

Maximizing Net Benefits Using Price-Responsive Demand Response

Supplemental Notice of Technical Conference on Demand Response
Compensation in Organized Wholesale Energy Markets
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ISO New England Supports Demand Resource Development



- In ISO New England's Forward Capacity Market:
 - Over 2,500 MW of demand resources participating
 - New, state-of-the-art infrastructure securely communicates dispatch instructions, and receives real-time telemetry and revenue-quality meter data from demand response resources
 - Enables demand response to be dispatched where and when needed, improving reliability and mitigating resource fatigue

Summary of ISO New England Comments for the Supplemental NOPR

- 1. A “net benefits” definition should match economic efficiency**
 - True net benefits are the difference between the value consumers receive from energy use and the cost of energy production
 - Net benefits are **not equal** to consumer savings less payments for demand response
- 2. A net benefits test must consider all ISO-administered markets**
 - Limiting attention to only the energy market will miss offsetting impacts in other ISO markets, such as the capacity market
- 3. Analysis of New England data shows paying full LMP for DR has negative net benefits, and may increase consumer (LSE) costs**
 - Capacity and energy price changes are offsetting
 - Paying full LMP to DR, even in highest-LMP hours, would not further the Commission’s goal of minimizing electricity costs

ISO New England is Committed to Maximizing Net Benefits

- ISO New England's objectives, under the Tariff, include operating markets that are **economically efficient**:
 - Wholesale markets that are economically efficient maximize net benefits
 - Well-designed approaches to demand response increase net benefits
- **How should net benefits be defined? Two alternatives:**
 - A. Net Benefit = value of energy consumption – cost of producing energy**
 - **Correctly** measures net benefit to society from (changes in) energy use
 - Consistent with the definition of economic efficiency and ISO's tariff
 - B. Net Benefit = (LMP reduction x consumption) – payment for DR**
 - **Misestimates** net benefits by ignoring: (a) costs of producing energy, and (b) value of foregone energy to consumers
 - This definition **overstates** true net benefit of reducing energy consumption

Both Energy and Capacity Market Impacts Must be Considered

- Policies that affect energy prices **will also change capacity prices**
 - A generation owner must raise its minimum capacity auction price offer to remain commercially viable at lower energy prices
- **As a result, capacity prices may increase:**
 - In New England, generation is 92% of all MW offering into the forward capacity auction
 - When generation sets the capacity clearing price, New England would see higher capacity prices
- **To correctly measure net benefits**, the test must evaluate the impacts of paying full LMP to DR on all ISO-administered markets
- **Key Concern:** Capacity price increases could **fully offset** LMP reductions if DR is paid full LMP, **making consumers worse off**

The ISO Analyzed Alternative Demand Response Compensation Proposals

- ISO New England retained the Brattle Group to conduct a net benefits analysis of alternative compensation proposals
 - The analysis defined net benefits as the difference between the value consumers receive from energy use and the cost of energy production
 - Considered capacity as well as energy market impacts
 - **Five proposals examined:**
 - Three alternative full-LMP compensation approaches, covering a range of “program hours” over which full-LMP compensation is provided
 - DR Compensation of LMP less the retail generation rate
 - Consumer prices indexed to LMP (real-time pricing or buy-the-baseline)
- **Full-LMP payment proposals had the lowest net benefits**
 - All full-LMP payment proposals resulted in **negative** net benefits
 - As program hours expand, net benefits become more negative

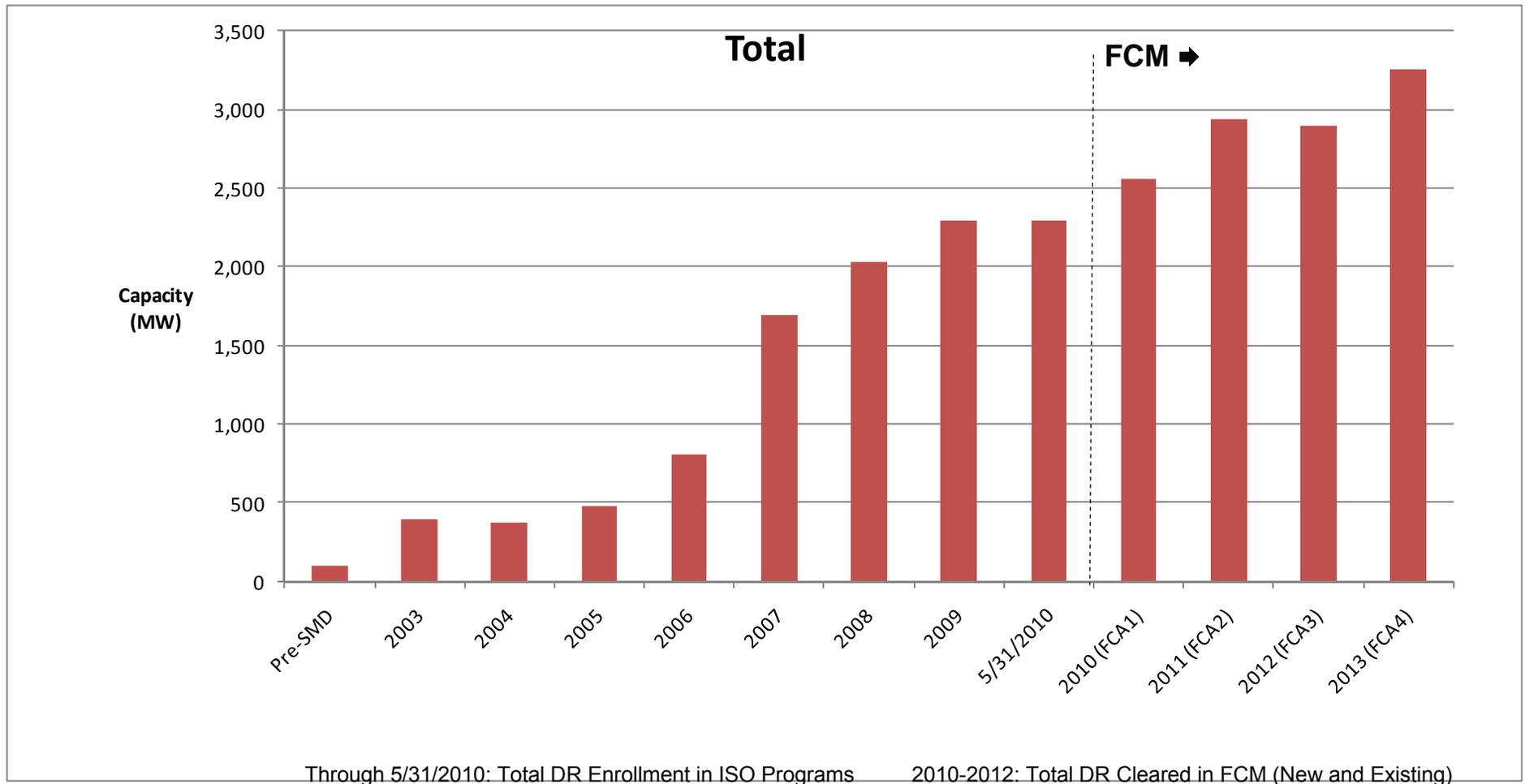
Other Conclusions from ISO Analysis of Alternative Compensation Proposals

- If DR is paid full LMP for energy reductions, capacity price increases can fully offset energy price reductions, making **consumers worse off in the end**
 - Casts doubt on whether NOPR would serve Commission objectives
- Analysis shows **no net benefits** occur even if DR paid full LMP only under limited (top-LMP) hours in New England
- **Alternative approaches, such as buy-the-baseline** (or real-time pricing), have positive net benefits
- **Compensation equal to the LMP less the retail generation rate (LMP-RR)** also has positive net benefits
 - LMP-RR achieved economically efficient reductions in high-LMP hours
 - During low-LMP hours, consumption is too low to maximize net benefits

Technical Appendix

Demand Resources in New England

Forward Capacity Market Promotes Growth



Evaluating the Net Benefits of Alternative Approaches to Price-Responsive Demand for New England

- ISO New England retained the Brattle Group to estimate the net benefits of different demand response compensation proposals advanced by New England stakeholders. This appendix summarizes:
 - Study Framework
 - Objectives, Concepts, Approach, Assumptions
 - Energy Market Analysis
 - Energy and Capacity Market Analysis
 - Summary

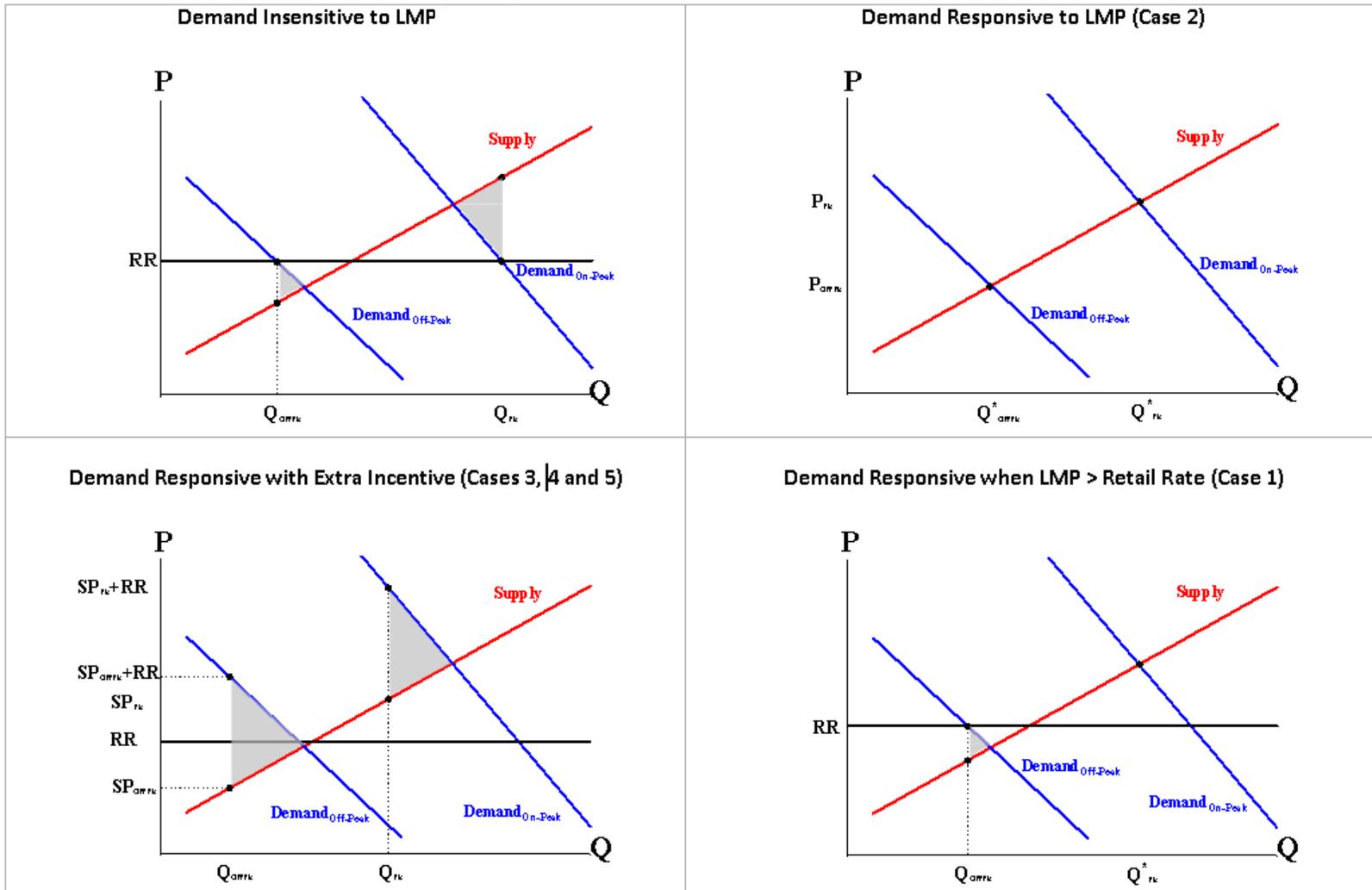
Study Objectives

Compare five demand response (“DR”) compensation approaches:

1. **DR paid LMP less the retail rate** for reductions in energy usage (i.e., $LMP - RR$)
 2. **Dynamic rates** equal to the LMP
 3. **DR paid full LMP** for energy reductions **in high-LMP hours**
 4. **DR paid full LMP** for energy reductions when DR payments \leq consumer savings
 - This proposal was evaluated using historical data
 - We do not know how to implement this proposal before-the-fact
 5. **DR paid full LMP** for energy reductions **in all hours**
- Evaluate the impact on both energy and capacity markets
 - Consider various DR penetration levels

Economic Concepts

Supply, Demand, Retail Rates, and Market Clearing in Four Principle Cases



Approach and Key Assumptions

- **Hourly analysis** of supply, demand, market clearing price/quantity, retail rates, and customer responses
 - For each case, assumed retail rates equal to load-weighted average LMPs + DR payment funding + 6¢/kWh T&D
 - Supply elasticities were derived by hour from ISO-NE bid stack data
- **Various levels of DR penetration** in the energy market:
 - **Low:** Half of DR currently in ISO-NE participates in the energy market
 - **Current:** All DR currently in ISO-NE participates in the energy market
 - **High:** DR in the energy market was assumed to equal the “Achievable Participation” level of DR identified in the 2009 National Assessment of Demand Response Potential” study by *Brattle/FERC*: 60-75% of customers are participating in DR programs/dynamic retail rates

Demand Elasticity

- Demand elasticity determines the consumption change (in MWh) in response to prices or incentive levels
- Demand elasticity assumption for DR is -0.05
 - Residential customers participating in the Connecticut Light and Power dynamic pricing pilot study had price elasticity of -0.026, which is likely a lower bound on customers' price elasticity
 - The RAND study, reported a range of elasticities between -0.318 and -0.054 for various regions, and -0.192 for New England
 - A value of -0.05 was selected to allow for the likely higher levels of conservation observed in the population of consumers

Results: Low Levels of DR (3% Participation)

	RESULTS	LMP-RR	RTP or BUY BASELINE	FULL LMP IN HIGH- PRICED HOURS	FULL LMP WHEN PRICE SAVINGS > DR PAYMENT	FULL LMP IN ALL HOURS	
PARTICIPATION	Number of Program Hours	3,286	8,760	895	7,662	8,760	
	Participation Level (MW)	784 (3%)	784 (3%)	784 (3%)	784 (3%)	784 (3%)	
	Elasticity of Participants	-0.050	-0.050	-0.050	-0.050	-0.050	
	Aggregate Elasticity	-0.002	-0.002	-0.002	-0.002	-0.002	
LOAD IMPACTS	Peak Load (MW)	26,134	26,134	26,096	26,096	26,096	
	Δ in Peak Load from Fixed Rates (MW)	-11	-11	-49	-49	-49	
	%Δ in Peak Load from Fixed Rates	-0.04%	-0.04%	-0.19%	-0.19%	-0.19%	
	Consumption (GWh)	134,452	134,467	134,434	134,294	134,268	
	Δ Consumption from Fixed Rates (GWh)	-13.9	0.2	-32.2	-172.8	-197.9	
	%Δ Consumption from Fixed Rates	-0.01%	0.00%	-0.02%	-0.13%	-0.15%	
	Δ Consumption from Baseline (GWh)	-14.1	NA	-32.9	-174.6	-199.7	
ECONOMICS	Load-Weighted Mean LMP (\$/MWh)	\$70.39	\$70.43	\$70.08	\$69.24	\$69.23	
	Mean LMP plus DR Side Payments (\$/MWh)	\$70.40	\$70.43	\$70.11	\$69.41	\$69.43	
	Side Payments to DR (\$)	\$646,317	NA	\$3,405,338	\$12,811,636	\$14,777,849	
	Avg. Side Payments to DR (\$/MWh reduced)	\$46	NA	\$103	\$73	\$74	
	Energy Market Only						
	Δ Consumer Surplus from Fixed Rates (\$)	\$21,125,660	\$16,317,274	\$59,632,311	\$154,353,902	\$152,812,446	
	Δ Producer Surplus from Fixed Rates (\$)	(\$20,796,709)	(\$15,812,113)	(\$63,047,145)	(\$175,595,632)	(\$177,107,122)	
	Δ Net Benefits from Fixed Rates (\$)	\$328,951	\$505,160	(\$3,414,833)	(\$21,241,730)	(\$24,294,676)	
	Energy and Capacity Markets						
	Δ Consumer Surplus from Fixed Rates (\$)	\$334,726	\$511,594	(\$3,355,803)	(\$21,096,252)	(\$24,147,948)	
	Δ Producer Surplus from Fixed Rates (\$)	(\$5,774)	(\$6,434)	(\$59,030)	(\$145,478)	(\$146,728)	
Δ Net Benefits from Fixed Rates (\$)	\$328,951	\$505,160	(\$3,414,833)	(\$21,241,730)	(\$24,294,676)		
<i>Note: Based on 2007 data.</i>							

Results: Current Levels of DR (6% Participation)

	RESULTS	LMP-RR	RTP or BUY BASELINE	FULL LMP IN HIGH- PRICED HOURS	FULL LMP WHEN PRICE SAVINGS > DR PAYMENT	FULL LMP IN ALL HOURS	
PARTICIPATION	Number of Program Hours	3,311	8,760	895	7,634	8,760	
	Participation Level (MW)	1,569 (6%)	1,569 (6%)	1,569 (6%)	1,569 (6%)	1,569 (6%)	
	Elasticity of Participants	-0.050	-0.050	-0.050	-0.050	-0.050	
	Aggregate Elasticity	-0.003	-0.003	-0.003	-0.003	-0.003	
LOAD IMPACTS	Peak Load (MW)	26,123	26,123	26,050	26,050	26,050	
	Δ in Peak Load from Fixed Rates (MW)	-22	-22	-95	-95	-95	
	%Δ in Peak Load from Fixed Rates	-0.08%	-0.08%	-0.36%	-0.36%	-0.36%	
	Consumption (GWh)	134,439	134,467	134,403	134,129	134,078	
	Δ Consumption from Fixed Rates (GWh)	-27.0	0.7	-62.9	-337.7	-388.8	
	%Δ Consumption from Fixed Rates	-0.02%	0.00%	-0.05%	-0.25%	-0.29%	
	Δ Consumption from Baseline (GWh)	-28.0	NA	-65.5	-344.5	-395.5	
ECONOMICS	Load-Weighted Mean LMP (\$/MWh)	\$70.24	\$70.31	\$69.62	\$68.01	\$67.98	
	Mean LMP plus DR Side Payments (\$/MWh)	\$70.25	\$70.31	\$69.70	\$68.34	\$68.37	
	Side Payments to DR (\$)	\$1,256,904	NA	\$6,449,243	\$24,664,986	\$28,683,467	
	Avg. Side Payments to DR (\$/MWh reduced)	\$45	NA	\$98	\$72	\$73	
	Energy Market Only						
	Δ Consumer Surplus from Fixed Rates (\$)	\$41,197,306	\$31,867,224	\$116,015,921	\$298,918,874	\$295,830,013	
	Δ Producer Surplus from Fixed Rates (\$)	(\$40,546,580)	(\$30,869,510)	(\$122,677,800)	(\$340,439,221)	(\$343,559,597)	
	Δ Net Benefits from Fixed Rates (\$)	\$650,727	\$997,714	(\$6,661,879)	(\$41,520,347)	(\$47,729,584)	
	Energy and Capacity Markets						
	Δ Consumer Surplus from Fixed Rates (\$)	\$672,861	\$1,022,418	(\$6,437,782)	(\$40,972,177)	(\$47,176,255)	
	Δ Producer Surplus from Fixed Rates (\$)	(\$22,134)	(\$24,704)	(\$224,097)	(\$548,170)	(\$553,328)	
	Δ Net Benefits from Fixed Rates (\$)	\$650,727	\$997,714	(\$6,661,879)	(\$41,520,347)	(\$47,729,584)	
	<i>Note: Based on 2007 data.</i>						

Results: High Levels of DR (60% Participation)

	RESULTS	LMP-RR	RTP or BUY BASELINE	FULL LMP IN HIGH- PRICED HOURS	FULL LMP WHEN PRICE SAVINGS > DR PAYMENT	FULL LMP IN ALL HOURS	
PARTICIPATION	Number of Program Hours	3,653	8,760	895	7,272	8,760	
	Participation Level (MW)	15,687 (60%)	15,687 (60%)	15,687 (60%)	15,687 (60%)	15,687 (60%)	
	Elasticity of Participants	-0.050	-0.050	-0.050	-0.050	-0.050	
	Aggregate Elasticity	-0.030	-0.030	-0.030	-0.030	-0.030	
LOAD IMPACTS	Peak Load (MW)	26,000	26,000	25,531	25,562	25,561	
	Δ in Peak Load from Fixed Rates (MW)	-145	-145	-614	-583	-584	
	%Δ in Peak Load from Fixed Rates	-0.55%	-0.55%	-2.35%	-2.23%	-2.23%	
	Consumption (GWh)	134,284	134,516	134,022	131,990	131,387	
	Δ Consumption from Fixed Rates (GWh)	-182.0	49.5	-444.8	-2,475.9	-3,079.8	
	%Δ Consumption from Fixed Rates	-0.14%	0.04%	-0.33%	-1.84%	-2.29%	
	Δ Consumption from Baseline (GWh)	-245.9	NA	-623.9	-2,914.6	-3,510.0	
ECONOMICS	Load-Weighted Mean LMP (\$/MWh)	\$68.42	\$68.85	\$64.33	\$53.91	\$53.49	
	Mean LMP plus DR Side Payments (\$/MWh)	\$68.48	\$68.85	\$64.76	\$56.36	\$56.63	
	Side Payments to DR (\$)	\$8,548,895	NA	\$28,962,321	\$152,526,712	\$201,879,878	
	Avg. Side Payments to DR (\$/MWh reduced)	\$35	NA	\$46	\$52	\$58	
	Energy Market Only						
	Δ Consumer Surplus from Fixed Rates (\$)	\$282,454,336	\$222,447,252	\$779,753,179	\$1,902,534,725	\$1,870,704,638	
	Δ Producer Surplus from Fixed Rates (\$)	(\$276,933,450)	(\$214,113,300)	(\$826,901,842)	(\$2,213,336,652)	(\$2,255,462,311)	
	Δ Net Benefits from Fixed Rates (\$)	\$5,520,887	\$8,333,952	(\$47,148,663)	(\$310,801,926)	(\$384,757,673)	
	Energy and Capacity Markets						
	Δ Consumer Surplus from Fixed Rates (\$)	\$6,701,236	\$9,695,258	(\$36,585,446)	(\$286,764,909)	(\$360,076,963)	
	Δ Producer Surplus from Fixed Rates (\$)	(\$1,180,349)	(\$1,361,306)	(\$10,563,217)	(\$24,037,017)	(\$24,680,710)	
Δ Net Benefits from Fixed Rates (\$)	\$5,520,887	\$8,333,952	(\$47,148,663)	(\$310,801,926)	(\$384,757,673)		
<i>Note: Based on 2007 data.</i>							

Summary of Effects: Energy Market Only

- **RTP/Buy-the-Baseline** has the highest net benefits
 - Highest net benefits occur where the marginal value of consumption equals the marginal cost of production – i.e., supply equals demand
- **Fixed retail rates have lower net benefits:**
 - Over-consumption in high-priced hours (*i.e.*, consuming energy in applications with marginal value less than the marginal production cost)
 - Under-consumption in low-priced hours (*i.e.*, missing opportunities to use energy when marginal value exceeds low production cost)
- **Paying DR full LMP reduces net benefits**, with constant under-consumption (and/or high-cost behind-the-meter generation)
 - While lower LMPs bring substantial gains to consumers (or LSEs), producers experience substantial losses
 - As discussed next, this can change capacity prices and negates the gains to consumers (LSEs), leaving consumers are worse off
- **Paying LMP minus retail rate for DR increases net benefits**

Capacity Market Dynamics

- **Issue:** Capacity price increases can fully offset LMP reductions if DR paid full LMP, leaving consumers worse off
 - Generators must raise capacity price offers to remain commercially viable on less energy revenue
 - Capacity prices apply to entire capacity requirement, which exceeds peak load, whereas energy price reductions apply to actual hourly load
- **Impact depends on what sets the capacity auction clearing price:**
 - If generation sets the capacity clearing price, New England would see higher capacity prices right away (at next forward capacity auction)
 - If a DR asset sets the capacity clearing price, increase may be deferred until new generation is needed and sets the price
- **Unlikely that DR will set capacity prices for extended periods:**
 - Generation is 92% of all New England resources (by MW)
 - If more DR clears the capacity market, it will be dispatched more frequently, which will limit DR penetration in capacity markets

Analysis of Energy and Capacity Markets

- **We examined:** If generation assets set the capacity auction clearing price, do capacity market impacts **leave consumers worse off?**
- **Main finding:** Net consumer benefits from a policy that pays full LMP to DR are **negative**. Capacity price increases more than offset energy price reductions
 - All full-LMP payment proposals result in negative net consumer benefits, relative to fixed rates
 - Providing full-LMP payments to reduce consumption still reduces LMPs, but payments impose a consumer burden that brings no benefit
 - Real-time pricing and LMP-RR still exhibit positive net benefits and positive consumer benefits, relative to fixed rates
- These results do not change the **relative** ranking of the compensation proposals based on net benefits in the energy market alone

Summary

- **Well-designed DR programs can improve net benefits:**
 - Fixed retail rates result in over-consumption in high-priced hours and under-consumption in low-priced hours
 - Real-time pricing and buy-the-baseline have positive net benefits
- **DR compensation at full LMP decreases net benefits:**
 - Full LMP incentive payments result in under-consumption in all periods and lower net benefits than fixed retail rates
 - The decrease in net benefits is directly proportional to the number of hours that full-LMP payments are allowed
 - Full-LMP incentive payments could produce reductions in LMPs in the near term. However, capacity prices adjust making consumers worse off
- **LMP-RR has higher net benefits:** It eliminates low-value, high-cost consumption in high-LMP periods
 - And it imposes a lower burden on consumers for DR payments
 - However, this approach does not maximize net benefits because it cannot fully address under-consumption in low-LMP periods