Chapter 3 – Methodology For Evaluating the Effects of PRL Programs

Estimates of the supply flexibilities are a critical element in calculating the effects of PRL load reduction on electricity prices, and in the overall program evaluation. The Day-Ahead Demand Response Program (DADRP) allows end-use customers to offer demand reduction bids into New York's day-ahead electricity market to help reduce system demand, and to receive market prices for any load reduction. Participants in the Emergency Demand Response Program (EDRP) are notified at least two hours in advance of when emergency system conditions are imminent, and they are guaranteed a minimum price for any load curtailment. Participants in ICAP/SCR must curtail after receiving two hours prior notice, provided that they were warned the day before that curtailments might be called for.

The overall strategy for evaluating both the DADRP and the EDRP and ICAP/SCR curtailments, and a list of the major market effects is given in Exhibit 3.1.

The Market Effects

The theory underlying the effect of load reduction or on-site generation from the two PRL programs is developed in detail in an earlier report to the NYISO by Neenan Associates (2001). The major components of this theory are illustrated simply in Exhibits 3.2a and 3.2b. The theory underlying EDRP effects is discussed first, and it is followed by a discussion of DADRP effects.

Market Effects of EDRP

In developing the theory underlying market effects of EDRP, it is assumed that demand is initially at a level indicated by point Q2 in Exhibit 3.2a. When the event is called, as the exhibit illustrates, demand is reduced to Q1 due to the load reduction, and the LBMP in the RTM consequently falls from P2 to P1. The situation when an event is called could, in fact, be worse than the one in the Exhibit 3.2a. Demand could initially be well beyond Q2, not intersecting the supply curve at all.

In either case, the load relief forthcoming during an EDRP event would depress market prices as long as the load curtailment results in a shift of the load level to the left of where it otherwise would have intersected the supply curve. Further, either an actual system outage would be avoided, or at a minimum, the reliability of the system (measured in terms of reducing the likelihood of a system outage) would be improved.

To assess the effects of actual EDRP events, one must essentially view things in reverse order. That is, once an EDRP event is called, the market equilibrium is at point 1 in Exhibit 3.2a. The observed price and quantity are P1 and Q1, respectively. Now, using the estimated supply price flexibilities from above (combined with data on actual EDRP load response), one must simulate what LBMP would have been had the load response not occurred—in this case simulate point 2 in Exhibit 3.2a. As indicated in Exhibit 3.2a, the most significant market effects are:

1. Reduction in RT-LBMP;
2. EDRP Payments (the shaded area 3 in Exhibit 3.2a);
3. Collateral Benefits, or Savings to Customers (area 4 in Exhibit 3.2a);
4. Any Reduction in Average Price or Price Variability; and
5. Effects on System Reliability.

Markets Effects of DADRP

The theory underlying the effect of load reduction bids in the DAM through DADRP is also developed in detail in an earlier report to the NYISO by Neenan Associates (2001). The major components of this theory are illustrated simply in Exhibit 3.2b. The detailed discussion of similar diagrams for EDRP provided above also applies to the circumstances involving DADRP. The primary differences in the theory underlying the two programs relate to the mechanisms by which the DADRP load reduction is scheduled. The DADRP load reduction is scheduled according to customers' bid prices, while EDRP's load reduction is called by the system operator. Once load is scheduled, the effects on the markets can be traced in similar fashions, except the effect of EDRP is obviously in the RTM, while the primary effect of DADRP is in the DAM.[1] As indicated in Exhibits 3.1, 3.2a, and 3.2b, the most significant market effects of DADRP are:

1. Reduction in DAM-LBMP;

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[1] Having said this, however, the discussion regarding the EDRP highlights the fact that the effects of the programs are not entirely limited to the markets in which the loads are initially scheduled.

2. DADRP Payments to Customers (the area [Q1-Q2]*P2 in Exhibit 3.2b);

3. Collateral Benefits, or Savings to Customers (area 5 Exhibit 3.2b); and

4. Any Reduction in Average Market Price or Price Variability.

While the market effects of both DADRP and EDRP can be evaluated in a similar fashion, there are two other important effects that must be examined. The primary purpose for EDRP is to increase the level of system security in situations where there is a shortage of system-wide generation reserves. Accordingly, to complete the evaluation, one must examine the potential value of EDRP load reduction on the expected value of unserved energy. In contrast, DADRP is designed to improve market efficiency, and from this perspective, it is important to quantify the extent to which payments for DADRP load reductions are offset by the corresponding reductions in deadweight market losses to society. These additional parts of the evaluation are now discussed in turn.

EDRP Effects on System Reliability

As stated above, the primary function of EDRP and the ICAP/SCR program is to provide system dispatchers with a way to improve system reliability. Customers willing to curtail under the direction of dispatchers provide a unique stock of resources that can be dispatched during periods of forecasted or actual reserve shortfalls. According to the NYISO Operations Manual, the NYISO can, under these conditions, count dispatched EDRP load and ICAP/SCR as operating reserves.

By agreeing to curtail on terms that are acceptable to them, which include being paid, these customers improve system reliability. This delivered value is, in turn, enjoyed by all other customers system-wide (Boisvert and Neenan, 2003). In order to design and operate these programs optimally, it is essential to explicitly assign a value to such curtailments to assure that the benefits delivered exceed their cost.

The benefits from EDRP-supplied reserves depend upon the relationship between reserves and the Loss of Load Probability (LOLP), as illustrated in Exhibit 3.3. As reserves continue to fall, at some point LOLP begins to rise steeply. This in turn increases the likelihood of a need to shed load in order to maintain system reliability. Such load shedding imposes outage costs on customers. Dispatching EDRP resources forestalls the increase in LOLP. The avoidance of increased LOLP reduces the potential for forced service outages, and generates value in terms of avoided outage costs.

Quantifying the reliability benefits of EDRP requires first determining by how much EDRP curtailments improved LOLP. Then, the improvement in LOLP must be converted into a dollar value of benefit to customers. To convert this expectation into a corresponding dollar value to customers, the method of analysis developed for previous years' evaluations is to first multiply the change in expectations of an outage by the amount of load that is subject to an outage. This yields the change in the expected amount of load subject to an outage (expected unserved energy). In turn, this number is multiplied by the value of lost load (VOLL). The latter value is a measure of the cost to consumers when service is curtailed under such circumstances.

This methodology utilizes time-honored methods for valuing reliability, and the benefits from EDRP curtailments are thus measured as the change in the expected value of unserved energy (EVUE). In past EDRP evaluations, the application of this method has been both feasible and compelling, since EDRP curtailment events corresponded to times when reserves were short, and therefore additional reserves were of considerable value at the margin. However, a full empirical analysis of the reliability benefits of EDRP would require reconstructing system operations at the time of each hour of each event to determine the change in LOLP. This level of detail has always been beyond the scope of EDRP evaluations. Therefore, it has been common to report the benefits over a range of changes in LOLPs and a range of VOLL values, in order to reflect reasonable upper and lower bounds on the estimates of the cost to customers of forced outages.

Although the logic of the methodology just described is compelling during normal EDRP events, there are some new challenges for evaluating EDRP's contribution to system reliability in 2003. These stem from the fact that EDRP was called this year only immediately after the Northeast Blackout of August 14, 2003. It should not be surprising that the method described above is not directly appropriate for assessing the value of EDRP and ICAP/SCR curtailments called on August 15 and 16. On August 15th, system operators declared an EDRP and ICAP/SCR emergency event as part of their effort to restore the bulk power grid in the wake of a loss of power to most of the NYCA grid. On August 16th, the NYISO system was completely "re-energized," but system operators, so as to have more reserves available in the face of still uncertain and less than normal operating circumstances, again called the EDRP and ICAP/SCR programs. While the valuation method used in previous years seems applicable to the second day's circumstances, it is not applicable to valuing curtailment resources when millions of customers are still without power.

Under conditions when load is being restored step-by-step, curtailment resources supplied by EDRP and ICAP/SCR customers allow other customers to come back online sooner. These other customers are moved from a situation of no power (where LOLP is equal to one) to a more, if not completely, normal state where they enjoy reliable electric service. In this case, each curtailed MWH corresponds to moving another MWH from an LOLP=1 state, in which the customer's expected unserved energy is equal to the load they would use if they could be brought back on line. Put differently, there is a one-to-one correspondence between EDRP and ICAP/SCR curtailment resources and the corresponding expected unserved energy. With this unique relationship established, valuing these curtailments can be accomplished by using the conventional methods of multiplying this quantity by the value of lost load.

In past evaluations, a range of VOLL values has also been used to reflect the potential wide range in the estimates of the cost to customers of forced outages. The literature suggests that, for relatively short duration outages (for example those due to rolling blackouts that move across the system), on average customers can adapt in ways that at least partially mitigate their outage costs. Under these circumstances, it is probably appropriate to use the lower range of values that have been proposed for VOLL. In contrast, where the outage is both widespread and of extended duration, customers have little recourse except to endure the hardships. For such cases, the use of higher VOLL in estimating the value of PRL program load curtailment resources seems appropriate. (See Billington (2002) for a review of outage costs.)

Measuring the Reduction in Deadweight Social Losses from DADRP

Although assessing the market impacts from DADRP is critical to an overall evaluation of the PRL programs, it is also important to understand the extent to which DADRP may contribute to overall market efficiency. This task can be accomplished by measuring the extent to which DADRP bids, when scheduled, contribute to a reduction in what economists call social deadweight losses. These losses are a result of customers overuse or underuse of electricity when subject to fixed tariffs, compared with what their use would have been if they could, or were forced to, under very specific conditions, respond to market prices. This type of behavior is exactly what is made possible through DADRP.

The full development of this welfare analysis is reported in Boisvert and Neenan (2003), and much of it is repeated for convenience in Appendix 3A. The essence of the analysis is found in Exhibit 3.4, where both peak and off-peak demand situations are depicted. The supply curve S, has the "hockey stick" shape, whereas peak and off-peak demands are given by D_p and D_o, respectively.

From the standpoint of DADRP, it is most important to focus on the demand and supply situation during the peak period. If customers face a fixed tariff T, then they will wish to consume X_4* during peak periods. Although customers pay only T/MW at retail, the wholesale price suppliers would require to deliver X_4* is P_4*. While the nature of electricity markets requires LSEs to purchase sufficient energy to meet demand X_4*, in economic terms, the market cannot clear at this quantity and price T, because the supply curve does not pass through that point. In contrast, if customers faced full wholesale prices in the competitive market, the market would clear at price P_4^c and quantity X_4^c. The inefficiency of the fixed tariff results from the fact that, for all units of consumption between X_4^C and X_4*, the marginal cost (given by the supply curve) of meeting this load is higher than its value to the customer (given by the demand curve).

The total difference between the value to customers and the cost to producers over the load range X_4* - X_4^C can be shown to be equal to the area d + d' in Exhibit 3.4. However, some of this social deadweight loss can be avoided through DADRP if:

- Customers bid load reduction equal to X_4* - X_4^C at any offer price at or below P_4^c., and
- The DADRP payment (equal to the area s" + e + d') is less than the deadweight loss (the area d + d'). For this to be true, the area s" + e must be less than the area d.

As is demonstrated in Appendix 3A, we can view this situation in two different ways. The first relates to the characteristics of supply and demand if firms have an incentive to respond to price and achieve the equilibrium defined by point Z'' in Exhibit 3.4. Viewed from this perspective, it is clear that as the supply curve becomes steeper (e.g. pivoting counter clockwise around point Z’’), the net welfare from a DR program increases because the area d becomes larger. Similarly, if the initial demand curve were less price responsive (made steeper by pivoting clockwise about the competitive equilibrium z’’) the net welfare calculation would also move in favor of the DR load, as the areas e and s’’ would both become smaller. In summary, the potential welfare gains from DR load programs are highest in situations where both the supply and demand curves are initially extremely price inelastic (“steeper”). These are the very circumstances that have lead to price spikes that disrupt newly formed wholesale markets.

The size of these two areas is clearly an empirical question, and an important part of this year’s PRL evaluation is an attempt to measure the reduction in this social deadweight loss from the past three years’ of DADRP bids. In so doing, however, it is important to recognize that because of the NYISO’s two settlement system, bids accepted under DADRP produce efficiency gains (reductions in deadweight losses) in both the DAM (when the load is initially scheduled) and in the RTM (when the load does not show up in real time). Payment is made only once.

In discussing these potential gains in the RTM, one must also recognize that if the price in the RTM is less than in the DAM on which they were scheduled to curtail, it can be seen that market efficiency is increased by letting customers who had DADRP bids accepted in the DAM buy through in real time and consume the extra electricity.[2] This result speaks directly to the long- term efficacy of DADRP and militates for a change in the current provisions that charge participants the greater of the DAM or RTM price for curtailment shortfalls.

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[2] Although not illustrated here, this result can be established in a similar way to the analysis in Appendix 3A that demonstrates that deadweight losses are reduced if consumption during off-peak periods is greater than it would be under a fixed tariff.

Exhibit 3.1: Simulation of Effects of PRL Reduction

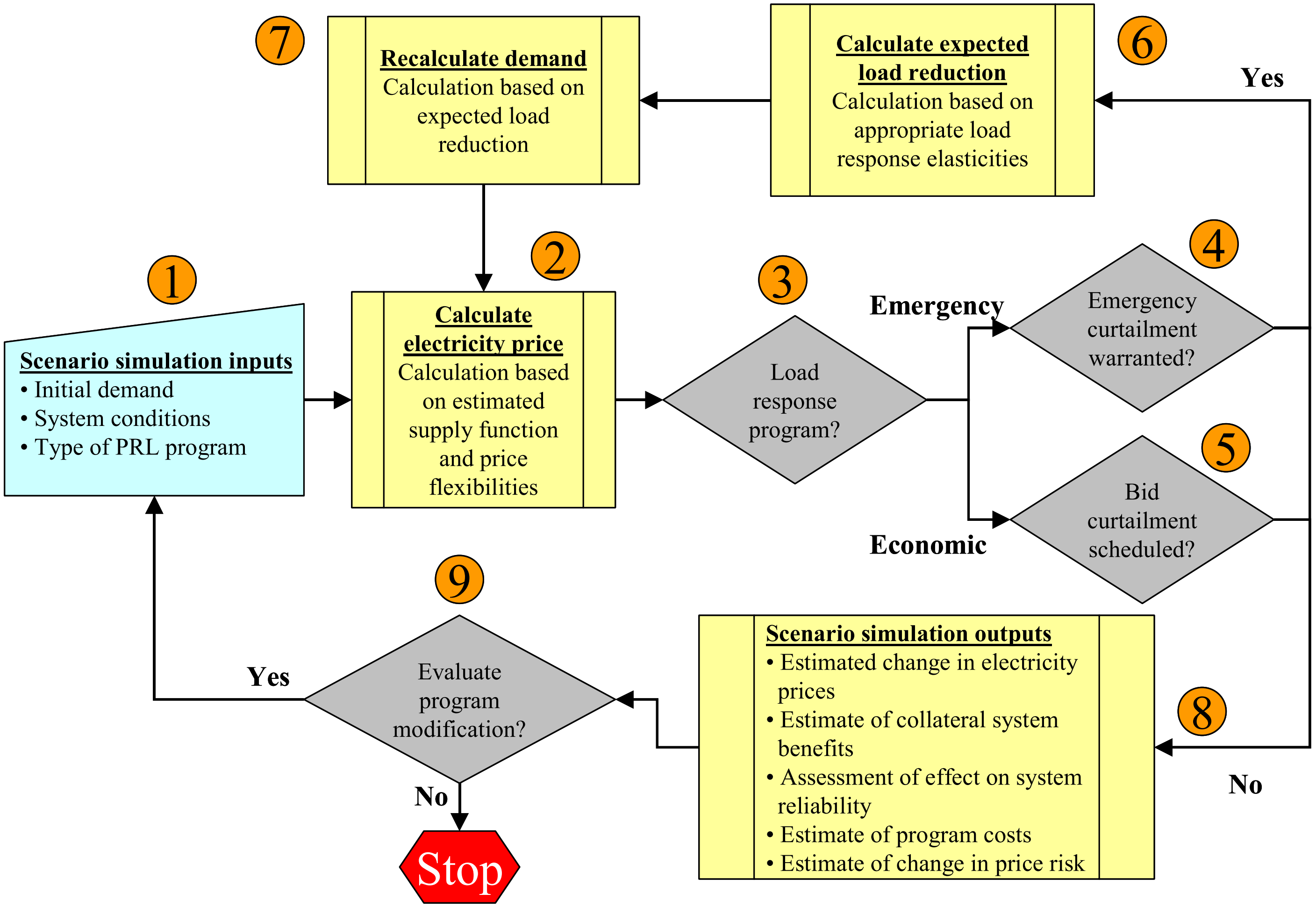
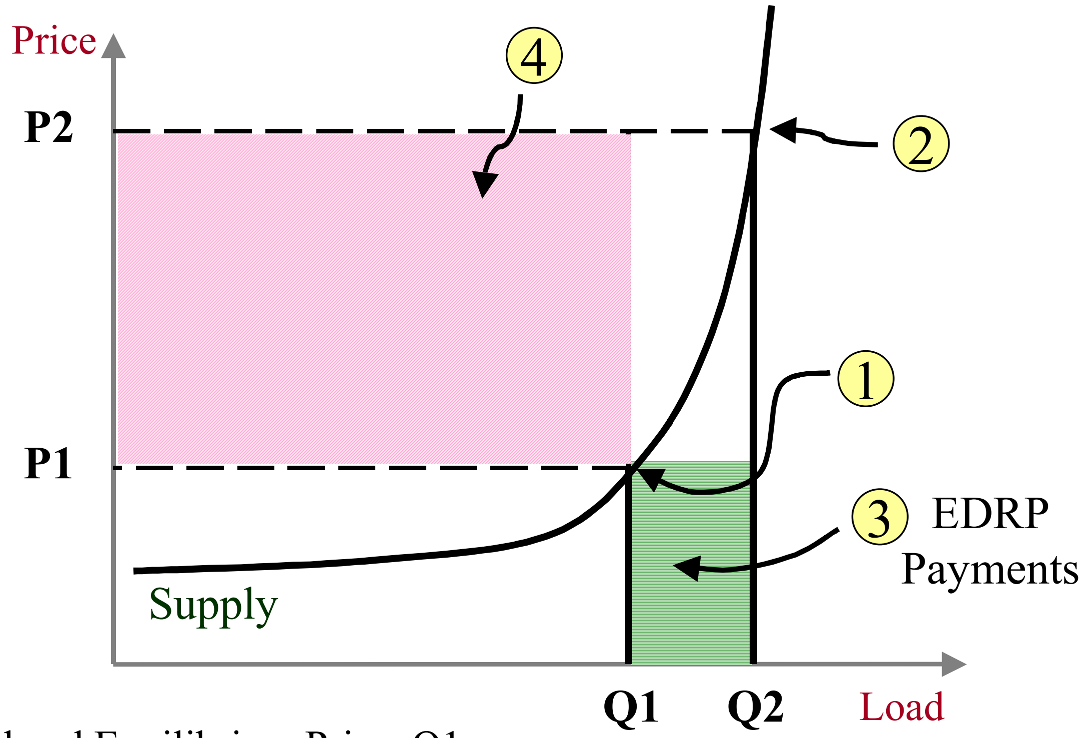


Exhibit 3.2a: Market Adjustments for EDRP



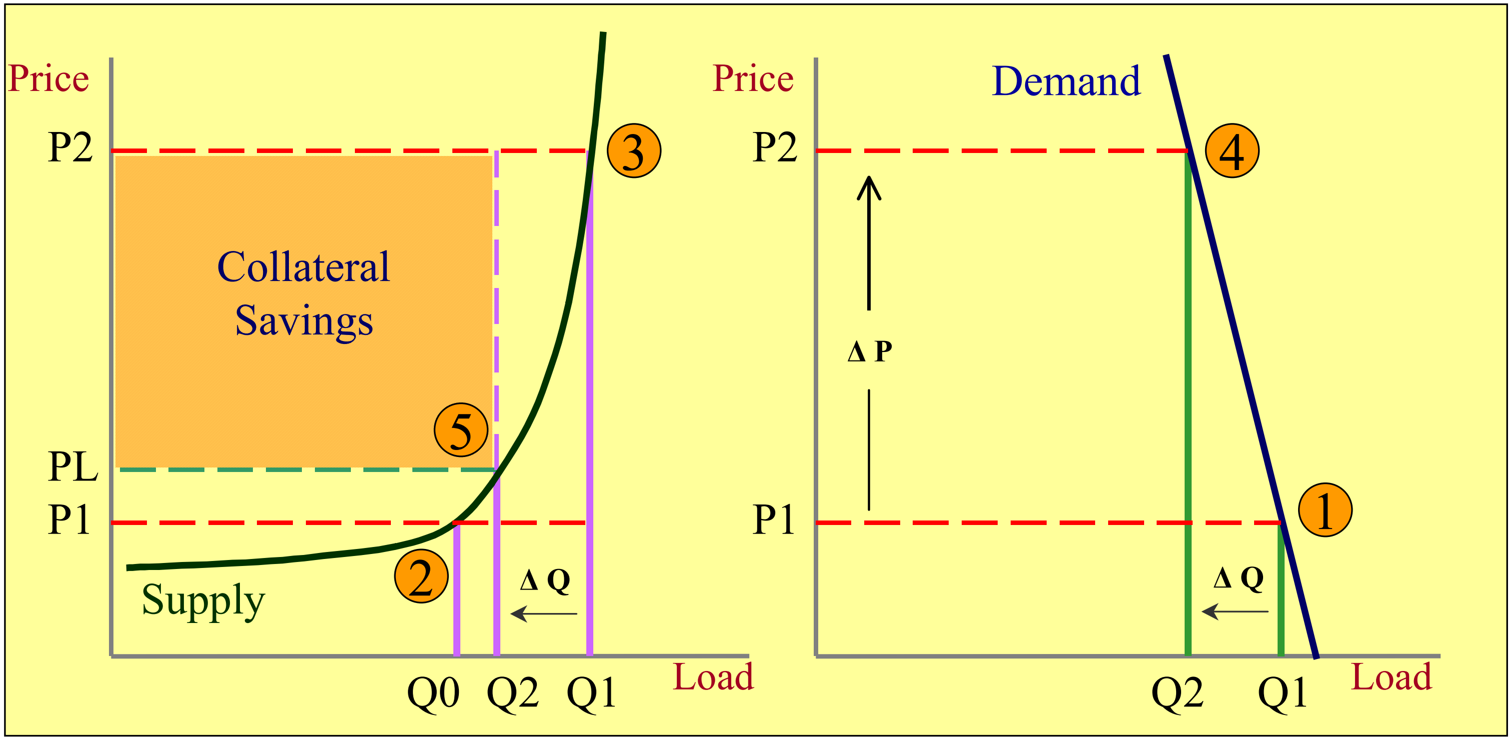
① Demand and Equilibrium Price, Q1 and P1, after EDRP Event called yielding load reduction of Q2 – Q1, equilibrium observed in the data.

② Demand and Equilibrium Price without EDRP Load Reduction, Q2 and P2.

③ Program Payments: (Q2 – Q1) x P1 or $500, whichever is higher

④ Collateral Savings: Q1 x (P2 – P1)

Exhibit 3.2b: The Dynamics of DADRP Price-Responsive Load



① Retail rate and corresponding demand.

② Supply offered at retail rate.

③ Retail demand supplied only at higher price.

④ Reduction in retail demand due to higher price.

⑤ LBMP after scheduled load reduction.

Exhibit 3.3: EDRP Value of Expected Unserved Energy

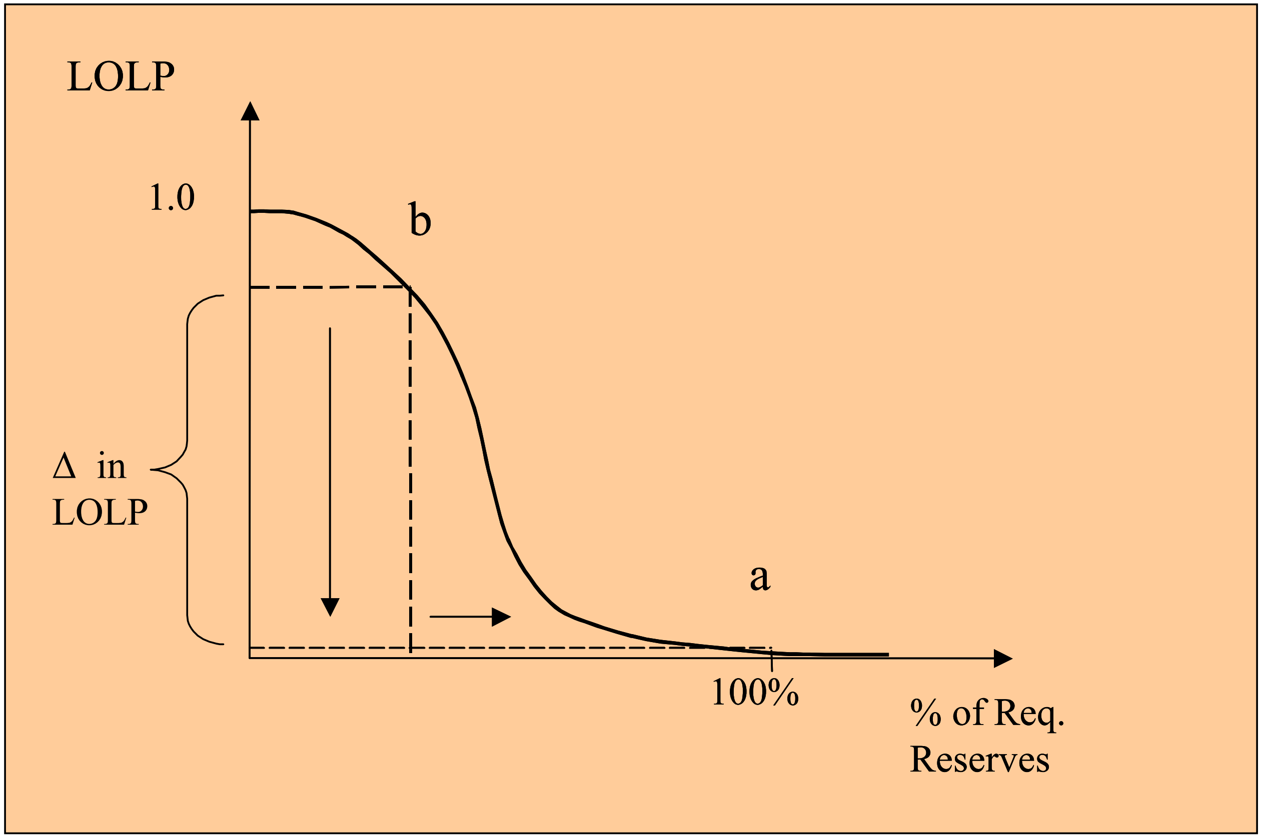
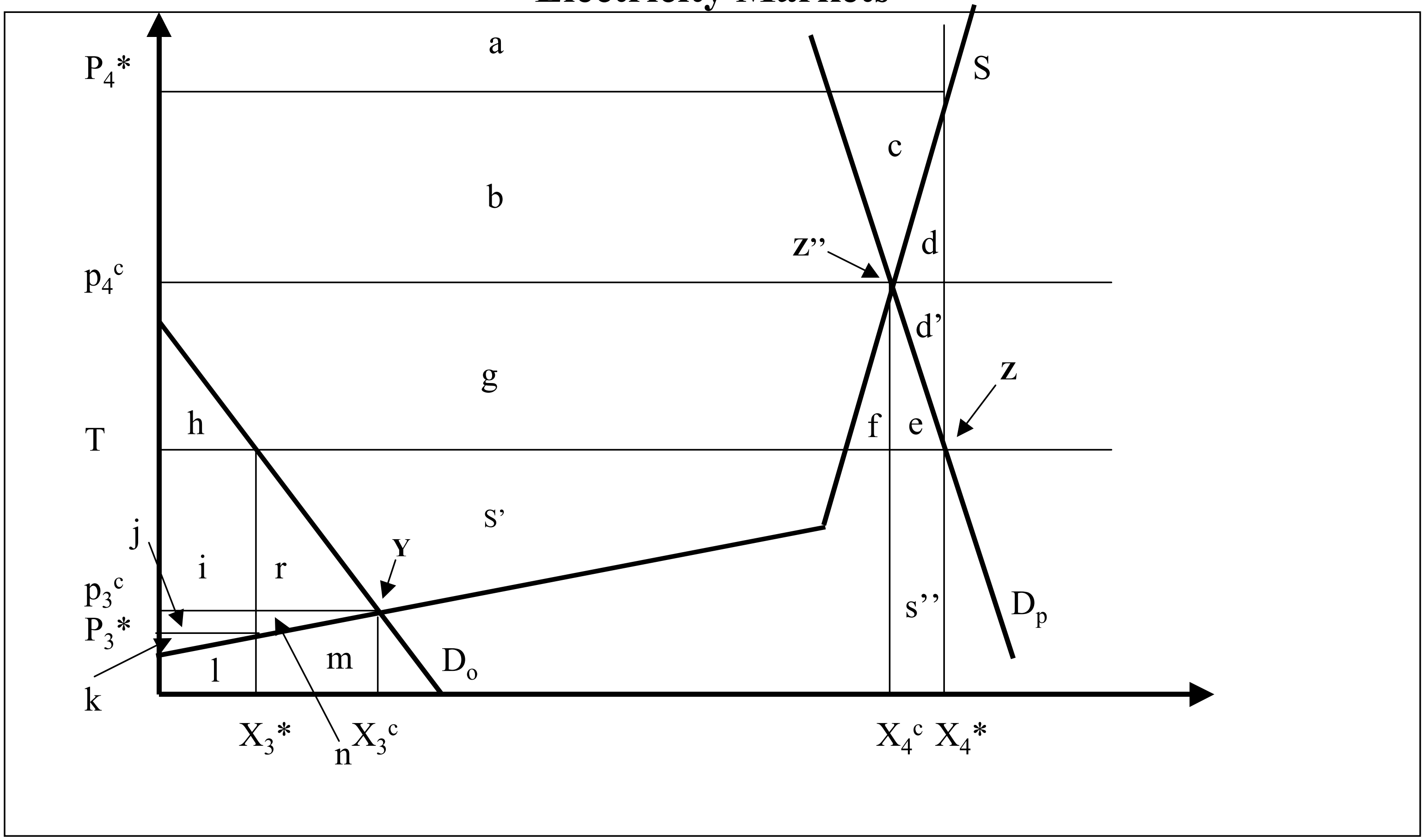


Exhibit 3.4: Net Welfare Gain from PRL Programs in Competitive Electricity Markets



Appendix 3A – A Diagrammatic Welfare Analysis of Competitive Electricity Markets

While assessing these market effects is a critical element of evaluating DADRP, one can also assess the effect on market efficiency through an analysis of DADRP effects on social welfare. Put differently, we wish to measure the change in combined producer and consumer surplus in allowing customers to respond to wholesale prices at certain times rather than face a flat rate. This welfare analysis is taken from Boisvert and Neenan (2003).

Competitive Electricity Market with Full Capacity to Adjust to Price Signals

To begin the analysis, we assume that the market for electricity is divided into two distinct periods, a peak period and an off-peak period. Further, it is a market that when generators' offers to sell un-contracted capacity and energy are submitted to a last price auction. However, demand is uncertain; price is known just prior to when the quantities each generator is to serve are determined. These conditions characterize day-ahead wholesale electricity markets such as that run by the New York ISO and are consistent with the standard market design as currently proposed by FERC.

We initially assume that customers can make *full* and *costless* adjustments to demand in response to price changes according to established derived demand schedules for electricity that represent the value of the marginal product of electricity to the firm. The situation is depicted in Exhibit 3-1A.

Off-Peak Demand

According to Exhibit 3-1A, the competitive equilibrium in the off-peak period is at point Y. Here, retail customers during off-peak periods follow demand curve depicted as D_o in the exhibit and buy X_3^c at price P_3^c at a total cost of X_3^c P_3^c. The demand curve is net of a constant wholesale margin, M. The generators supply X_3^c according to supply curve S and are paid P_3^c yielding revenue equal to $P_3^c X_3^c$. Under these conditions, welfare is measured by the sum of consumer and producer surplus:

- Consumer surplus is the area under the demand curve Do and above the price line P_3^c, as indicated by the box labeled i and the triangles h and r.
- Producer surplus is the area above the supply curve S and below the price line P_3^c, as indicated by (j + k + n).
- Welfare is the sum of the producer and consumer surpluses, area {h + i + r} + {j + k + n}.

Peak Demand

The competitive equilibrium for the peak period if customers respond to price changes is at Z'', the intersection of the peak demand curve D_p and price P_4^c (see Exhibit 3-1A). During periods of peak demand, retail customers buy X_4^c at a price of P_4^c and a cost of $X_4^c P_4^c$, where the demand curve is net of a constant wholesale margin, M, similar to the case for the off-peak period. The generators supply X_4^c and are paid P_4^c, and they receive revenues of $P_4^c X_4^c$. The measure of welfare is again given by the sum of consumer and producer surplus.

- Consumer Surplus is the area to left of D_p and above P_4^c , the area (a + b).
- Producer Surplus is the area above S, to the left of D_p and below P_4^c , the area (h + i + r + j + k + n + s' + g).
- Welfare is the area {a + b} + {h + i + r + j + k + n + s' + g}.

Unfortunately, electricity is not storable, so the analysis of Just et al. (1982) does not apply directly to these circumstances. Further, under current retail market conditions most customers can still buy electricity at fixed rates, but their suppliers face fluctuating market prices.[1] To see the value of inducing price responsiveness by DADRP participants, we must

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[1] For many customers, it is not practical to adjust demand in response to price changes; the transactions costs (outage costs plus costs of administration, meters, etc.) of doing so are very high. This means that the

compare the case just illustrated, where demand can fully respond to price, with the previous situation whereby retail customers can use any amount of electricity at fixed prices.

Competitive Wholesale Electricity Market with Retail Demand Served at Fixed Prices

Off-Peak

We begin by examining the outcome for the off-peak period under the flat tariff T, again assuming that demand curves are net of any wholesale margin.

In off-peak periods, the fixed tariff (T in Exhibit 3-1A) is set above the off-peak market price, because peak power is purchased at a price higher than T. For the wholesaler to cover the cost of both peak and off-peak power purchases, T must be a weighted average of the peak and off-peak prices.[2] The equilibrium for the customer, in this case, is at point X, consuming quantity X_3^*. At point X:

- Consumer Surplus = (h)
- Producer Surplus = (i + j + k) (i + j go to the customer's load-serving entity (LSE); k goes to the generator)
- Social Welfare = {h} + {i + j + k}
- Social loss compared with the competitive market situation where customers can respond to price is: { r (foregone consumer surplus) + n (foregone producer surplus)}.

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two aggregate demand curves in Figure 1 are the horizontal sum of many individual demand curves, most of them completely inelastic (e.g. completely vertical), or nearly so.

[2] As above, T is a weighted average price, where the weights are the proportion of electricity consumed in each period.

Compared with the situation where customers can respond to price, social welfare is reduced under the flat tariff by the areas r + n, which is called deadweight loss, while consumer surplus, area i, is transferred from customers to the LSE. Transfers do not affect the level of net social welfare, only how it is shared among consumers, generators, and retail suppliers.

To summarize, social welfare can be increased by offering to sell additional load at the lower price P_3^c. Demand and supply will continue to adjust, until the equilibrium point Y is reached. At Y:

- Producer surplus increases by an amount equal to the area n
- Consumer surplus increases by an amount equal to the area r, which either the supplier retains unless it lowers the price of all X_3^c to the customer, in which case the customer would realize the full benefit, and area i is transferred back to consumers.

Regardless of who retains the increase in producer and consumer surplus, Y is preferred socially to X since it represents the optimal use of resources.

Peak Period

We next examine the situation in the peak period in a similar fashion, using Exhibit 3-2A for ease of exposition. When customers are faced with a fixed tariff, the equilibrium point will be at point Z in Exhibit 3-2A, where the retail price is fixed at T and quantity consumed is X_4*. The flat tariff also leads to inefficiencies in the peak period because for demand greater than X_4^c, the usage price, which represents value to the firm given by points on the demand curve, is below marginal cost (e.g. the supply curve). The use of electricity whose value in production is below the cost of electricity results in deadweight loss in welfare to society represented by the combined area d + d′.

The distribution of producer and consumer surplus in the peak period case requires care to disentangle. We know that on average the price T covers the cost of the LSE's purchases of energy to serve the customers both during peak and off-peak periods. Therefore, in looking at Exhibit 3-2A, we can assume that expenditures by LSE to buy power at peak prices above T is effectively collected from the customer through off-peak sales at T which is above the supply cost, and which is then passed along to the generator. If the supply curve were indeed flat, as it effectively is from the customer's perspective when facing a fixed price of T, consumer surplus at price T (Exhibit 3-2A) would be: a + b + g′ + f + e, and there would be no producer surplus. The wholesale suppliers and in turn generators would be paid T for each unit, and that payment would equal marginal cost.

However, implicit in the fixed tariff T (determined simultaneously with X_4*and X_3*) is a payment of X_4*[P_4*- T] (and quantity weighted) to cover the wholesaler's cost of X_4* over and above T. This amount is transferred to the generator and is equal to the combined area b + c + d + d′ + g′ + f + e. The areas b + c + f + e are consumer surplus transfers from the customer to the generator during the peak period and thus augment producer surplus above the level s′. The final result is that consumer surplus = a, and producer surplus = s′ + b +g' + c + d + d'. The generator also receives payments (economic rents) equal to the combined area d′ + d, which represents additional costs to the customer resulting from the inefficiency in pricing all usage at T rather than at the true differential prices that reflect the marginal cost of supplying electricity. From society's perspective, the additional resources needed to produce $X_4^* – X_4^c$ (e.g., consumption over and above the optimal level) would have been better allocated to other uses; thus the combined area d′ + d is lost to detriment of society, and is referred to as the deadweight loss.

The challenge facing electricity market designers and policy makers is how to design retail programs that can reduce or eliminate altogether the size of these deadweight losses. There is perhaps no single solution to the problem, but we can highlight the important issues by illustrating the impact of a Demand Response (DR) program, which encourages customers to bid P_4^c to provide load reduction in the amount $[X_4^* – X_4^c]$, thereby eliminating the deadweight loss. Payments to those that accomplish this load reduction would be the combined area $s'' + e + d'$ (see Exhibit 3-2A). As long as this area is less than the deadweight loss of $d' + d$, then social welfare is unequivocally improved. In other words, for there to be an increase in net social welfare for a DR program, $(s'' + e) < d$; these areas are illustrated in Exhibit 3-2A.[3]

The size of these two areas is clearly an empirical question.[4] From a policy perspective, we can view this situation in two different ways. The first relates to the characteristics of supply and demand if firms had an incentive to respond to price and achieve the equilibrium defined by point Z’’ in Exhibit 3-2A. Viewed from this perspective, it is clear that as the supply curve becomes steeper (e.g. pivoting counter clockwise around point Z’’), the net welfare from a DR program increases because the area d becomes larger. Similarly, if the initial demand curve were less price responsive (made steeper by pivoting clockwise about the competitive equilibrium Z’’)

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[3] Borenstein and Holland (2002) provide an analysis of the second-best optimum if customers are to remain on flat tariffs. Their arguments are summarized here because through further analysis, one may be able to discover an algebraic relationship between these areas, although such an analysis is not done in this paper. As stated above, Borenstein and Holland (2002) shows that the quantity weighted average price, T, is the flat tariff that will cover the costs of retail electricity suppliers. However, this is not the flat tariff that provides the second-best welfare solution if retail customers stay on flat tariffs. Instead, they show that the flat rate tariff that minimizes the dead weight loss is one in which the price weights are the relative slopes of the peak and off-peak demand curves. This rate may be higher or lower than the value of T. This is an important result, but it depends on the supply curve being perfectly elastic up to system capacity, and vertical at that point. If supply elasticities are in between these extremes, the second-best fixed tariff would also likely involve the slopes of the supply curves as well, although this is not derived explicitly here. At some time it would be useful to derive this more general result, although it is not critical to the validity of their argument.

As Borenstein and Holland (2002) also point out, one difficulty with this second-best fixed tariff does not necessarily allow retail suppliers to cover their costs. However, these costs can be covered along with achieving the second-best solution under competition through a tax or subsidy that is the quantity weighted average of the new second-best flat tariff.

[4] For convenience, Figure 3 was drawn assuming linear supply and demand curves, but this representation may in fact distort the size of the areas being compared.

the net welfare calculation would also move in favor of the DR load, as the areas e and s’’ would both become smaller. In summary, the potential welfare gains from DR load programs are highest in situations where both the supply and demand curves are initially extremely price inelastic (“steeper”). These are the very circumstances that have lead to price spikes that disrupt newly formed wholesale markets.

Therefore, from a societal perspective, it makes sense to focus on exposing customers to market prices during the peak period when they are high. This view provides a basis for understanding the size of the deadweight losses and the potential gains from implementing DR programs. Prior to program implementation, firms would be facing a fixed tariff and consuming at point Z in Exhibit 3-2A. Thus, if we take this as a starting point, the welfare gains from a DR program can be increased if firms: a) can be encouraged to reduce overall peak demand (e.g. resulting in a shift in D_p to the left) and/or, b) if the supply curve is sufficiently steep, firms can be encouraged to be more price responsive just during peak periods (e.g., resulting in D_p pivoting counterclockwise around point Z’’). The former situation calls for permanent changes in consumption patterns by introducing time-of-use pricing. The latter is more effectively accomplished by exposing customers to prices, or incentives derived there from, when such market conditions obtain.

Exhibit 3-1A: Net Welfare Gain from PRL Programs in Competitive Electricity Markets

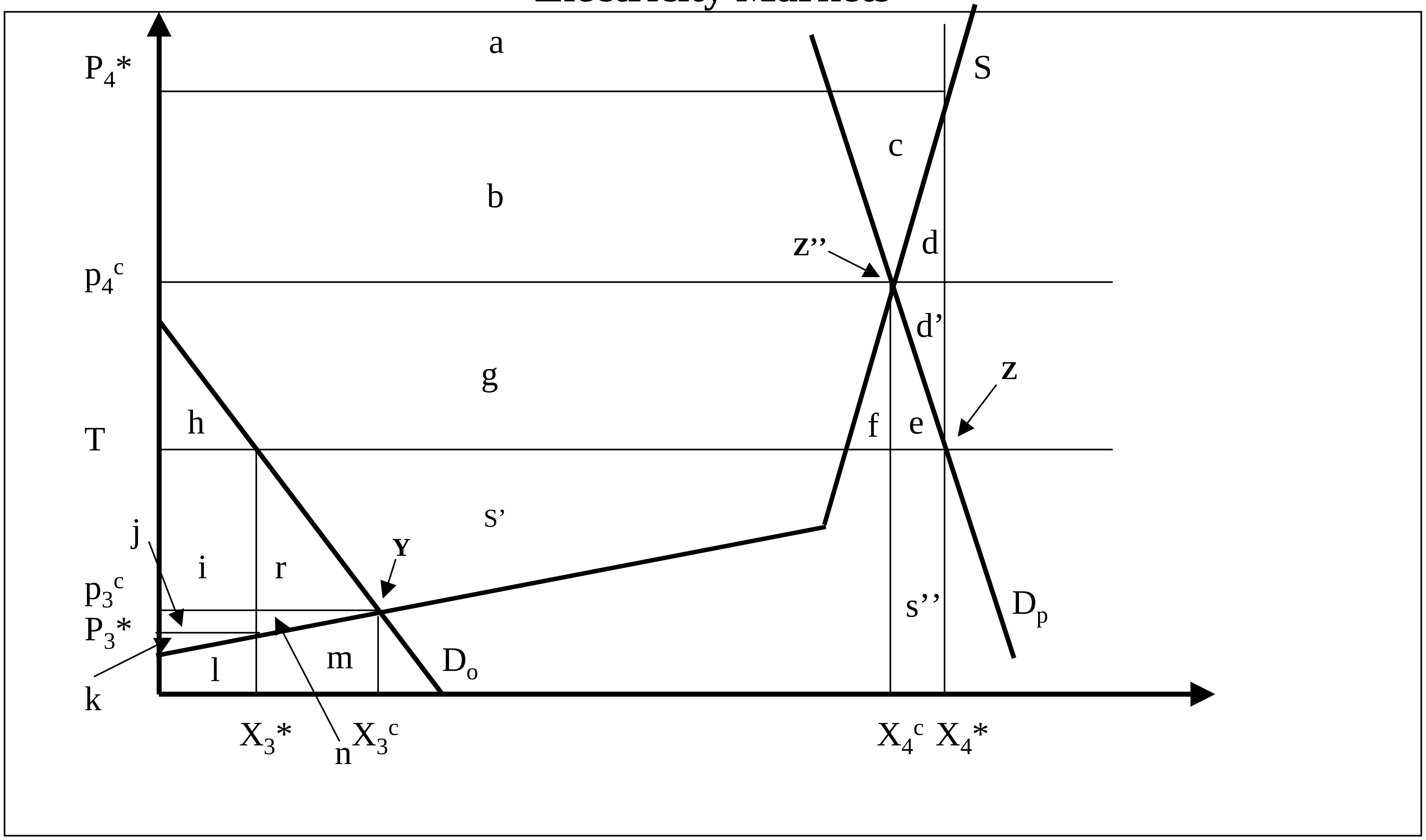

Exhibit 3-2A: Net Welfare Gain from an Interruptible Load Bidding PRL Program in Competitive Electricity Markets