



Demand Resource Participation in the Energy Market

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**The views presented here are my own, and do not necessarily
represent those of the MA Department of Public Utilities or NECPUC.**

Incorporation of Demand Resources into the Energy Market

- Reliability – based programs
 - Historically, Interruptible Customers receive favorable rate in exchange for curtailing when notified
 - Currently, ISO New England OP4 Conditions trigger response from demand resource with a Capacity Supply Obligation from the Forward Capacity Market
- Economic programs
 - Day Ahead Load Response Program participants may offer “supply” into day-ahead market above minimum offer level
 - Real Time Load Response Program participants may offer “supply” into real-time market when forecasted price exceeds \$100 / MWh and eligibility period is open
- Goal: demand that responds to high prices, aka: price-responsive demand
 - Wholesale integration, similar to Load Response Programs
 - Retail price-responsive demand enabled by smart grid and dynamic pricing



Overview and Recommendations

- Full LMP is the appropriate payment level for demand response.
- However, full LMP should only be provided in limited hours. Limit should be based on the following objectives:
 1. Ensure market customers enjoy net benefits from DR;
 2. Mitigate price formation concerns;
 3. Ensure that adequate baselines can be maintained;
 4. Maintain balance between wholesale and retail demand response.
- The mechanism for limiting the hours of full LMP payment should be developed at the ISO/RTO level.
 - In New England, the existing threshold mechanism should be used to limit the hours of full LMP payment.

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NECPUC PRD Proposal: June 23 2009 – Summary

- Referred to as the “Limited Supply-Side Approach.”
- Demand response allowed to bid directly against supply resources.
- Demand response whose bids clear would be paid the full LMP.
- Energy market clearing prices would be adjusted downward to reflect the addition of demand response.
- A threshold floor price would be used to limit payment to demand response to the highest-priced hours of the year.
 - The floor price fluctuates with market prices.
- The costs associated with demand response would be collected from all energy purchasers by raising the market clearing price.
 - The prices paid to suppliers would not be increased.



NECPUC Proposal on Appropriate Payment Level

- NECPUC recognizes the concerns about price formation (i.e., the “double payment” issue). Nonetheless, payment at the full LMP is appropriate, for the following reasons:
- PRD is necessary to support an efficient, fully competitive market.
- Payment of the full LMP is necessary to overcome the market barriers that demand response resources face.
- NECPUC’s proposed threshold mechanism significantly limits the extent to which price formation is a problem.
- NECPUC’s proposed threshold mechanism also limits demand response to those hours when they are most likely to provide net benefits to customers.
- Experience indicates that payments at less than the full LMP will not encourage the full amount of available demand response.



Areas of Further Work to Integrate Demand Resources

- Technical Conference and Supplemental NOPR on 'net benefits test' and cost allocation
- Price effects in the energy market of reliability-based dispatch of demand resources
- Comparability requirements of Order 719: integration in the reserves and regulation markets
- Concurrent participation in the capacity, energy, and ancillary services markets



Additional Resources

- [NECPUC Comments in the FERC NOPR](#)
- [NECPUC White Paper](#)
- [Commissioner Tim Woolf's presentation to NARUC's Electricity and Energy Resources and Environment Committees](#)
- ISO New England and NEPOOL Status reports [at FERC](#):
 - Price Responsive Demand, Docket ER08-830 (December 18, 2009)
 - Load Response Programs, Docket ER03-345 (June 30, 2010)
 - Order 719 Compliance, Docket ER09-1051 (April 21, 2010)



Appendix A

Detailed Description and Rationale for
NECPUC's Limited Supply-Side Proposal



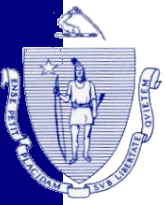
Payment Level for Demand Response – Two Primary Options

- Pay demand response the full LMP.
 - (1) Demand response should be paid the same amount as supply-resources, since they provide comparable value to the market.
 - (2) Paying the full LMP will be necessary to overcome the market barriers to demand response.
- Pay demand response LMP less the generation portion of the retail rate (LMP-RR).
 - (1) Customers that provide demand response benefit from both reductions in electricity bills and the payment from the energy market. This could be considered a “double payment” and could encourage customers to implement more demand response than is economically efficient.
 - (2) Removing the retail portion of the generation rate results in customers receiving a virtual real-time price (i.e., the efficient price signal).



Payment Level for Demand Response - Two Different Perspectives

- Perspective #1: PRD mechanisms should compensate demand response in a way that is comparable to supply resources.
 - Therefore, payments should equal full LMP.
- Perspective #2: PRD mechanisms should be designed to send customers appropriate price signals to implement demand response.
 - Therefore, payments should equal LMP-RR.
- These are different because of conflict between theory and practice.
 - *In theory*, proper price signals should result in the optimal level of demand response.
 - However, *in practice* price signals alone are not sufficient.
- Due to a variety of market barriers and market imperfections.



Market Barriers and Market Imperfections

- Market barriers:
 - Many customers do not see real-time price signals.
 - Many customers do not have the necessary technologies:
 - Advanced meters, automated load curtailment systems, energy management systems, etc.
 - Many customers do not have sufficient information about how the wholesale markets work and how to curtail load.
 - Many customers require technical support to help manage and dispatch curtailment operations.
 - Many customers do not have sufficient incentive to curtail load, given size of electric bill and other budget priorities.
- Market imperfections:
 - Customers do not receive proper capacity price signals from the Forward Capacity Market.
 - Customers do not receive any price signals with regard to avoided transmission or distribution capacity.



The Price Formation (“Double Payment”) Concern

- From the perspective of sending the appropriate price signal, paying the full LMP raises concerns about a “double-payment” issue.
 - This is also referred to as a “price formation” problem, because the price signals are distorted (in theory).
- Demand resource providers that receive the full LMP payment benefit from both (1) the payment from the energy market, and (2) reductions in electricity bills (in particular, the retail generation rate “RR”).
- This is an economically inefficient outcome (in theory), because it could lead to over-investment in demand response.
- The proposed solution is to pay demand response the LMP minus the generation portion of the retail rate (LMP-RR). In this way, customers would receive a combined price signal equal to the real-time wholesale energy price.

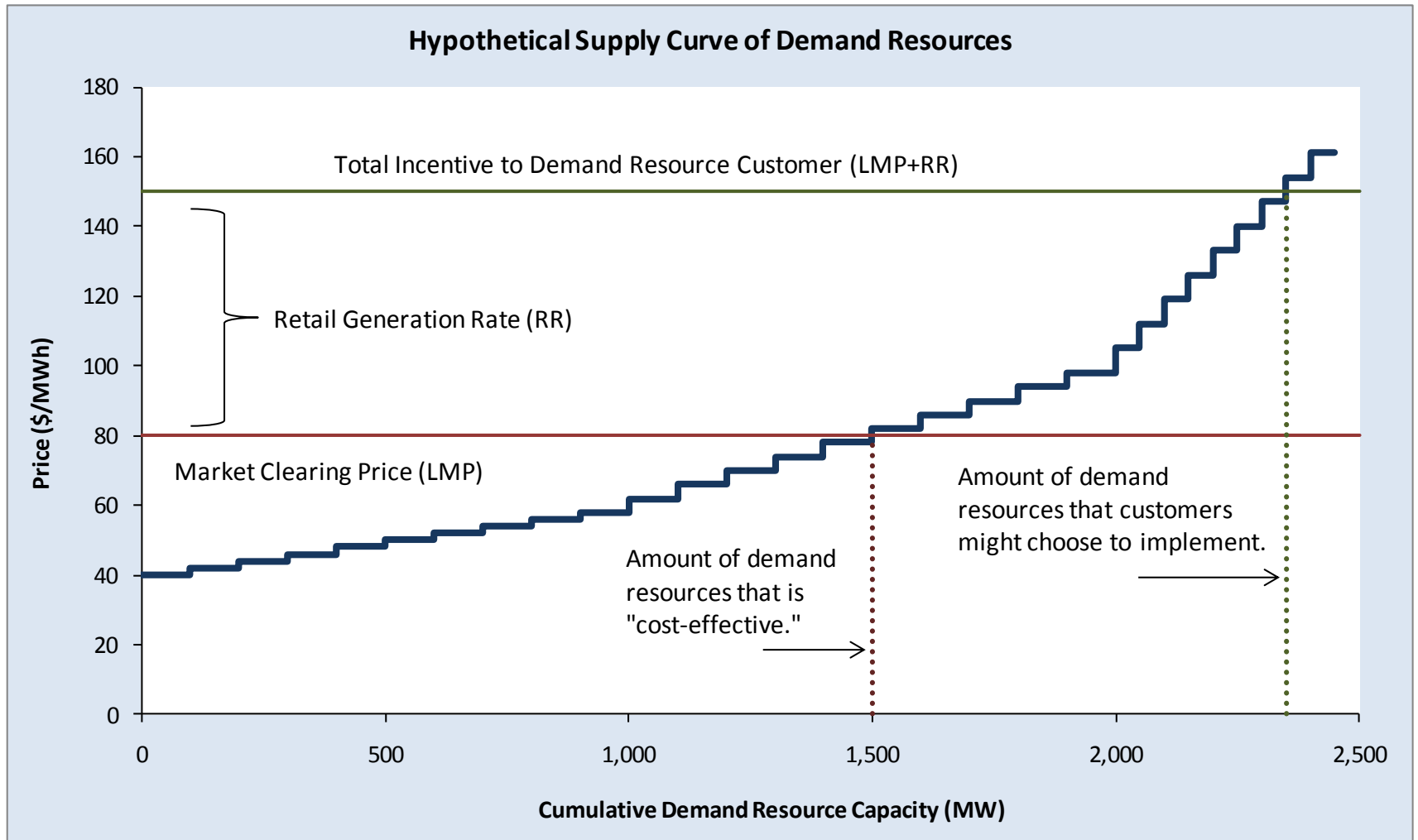


The Price-Formation Problem – Example

- Assume a customer's retail energy rate is \$70/MWh.
- Assume that the LMP is \$80/MWh.
- This customer has an economic incentive of \$150/MWh to operate a demand resource (\$70 bill savings + \$80 LMP payment).
- If a customer operates a demand resource that costs, for example, \$140/MWh, this would displace a lower-cost marginal resource at \$80/MWh.
- This would be an economically inefficient outcome (in theory).



The Price-Formation Problem



What is the Appropriate Level of Demand Response?

- Lesson from retail energy efficiency practices:
The appropriate (i.e., cost-effective) level of demand response depends upon the perspective chosen.
 - Societal Test
 - Total Resource Cost Test
 - Energy System Test
 - Participant Test
 - Non-participant Test
- Which perspective to use is a policy call.
 - Commissions typically use the Total Resource Cost Test.
 - Some commissions use a Societal Test.
 - Some commissions require that several tests be applied.
- The costs and benefits considered in determining cost-effectiveness must be internally consistent with the perspective chosen.

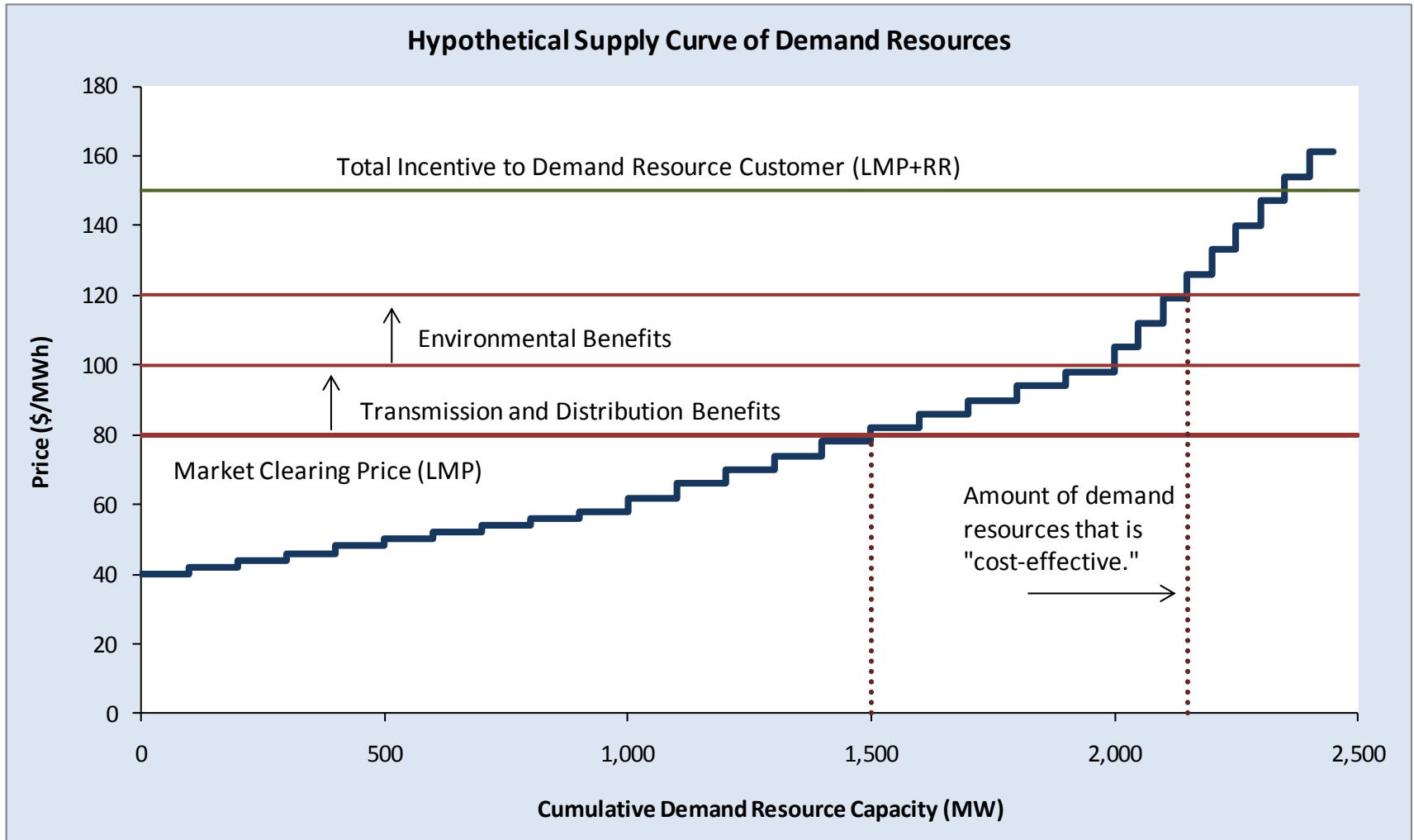


Price Formation Issue Must be Considered From the Appropriate Economic Perspective

- The demand resource customer's bill savings occur outside of the energy market – i.e., they are societal costs/benefits.
- However, there are many other societal costs and benefits of demand response (and supply resources) that are not accounted for.
 - For example, avoided transmission costs, avoided distribution costs, environmental benefits, improved reliability, reduced price volatility, etc.
- Without accounting for all societal costs, it is not possible to say that operating the higher-cost demand resource is economically *inefficient*.
 - It is also not possible to say that operating that demand resource is economically *efficient*.
- The societal perspective should not be applied.
 - In wholesale markets, the only practical, internally consistent way to consider economic efficiency is from the perspective of the market.
 - From the perspective of the market, the demand response customers' retail bill savings do not need to be considered.



Price Formation and the Societal Perspective



All of the prices, costs and benefits presented here are purely illustrative.

Bottom Line on Price Formation Issue

- Price formation concerns should not create a binding constraint on the choice of payment for demand response.
 - This is consistent with the market perspective.
- Nonetheless, price formation concerns should not be completely ignored either.
 - It is possible to over-invest in demand response.
- Instead, price formation concerns should be one of the factors used in determining which hours to pay demand response the full LMP.



NECPUC Proposal Addresses the Price Formation Problem

- NECPUC recognizes the concerns about price formation.
- Under the Limited Supply-Side proposal, demand response would be limited to bidding only in the highest-priced hours of the year.
- Those highest-priced hours would be determined using the threshold currently being used in the Day-Ahead Load Response Program (see next slide).
- Recently, this threshold limited demand resource bidding to roughly eight percent of the hours per year.
- This threshold mechanism dramatically reduces the risk of over-investment in demand response due to the price formation problem.



NECPUC Proposed PRD Threshold Mechanism

- Currently utilized in the Day-Ahead Load Response Program.
- Indexed to the Forward Reserve Fuel Index to reflect current fuel price conditions:

$$\text{Fuel Price (\$/MMBTU)} * \text{Heat Rate (MMBTU/MWh)} = \text{Threshold Price (\$/MWh)}$$

- Example: (April 2010):

$$\$5.57 * 11.370 = \$63/\text{MWh}$$

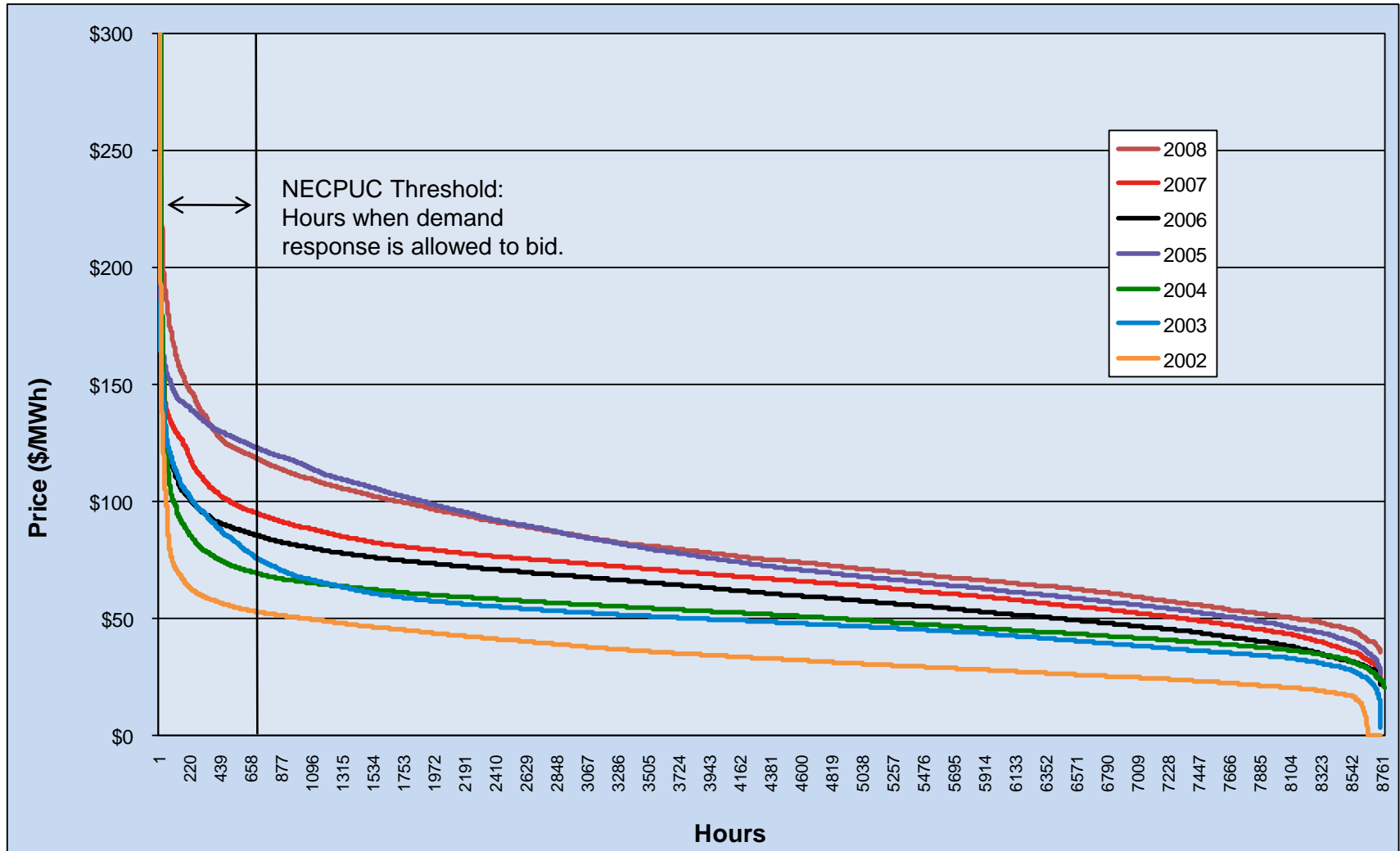
- Example: (March 2010):

$$\$6.51 * 11.370 = \$74/\text{MWh}$$

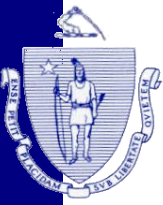
See 123 FERC ¶ 61,021 (April 4, 2008) in Docket ER08-538-000



NE Wholesale Energy Market: Price Duration Curve



Source: ISO-NE website



How to Ensure That Demand Response Provides Net Benefits?

- In many hours, demand response will provide net benefits (i.e., reduced energy costs) to all energy market customers.
- However, in some hours demand response might result in net costs to customers, due to the “missing money.”
- Unlike supply resources, demand response creates a missing money issue, as a result of having lower demand to recover costs over.
- Without PRD (no missing money):
 - $LMP / MWh = \text{Price}$
- With PRD:
 - $LMP / (MWh - DR \text{ savings}) = \text{higher price, or}$
 - $LMP / MWh = \text{Price, and DR payments are recovered out of market.}$

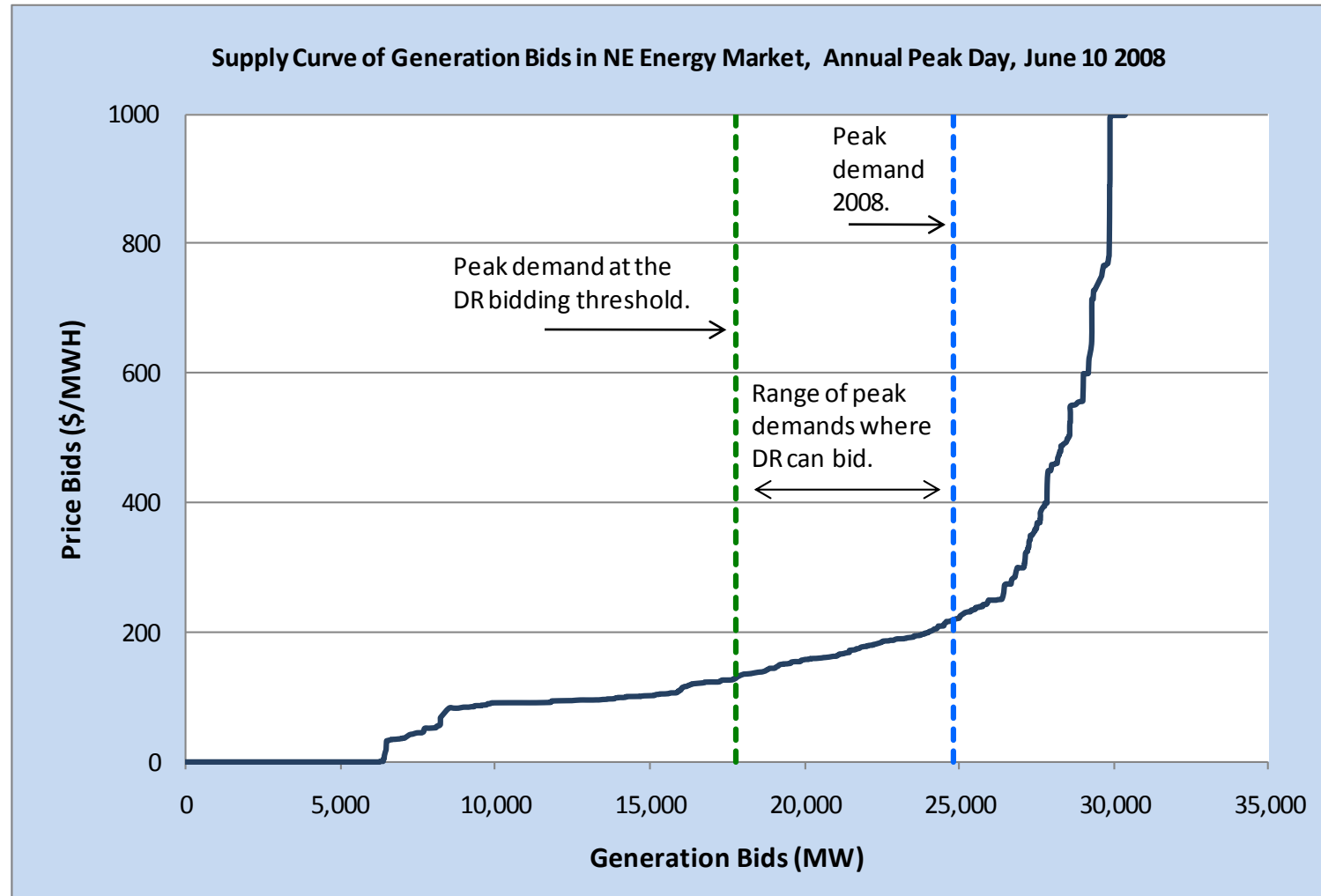


When Will Demand Response Provide Net Benefits to Customers?

- Demand response will provide net benefits to customers, as long as they reduce energy costs (through lower energy prices) by an amount that exceeds the demand resource costs (i.e., the missing money).
- The extent to which demand response provides net benefits will depend upon the supply resources that they displace.
- This will depend upon where the demand curve intersects the generation supply curve.
 - If the supply curve is steep, there could be significant net benefits.
 - If the supply curve is flat, there could be net costs.
- NECPUC's proposed threshold mechanism will increase the likelihood that demand resources provide net benefits to customers.



Range of the Generation Supply Curve Where Demand Response Can Bid – Illustrative Example from 2008



Source: ISO-NE website



Really Rough Estimate of Potential Demand Response Impacts in Peak Hours

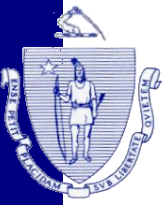
Based on generation supply curve for 12:00 noon, June 10, 2008.
This is at roughly 98% of the total peak demand for 2008.

Five hypothetical levels of demand response. (At this point on the supply curve, the average bid block size is about 30 MW.)

Demand Response Capacity (MW)	DR Capacity (% peak)	DR Price Reduction (\$/MWh)	DR Costs (\$)	DR Savings (\$)	DR Net Benefits (\$)	DR Net Benefit (% of total mkt cost)	DR Benefit Cost Ratio
1975	8%	27.0	361,333	656,697	295,363	5.8%	1.8
1005	4%	18.0	192,864	437,798	244,934	4.8%	2.3
807	3%	16.0	156,679	388,424	231,745	4.5%	2.5
600	2%	14.1	117,526	342,698	225,172	4.4%	2.9
300	1%	8.2	60,529	198,712	138,183	2.7%	3.3

Conclusion: During high-priced hours there is a large potential for net benefits from demand response.

Caveat: This is simplistic and just for illustrative purposes.



Really Rough Estimate of Potential Demand Response Impacts in Off-Peak Hours

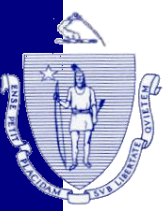
Based on generation supply curve for 12:00 noon, June 10, 2008.
Same as above, but at the 12,000-14,000 MW range in the supply curve.

Five hypothetical levels of demand response. (At this point on the supply curve, the average bid block size is about 50-100 MW.)

Demand Response Capacity (MW)	DR Capacity (% peak)	DR Price Reduction (\$/MWh)	DR Costs (\$)	DR Savings (\$)	DR Net Benefits (\$)	DR Net Benefit (% of total mkt cost)	DR Benefit Cost Ratio
1971	14%	4.8	182,692	56,251	-126,441	-9.4%	0.3
842	6%	1.7	80,605	22,268	-58,337	-4.3%	0.3
431	3%	1.6	41,320	21,105	-20,215	-1.5%	0.5
325	2%	1.0	31,359	12,925	-18,434	-1.4%	0.4
175	1%	0.4	16,977	5,990	-10,987	-0.8%	0.4

Conclusion: During some hours there is potential for demand response to result in net costs to customers.

Caveat: This is simplistic and just for illustrative purposes.



Alternative Threshold Mechanism

- Consumer Demand Response Initiative (CDRI) proposes an algorithm to directly calculate those hours when demand response will provide net benefits to customers.
 - Would be a dynamic threshold calculated iteratively each hour.
- Demand response would be dispatched only when the price reduction caused by the demand resource exceeds the cost of the demand resource.
- Establishes an adjusted price:
 - Adjusted Price = (revenue requirement including DR costs) / (energy demand including DR reductions).
 - If adjusted price is less than what the LMP would be absent the demand resource, then the demand response offer clears the market.
- Demand resources and supply resources are all paid the reduced LMP, but consumers are charged the higher adjusted price.



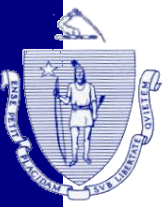
Payment of Full LMP Should be Limited to Address Baseline Issues

- One of the most direct ways to demonstrate that a customer has curtailed load in response to a wholesale market payment is to establish customer baselines.
 - The baseline represents typical customer loads in the absence of demand response.
 - Load curtailment is measured by the reduction of load relative to the baseline.
- If customers are paid to dispatch demand response in all hours, then there may be very few hours to use for setting a baseline.
 - Creates a potential for gaming.
- The New England Day-Ahead Load Response program encountered some problems where customers were participating in too many hours to determine reliable baselines.
- The response was to establish a threshold mechanism; the same mechanism that NECPUC has proposed above.



Payment of Full LMP Should be Limited to Maintain a Balance Between Wholesale and Retail Demand Response Activities

- Rationale for wholesale-level demand response programs:
 - Benefits to wholesale market and its customers.
 - Consistency across states and regions.
 - Overcome state inactivity.
- However, if wholesale market demand response programs are too generous in too many hours, then they could squeeze out potential retail demand response programs.
 - For example, Real-Time Pricing programs for load-shifting technologies (e.g., cool storage), or for electric vehicles.
- Limiting the hours in which demand response can receive the full LMP payment will mitigate conflicts between wholesale and retail programs.



Summary \ Conclusions

- Paying demand response the full LMP is most likely to lead to the appropriate level of demand response.
 - Demand response would be paid the same as supply resources.
 - Demand resource providers would be offered sufficient revenues to overcome market barriers.
- Hours should be limited, based on the following objectives:
 1. Ensure market customers enjoy net benefits from DR;
 2. Mitigate price formation concerns;
 3. Ensure that adequate baselines can be maintained;
 4. Maintain balance between wholesale and retail demand response.
- The NECPUC price threshold strikes the appropriate balance between these objectives.



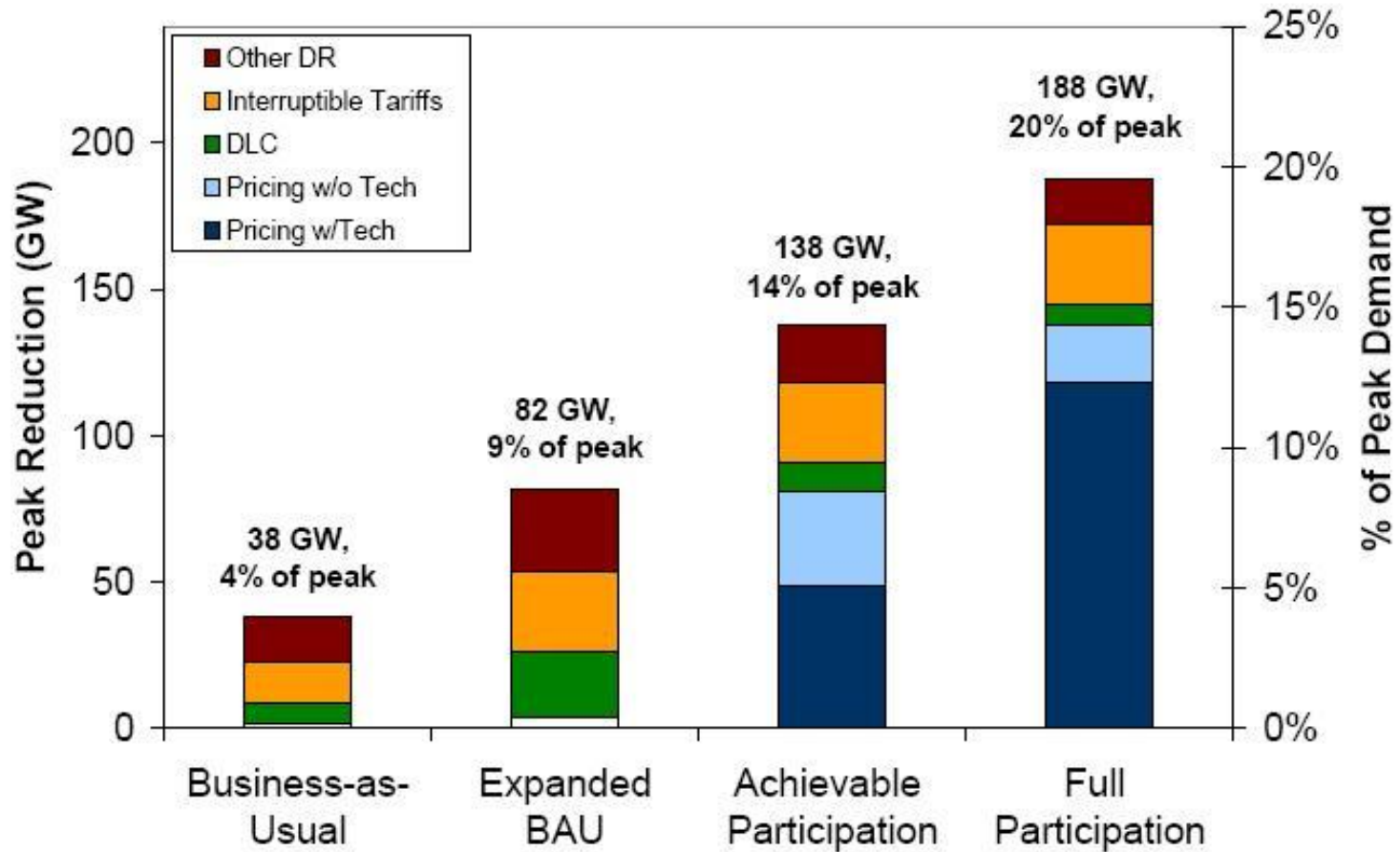
Appendix B

FERC Estimate of Demand Response Potential
and Implications for Appropriate Payment Level



FERC Estimate of Potential US Demand Response – By Program Type

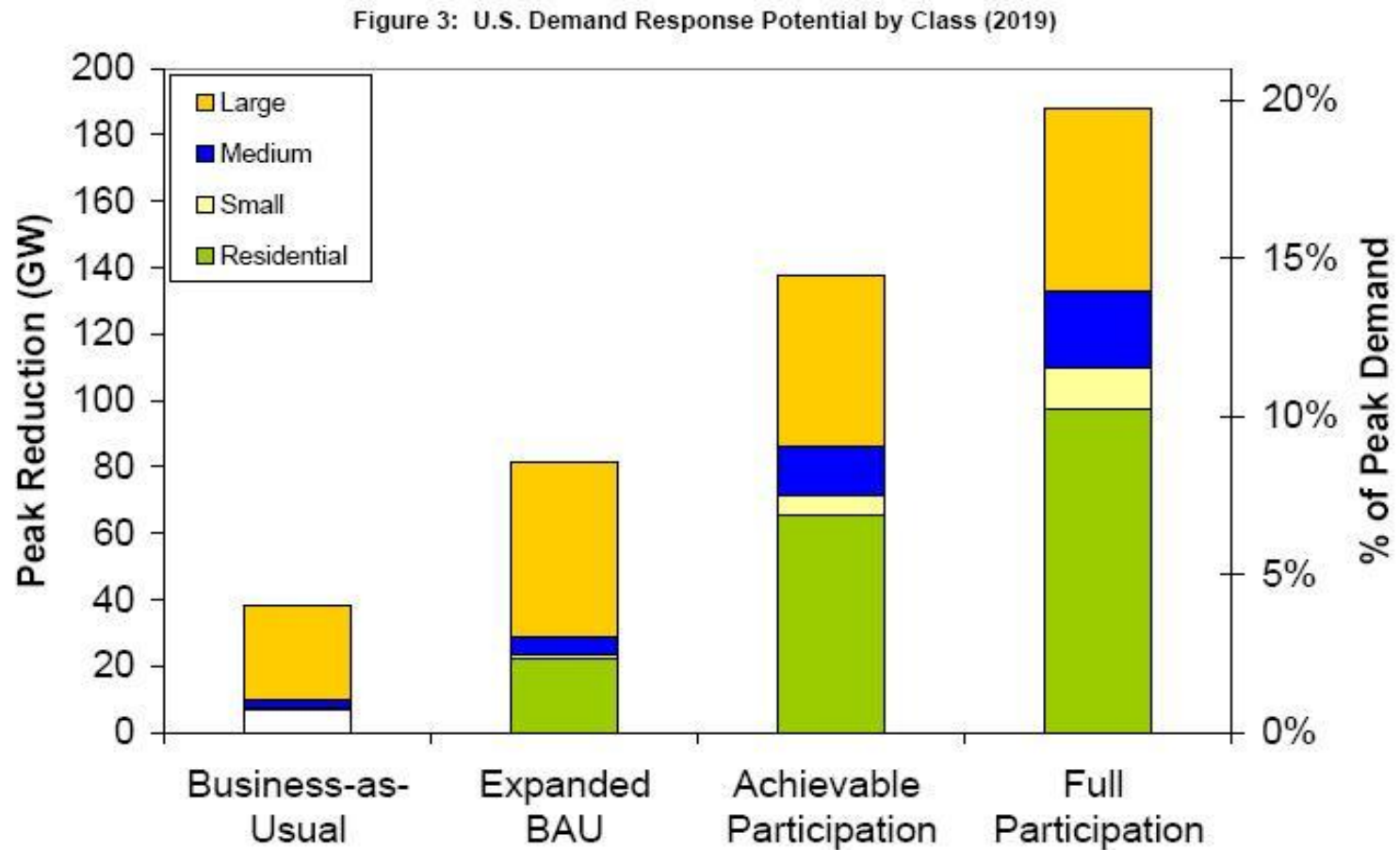
Figure 2: U.S Demand Response Potential by Program Type (2019)



Source: Federal Energy Regulatory Commission, *A National Assessment of Demand Response Potential*, Staff Report, June 2009.



FERC Estimate of Potential US Demand Response – By Customer



Source: Federal Energy Regulatory Commission, *A National Assessment of Demand Response Potential*, Staff Report, June 2009.



Implications of FERC Estimate of US Demand Response Potential

- If we are to implement the higher levels of demand response (achievable and full cost-effective levels), then we must:
 - 1) Provide customers with enabling technologies, and
 - 2) Tap the residential and small C&I customer market.
- Achieving these goals requires:
 - Active demand response providers;
 - Customer aggregators; and
 - Significant payment levels to help overcome market barriers.
- Paying demand response the full LMP is more likely to lead to these outcomes, relative to paying LMP-RR.



Appendix C

Demand Response Compensation in Organized Wholesale Energy Markets

FERC Notice of Proposed Rulemaking, RM10-17



FERC Notice of Proposed Rulemaking (NOPR)

- Issued on March 18, 2010
- Proposes an approach for compensating demand response resources to improve competitiveness of organized wholesale energy markets:
 - “Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) with tariff provisions permitting demand response providers to participate as resources in energy markets by reducing consumption of electricity from their expected levels in response to price signals be required to **pay demand response providers, in all hours, the market price (i.e. full LMP)** for energy for such reductions.”
- Applies to day-ahead and real-time energy markets
- Comments are due on May 13, 2010
- [Federal Register, Vol. 75, No. 59, PP. 15362-15371 \(March 29, 2010\)](#)



Need for Reform

- “demand response providers collectively play a small role in wholesale markets” (P. 15365)
- “the Commission is concerned that some existing, inadequate compensation structures have hindered the development and use of demand response” (id.)
- Case Study: PJM Economic Load Response Program
 - Market Monitor: following decrease in compensation, settled demand reductions decreased by 36.8 percent
- “Based upon our own review, the Commission is now concerned that evidence of demand reductions in PJM, and inadequate demand response participation, now and in the future, may be the result of **compensation that is no longer just and reasonable**, because... the existing and varying levels of compensation generally **fail to reflect the marginal value of demand response** resources to ISO and RTO energy markets.” (id.)



Current ISO and RTO Demand Response Programs

- Each RTO and ISO has developed its own compensation methodologies for demand response resources in its energy market
 - PJM: Locational Marginal Price (LMP) minus Generation and Transmission.
 - ISO-NE and NYISO: LMP when prices above a threshold level.
 - Differing threshold levels
 - MISO: LMP in energy market when demand response provider has purchased the amount reduced in the day-ahead market for energy and ancillary services.
 - CAISO: LMP for day-ahead and real-time energy and non-spinning reserves.
 - SPP: no demand response program.



FERC NOPR: the Proposal

- Add Section 35.28(g)(1)(v) to 18 C.F.R. 35.28 (Open-Access Transmission Tariff)
- Proposed Rule:
 - Each Commission-approved ISO and RTO that has a tariff provision providing for participation of demand response resources in its energy market must **pay demand response resources, in all hours, the market price for energy**, i.e. full LMP, for demand reductions made in response to price signals
- Rationale:
 - The **LMP represents the marginal value** of the resource being used by the RTO or ISO to balance supply and demand, it follows that the **LMP should be paid to any resource clearing** in the RTO's or ISO's energy market
 - Paying the LMP in all hours should **allow more demand response resources to cover their investment costs and increase their ability to participate** in the organized wholesale electric markets
 - Increasing the aggregate amount of demand response resources will **help move prices closer to the levels that would result if all demand could respond to the marginal cost of energy**

