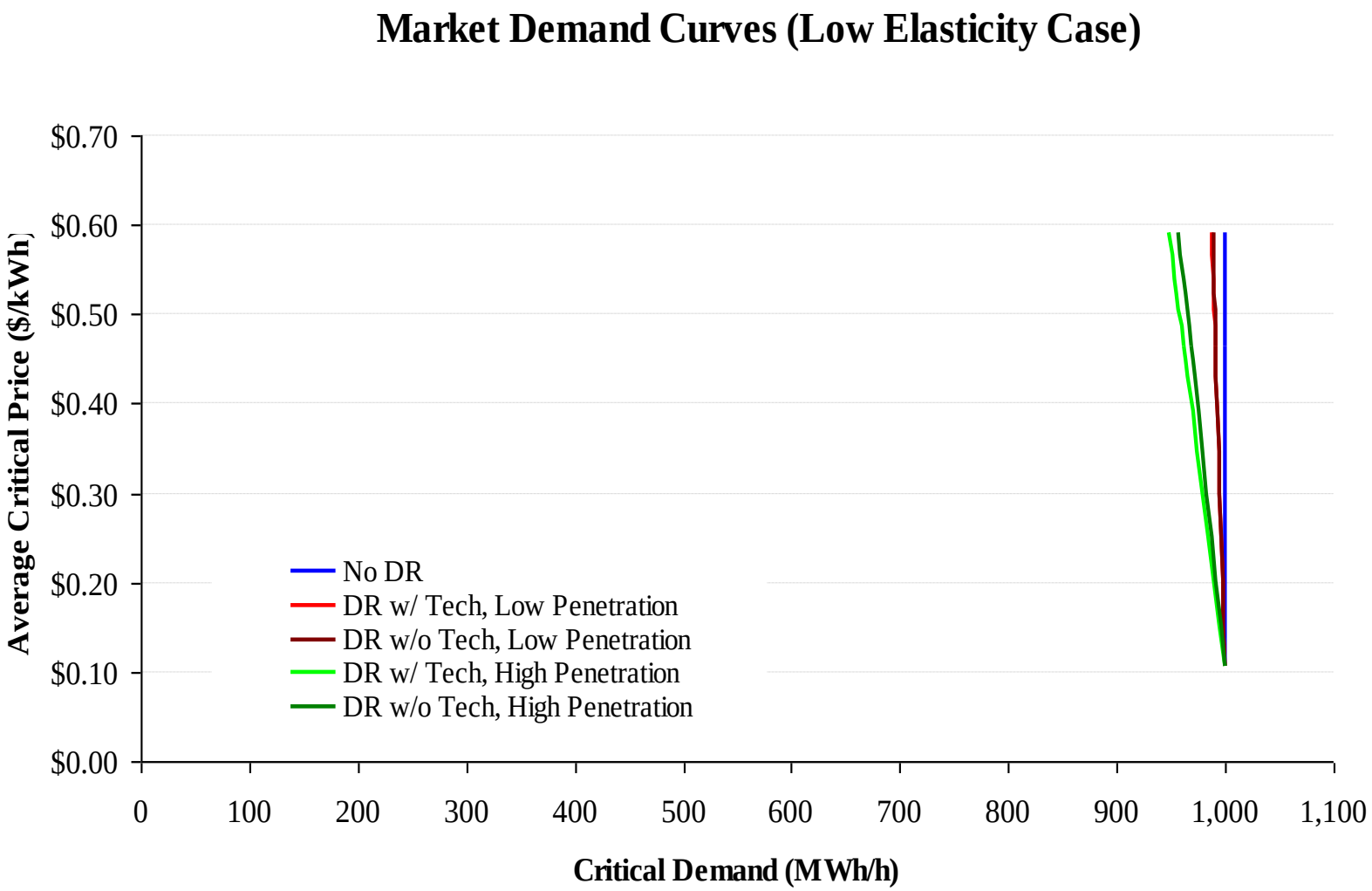
Load Duration Curve for the Average Customer (High Elasticity Case)



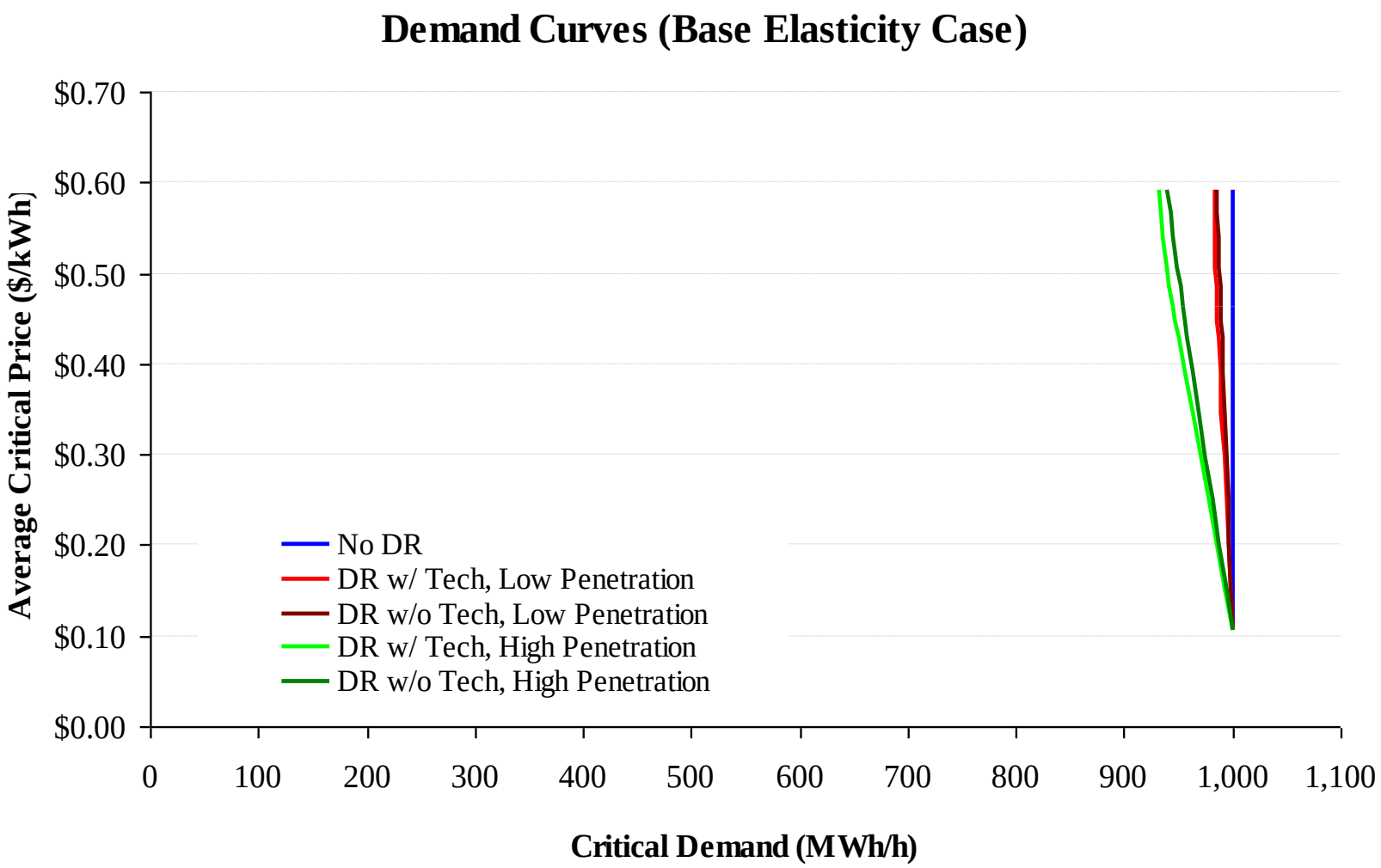
Summary of the Simulations

- Impacts are in the range of 16 to 43 percent
  - The lowest impact is from the scenario with “low elasticity + Historic Price + w/o Tech”
  - The highest impact is from the scenario with “high elasticity + Spiky Price + w/ Tech”
- Availability of enabling technologies increase demand response, as do the higher price elasticities and higher prices

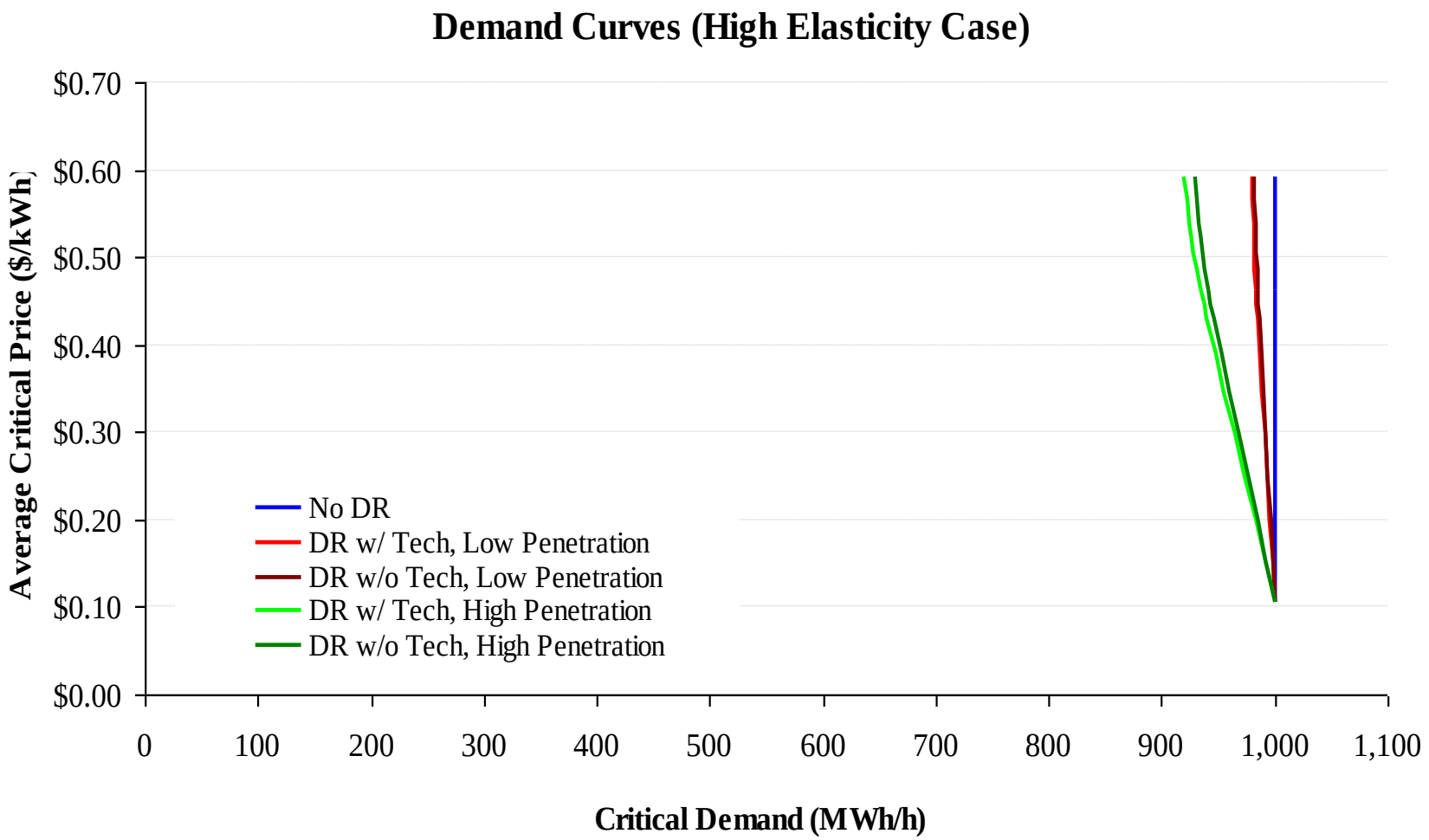
PRD Curve based on "Low Elasticity" Assumption



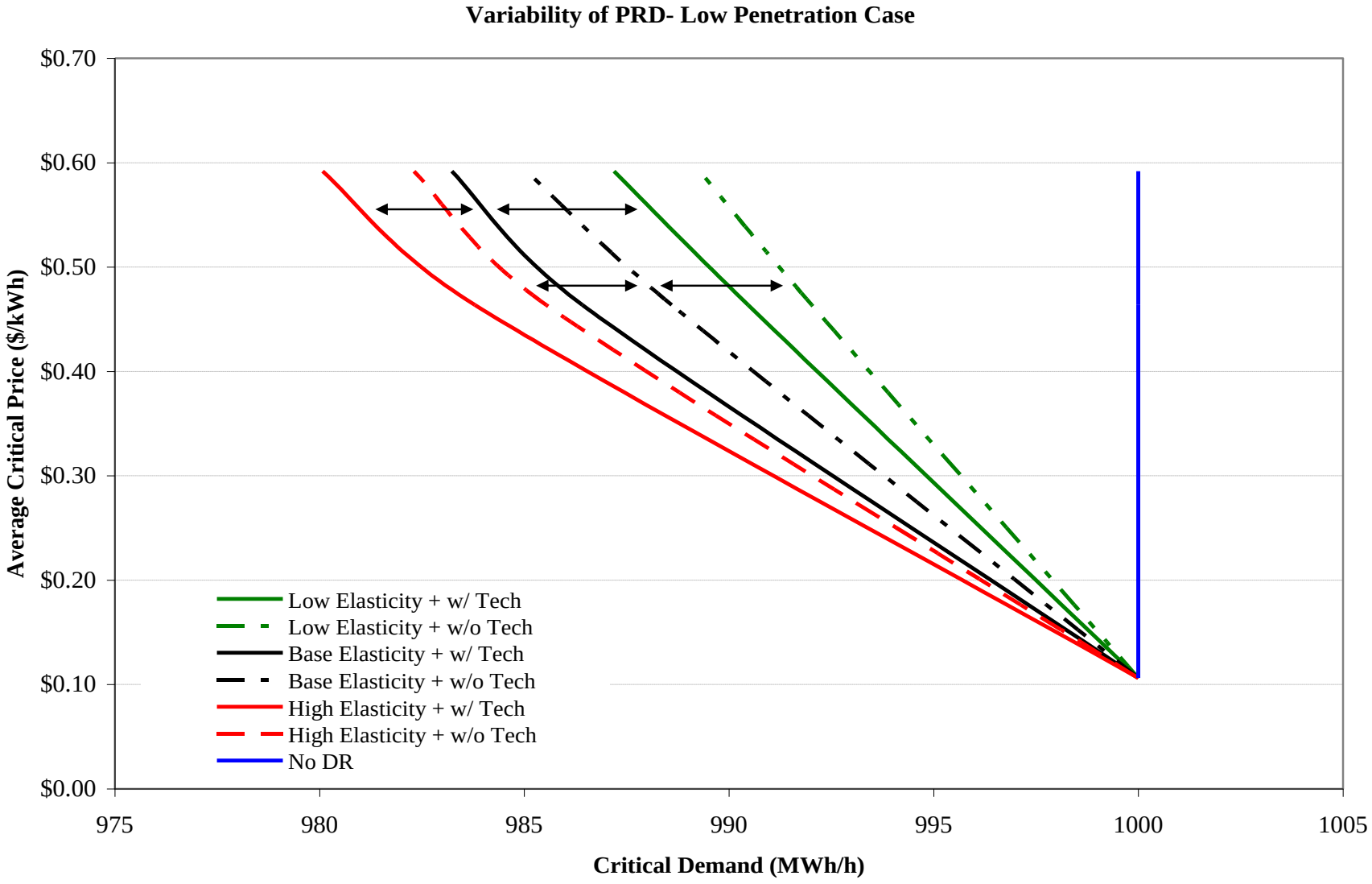
PRD Curve based on "Base Elasticity" Assumption



PRD Curve based on "High Elasticity" Assumption



Variability of PRD- Low Penetration Case



Conclusions

- Models and data are available to simulate customer response to dynamic pricing
- In our simulations, real-time pricing has been shown to elicit significant amounts of demand response ranging from 16 to 43 percent per customer
  - The lowest impact is from the scenario with "low elasticity + Historic Price + w/o Tech"
  - The highest impact is from the scenario with "high elasticity + Spiky Price + w/ Tech"
- Availability of enabling technologies increase demand response, as do the higher price elasticities and higher prices

References

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Biographical information

Ahmad Faruqui is a principal with *The Brattle Group*. He led a state-by-state assessment of the potential for demand response for the Federal Energy Regulatory Commission and is assisting FERC in the development of a national action plan. Last year, he performed a national assessment of the potential for energy efficiency for the Electric Power Research Institute and wrote a report on quantifying the benefits of dynamic pricing for the Edison Electric Institute. He has worked on fostering economic demand response for the Midwest ISO and ISO New England and on load management standards for the California Energy Commission. Since the year 2000, he has been assisting utilities and commissions throughout the US and Canada assess the economics of dynamic pricing, demand response and advanced metering. This has often involved the design and evaluation of innovative pilot programs. Early in his career, he wrote an evaluation of 14 experiments with time-of-use pricing which is cited in Professor Bonbright's text on public utility rates. The author of four books and more than a hundred papers on energy policy, he holds a doctoral degree in economics from the University of California at Davis. He is based in *Brattle*'s San Francisco, California office and can be reached via email at ahmad.faruqui@brattle.com or by phone at (925) 408-0149.