Information Document
Capacity Market Clearing
ID #[xxxx-xx]

Information Documents are not authoritative. Information Documents are for information purposes only and are intended to provide guidance. In the event of any discrepancy between an Information Document and any Authoritative Document(s)[1] in effect, the Authoritative Document(s) governs.

1 Purpose

This Information Document relates to the following Authoritative Document:

- Section 201.13 of the ISO rules, *Capacity Market Clearing* ("Section 201.13").

The purpose of this Information Document is to provide additional information in relation to Section 201.13. Specifically, this section outlines:

(a) social surplus;

(b) deadweight loss and marginal inflexible blocks;

(c) transmission constraints;

(d) price setting logic;

(e) cleared volume logic; and

(f) final selection of marginal offer blocks with the same price.

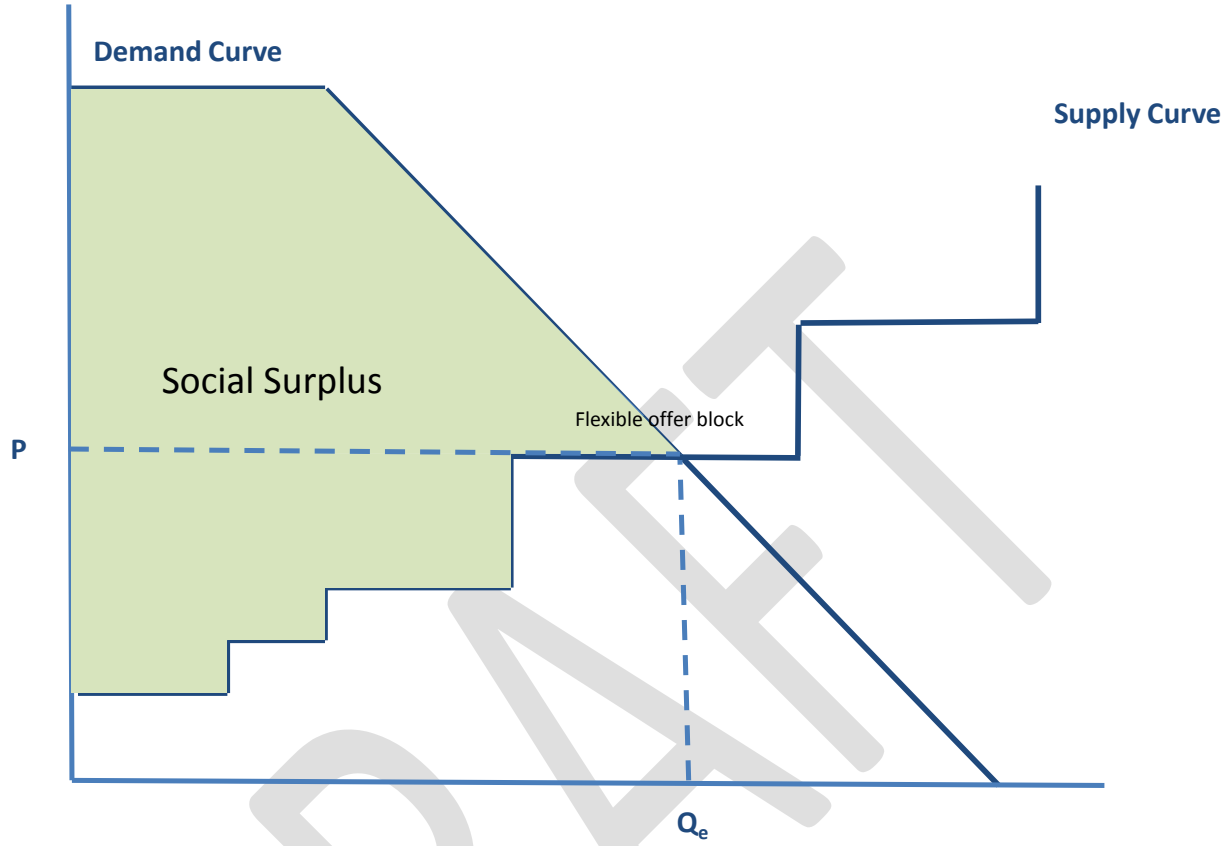
2. Social Surplus

To determine the price and clearing volume an algorithm that maximizes social surplus will be used.

Social surplus is the area below the demand curve and above the supply curve to the left of the cleared volume. Social surplus is maximized when the market clears at the quantity where the demand curve and the supply curve intersect. When the capacity block that intersects the demand curve is a flexible block, the capacity market will clear at the volume and the price corresponding to the intersection point as seen in the figure below.

[1] "Authoritative Documents" is the general name given by the AESO to categories of documents made by the AESO under the authority of the *Electric Utilities Act* and associated regulations, and that contain binding legal requirements for either market participants or the AESO, or both. AESO Authoritative Documents include: the ISO rules, the Alberta reliability standards, and the ISO tariff.

Figure 1: Maximizing Social Surplus when the Capacity Block that Intersects with the Demand Curve is Flexible

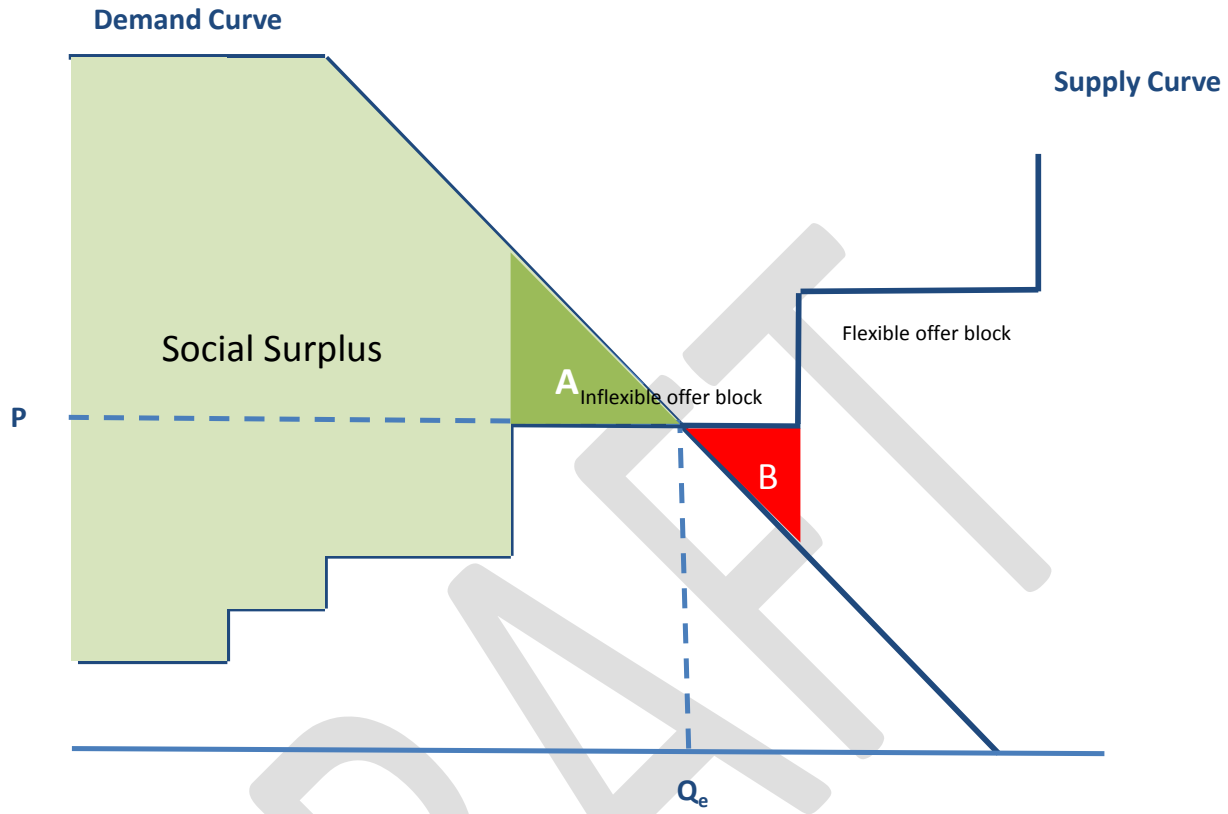


3. Deadweight Loss and Marginal Inflexible Blocks

If an inflexible block intersects with the demand curve, deadweight loss will occur due to either not procuring the volume of which the value of the capacity exceeds the cost of the capacity (indicated by area A) or having to procure capacity of which the cost of the capacity exceeds the value of the capacity (indicated by area B) as shown in Figure 2.

When an inflexible block intersects with the demand curve, social surplus is maximized by minimizing the deadweight loss. Depending on which solution maximizes social surplus, the market may clear at the capacity block below the inflexible block, clear the entire inflexible block, or skip the inflexible block and clear a flexible block whose offer price is higher than the inflexible block.

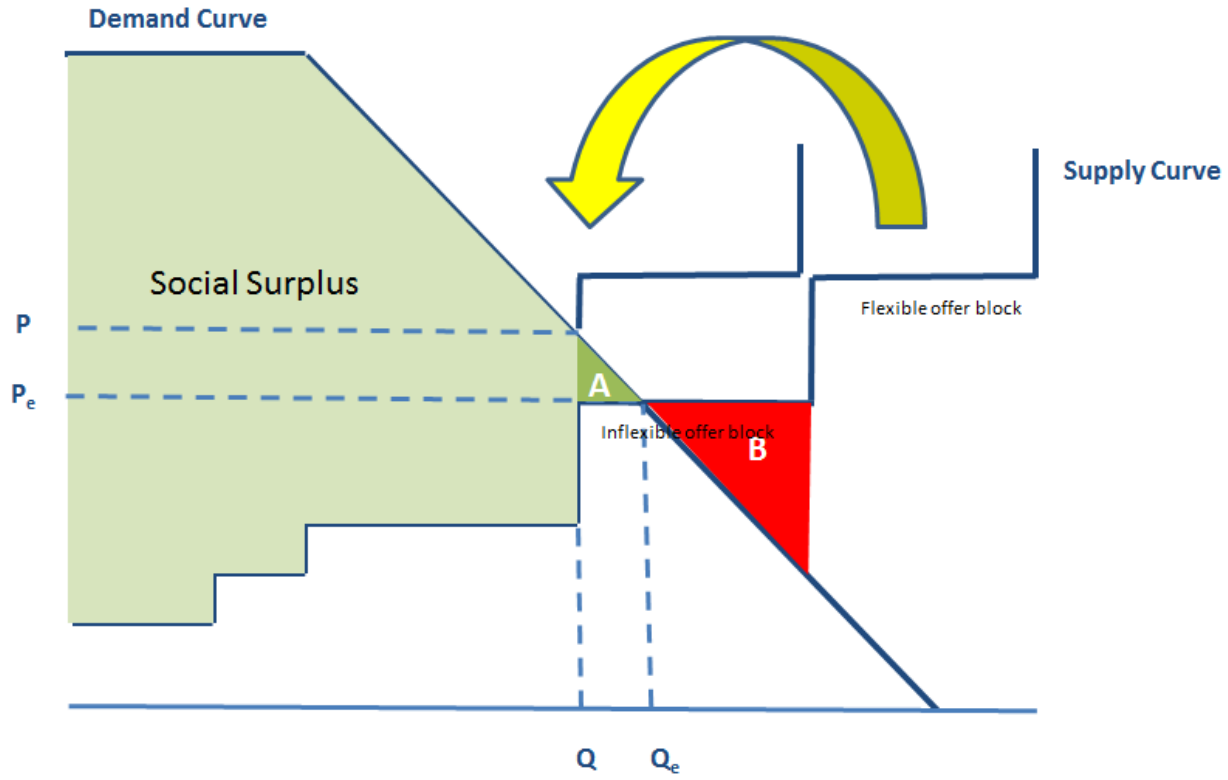
Figure 2: Deadweight Loss Occurs when the Capacity Block that Intersects with the Demand Curve is Inflexible



Clearing at the Capacity Block below the Inflexible Block that Intersects the Demand Curve

Figure 3 is an example where clearing at the capacity block below the inflexible capacity block that intersects the demand curve would maximize social surplus. In this example, the social surplus gained (indicated by area A) by taking the entire inflexible block is smaller than the deadweight loss (area B). In addition, the flexible block whose offer price is above the inflexible block's offer price does not intersect with the demand curve if the inflexible block is skipped. Therefore, clearing at the capacity block below the inflexible block that intersects the demand curve would maximize social surplus.

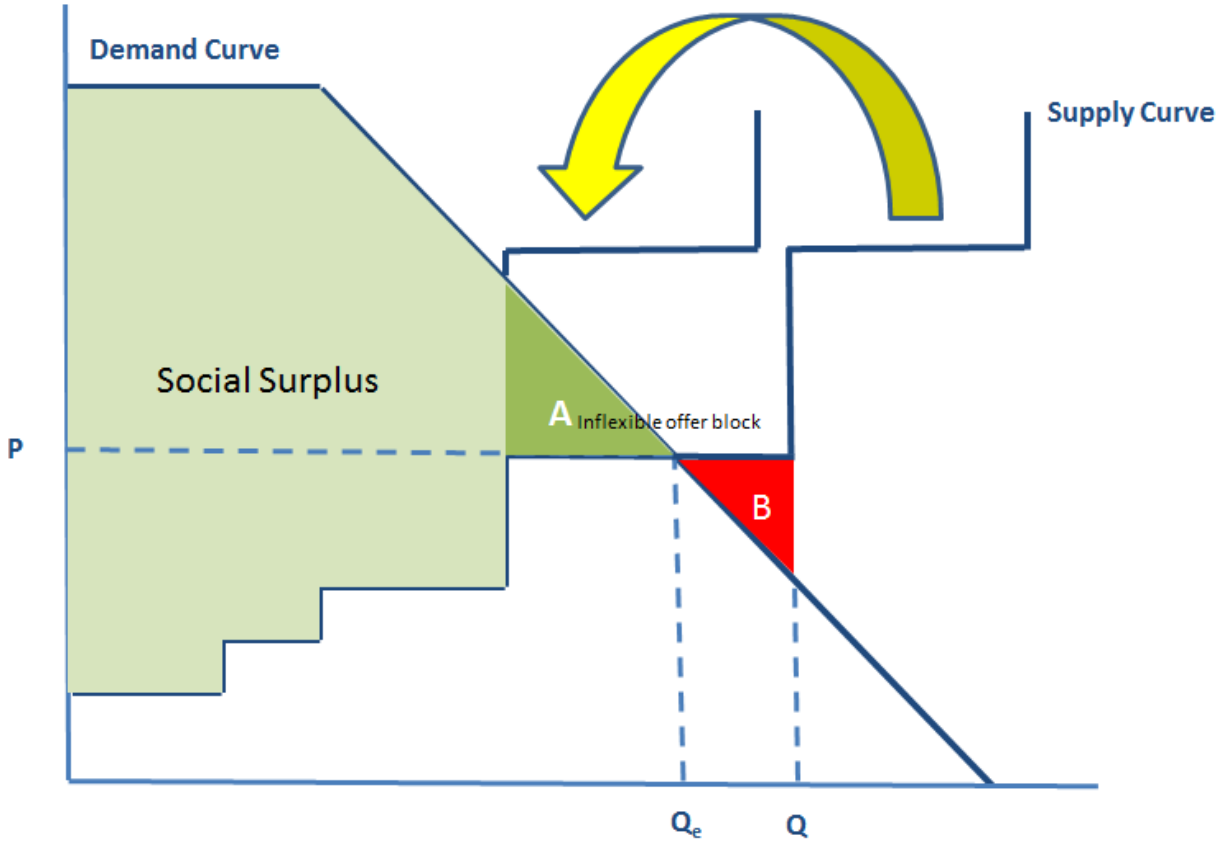
Figure 3: An Example of Clearing at the Capacity Block below the Inflexible Block



Taking the Entire Inflexible Block that Intersects the Demand Curve

Figure 4 is an example where taking the entire inflexible block that intersects the demand curve maximizes social surplus. In this example, social surplus gained (indicated by area A) by taking the entire inflexible block is greater than the deadweight loss (indicated by area B). In addition, the flexible block whose offer price is above the inflexible block's offer price does not intersect with the demand curve if the inflexible block is skipped. Therefore, taking the entire inflexible block that intersects the demand curve would maximize social surplus.

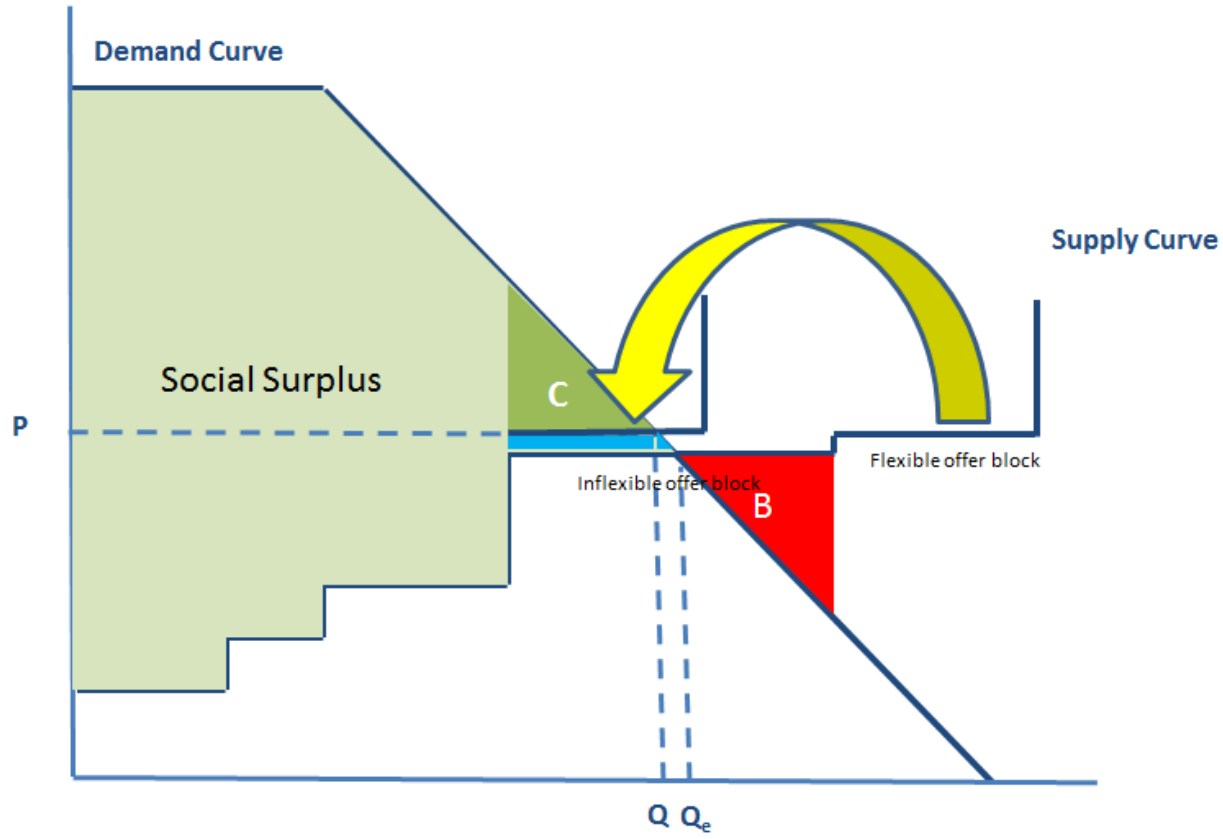
Figure 4: An Example of Taking the Entire Inflexible Block that Intersects the Demand Curve



Skipping the Inflexible Block that Intersects the Demand Curve and Clearing at the Flexible Block with a Higher Offer Price

Figure 5 is an example where skipping the inflexible block that intersects the demand curve and clearing at the flexible block with a higher price would maximize social surplus. In this example, compared with clearing at the capacity block below the inflexible block, the greatest net gain in social surplus is achieved by skipping the inflexible block that intersects the demand curve and, instead, clearing the flexible block with a higher offer price (indicated by area C). This area is larger than the area which would result from taking the entire inflexible block that intersects with the demand curve (indicated by area C plus the blue area minus area B). Therefore, skipping the inflexible block that intersects the demand curve and clearing at the flexible block with a higher offer price would maximize social surplus.

Figure 5: An Example of Skipping the Inflexible Block that Intersects the Demand Curve and Clearing at the Flexible Block with a Higher Offer Price

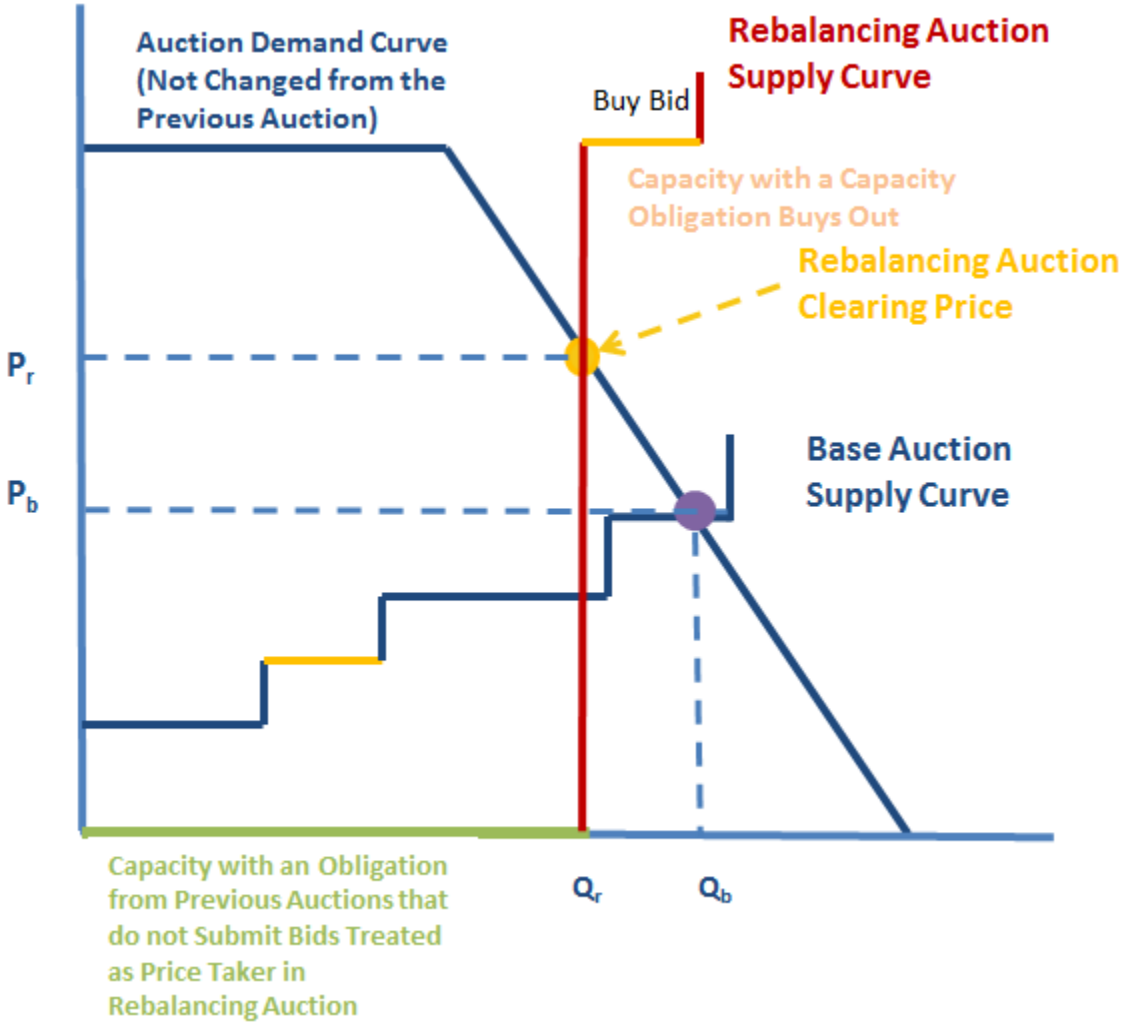


4. Rebalancing Auction Clearing

The AESO will clear a rebalancing auction on a gross basis. All of the AESO's bids and offers will be reflected in the demand curve and all bids to buy out capacity commitments and offers to sell capacity will be represented on the supply curve. Cleared assets from the prior auction(s) that do not submit bids will be treated as price takers in the rebalancing auction.

The following example (Figure 6) assumes that the rebalancing auction demand curve is not revised from the previous auction and that no capacity offers are submitted in the rebalancing auction. The bid submitted to buy out the exiting obligation (indicated by the orange portion on the base auction supply curve) is represented on the supply curve in the rebalancing auction (indicated by the orange portion on the rebalancing supply curve). Cleared capacity assets from the prior auction(s) that do not submit bids are treated as price takers in the rebalancing auction (indicated by the green portion on the rebalancing auction supply curve). The rebalancing auction will clear using the same mechanics as the base auction. In this example, the rebalancing auction is cleared at a higher price (indicated by P_r) than base auction (indicated by P_b). The total procurement volume is reduced through the rebalancing auction from Q_b to Q_r. Although the AESO does not explicitly submit the capacity offers, the demand curve allows it to sell its previously procured capacity volume (indicated by the difference between Q_b and Q_r).

Figure 6: An Example Rebalancing Auction Clearing

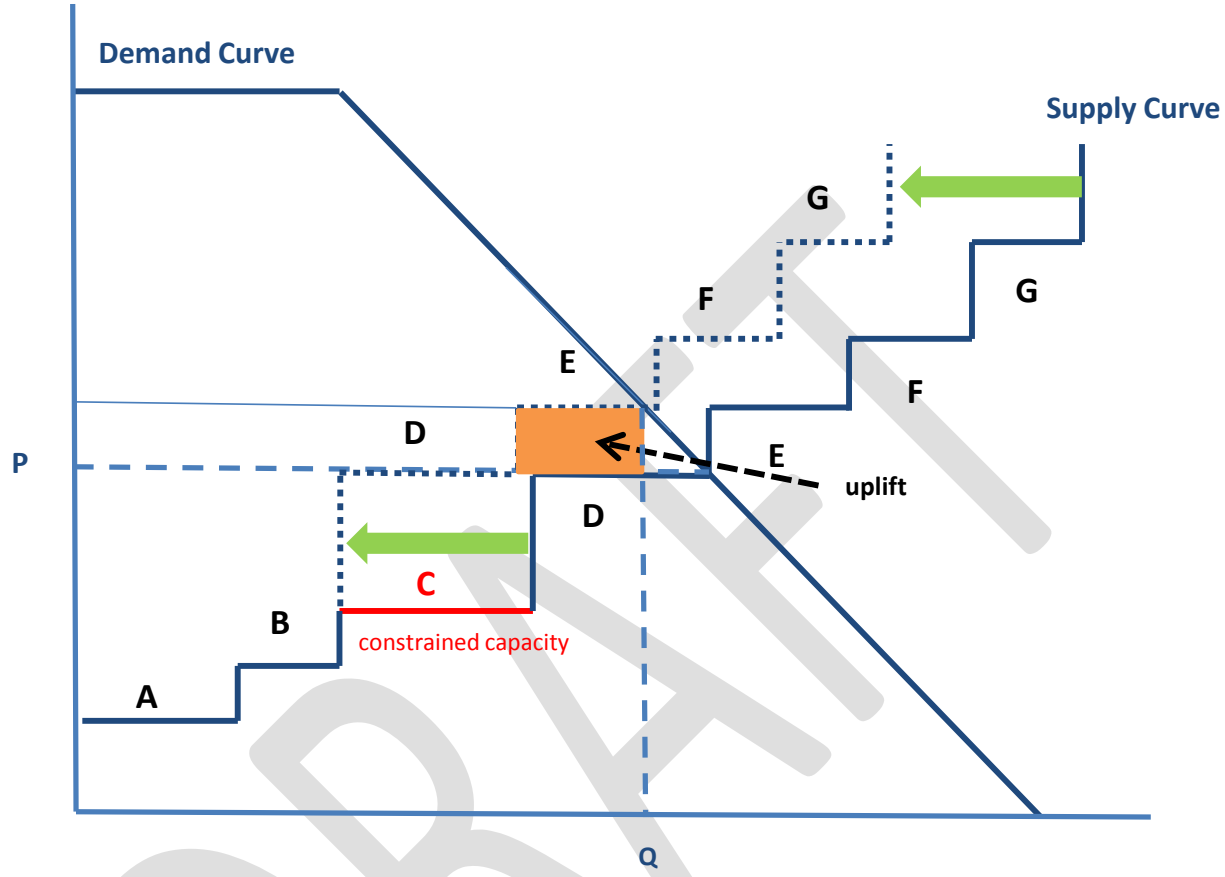


5. Transmission Constraints

When an offer from a asset located behind anticipated transmission constraints is received and the related capacity is not expected to be fully deliverable, the AESO will not clear some or all of the offer and may clear an additional offer or offers that would otherwise not clear if transmission constraints were not anticipated. If the offer price of an asset that would otherwise not clear if transmission constraints were not anticipated is higher than the unconstrained clearing price, the asset will receive an uplift payment that equals the difference between its offer price and the unconstrained capacity market clearing price multiplied by its volume cleared.

In Figure 7, absent transmission constraints, offers A, B, C, and D will be cleared at the clearing price P ('unconstrained clearing price'). However, assume offer C is behind the anticipated transmission constraint and cannot be delivered. Therefore, offer C will not be cleared. Part of the volume from an additional offer, offer E will be cleared. All cleared offers, A, B, D and E will receive price P. In addition, because E's offer price is higher than P, E will also receive an uplift payment, which equals the difference between E's offer price and the clearing price multiplied by the volume cleared (indicated by the orange rectangle).

Figure 7: Market Clearing When Capacity are not Expected to be Deliverable due to Anticipated Transmission Constraints



6. Price Setting Logic

The capacity market clearing price will be set by the last capacity block cleared assuming no transfer path limits or transmission congestion constraints are anticipated.

When the Entire Procurement Volume or the Entire Supply Curve is below the Demand Curve

Figure 8 illustrates that when the entire procurement volume is below the demand curve, the market clearing price will be set at the point where the vertical line connects the cleared volume and the demand curve

Figure 8: Price Setting When the Entire Procurement Volume is below the Demand Curve

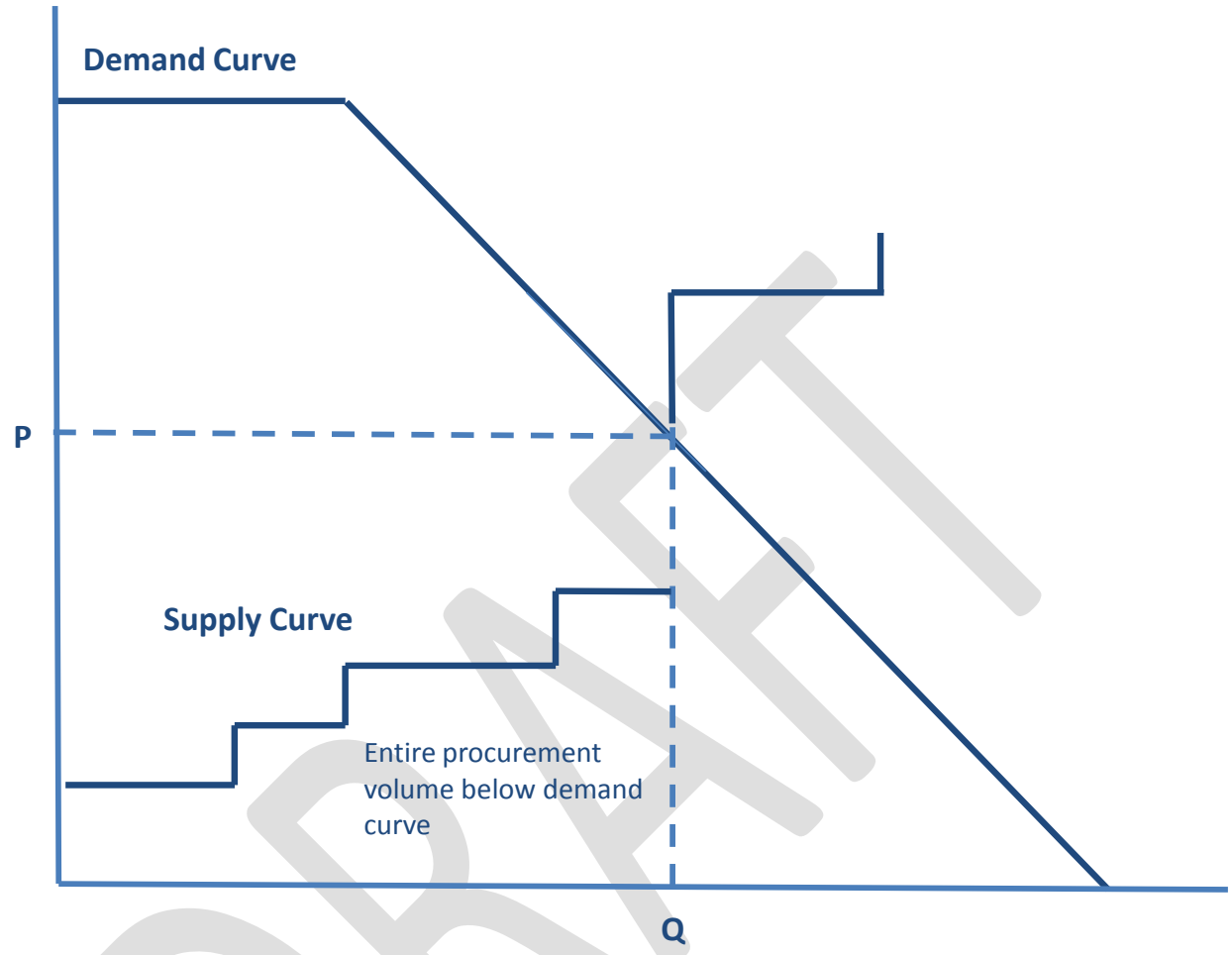
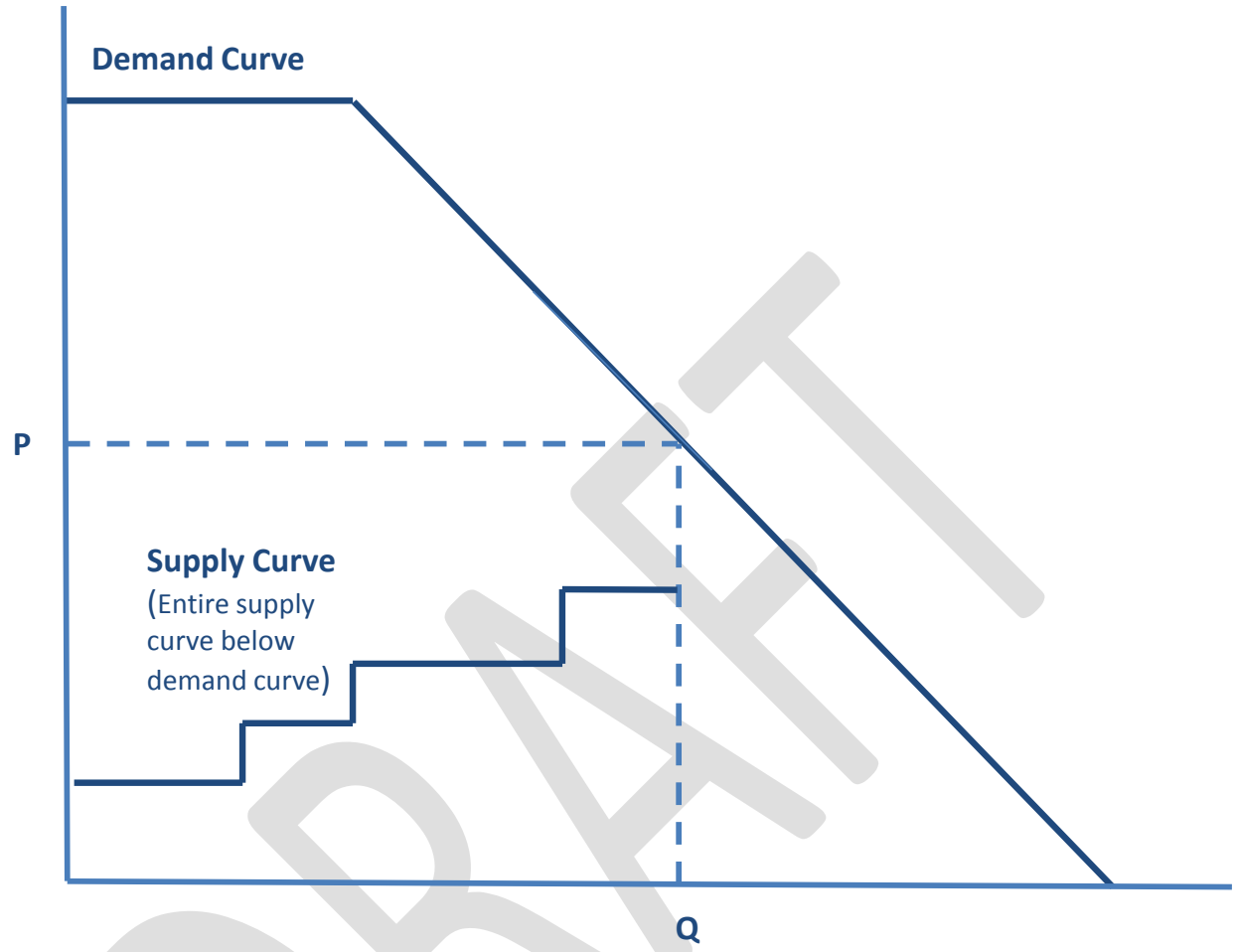


Figure 9 illustrates that when the entire supply is below the demand curve, the market clearing price will be set at the point where the vertical line connects the cleared volume and the demand curve.

Figure 9: Price Setting When the Entire Supply Curve is below the Demand Curve



7. Cleared Volume Logic

Total procurement volume is the cumulative volume of all the capacity blocks selected by maximizing social surplus, which is indicated as Q_e in Figures 1 and 2 and Q in Figures 3 to 8.

8. Tie Breaking

The market clearing algorithm will seek to maximize social surplus. However, when more than one capacity block with the same offer price may provide the same social surplus, the market clearing process will use the following steps to select volume among these capacity blocks and the steps will also be applied when clearing volumes behind anticipated transmission constraints:

1. Encourage flexibility by clearing flexible blocks first, whenever possible
2. Prorate flexible blocks if same price
3. Clear smallest to largest inflexible block, whenever possible
4. Inflexible block with same volume and price determined by random draw

In the following examples, social surplus is maximized when volume Q is cleared and 10 MW with the offer price of $50/kW-year is required (Figure 10).

Figure 10: Multiple Capacity Blocks with the same Offer Price

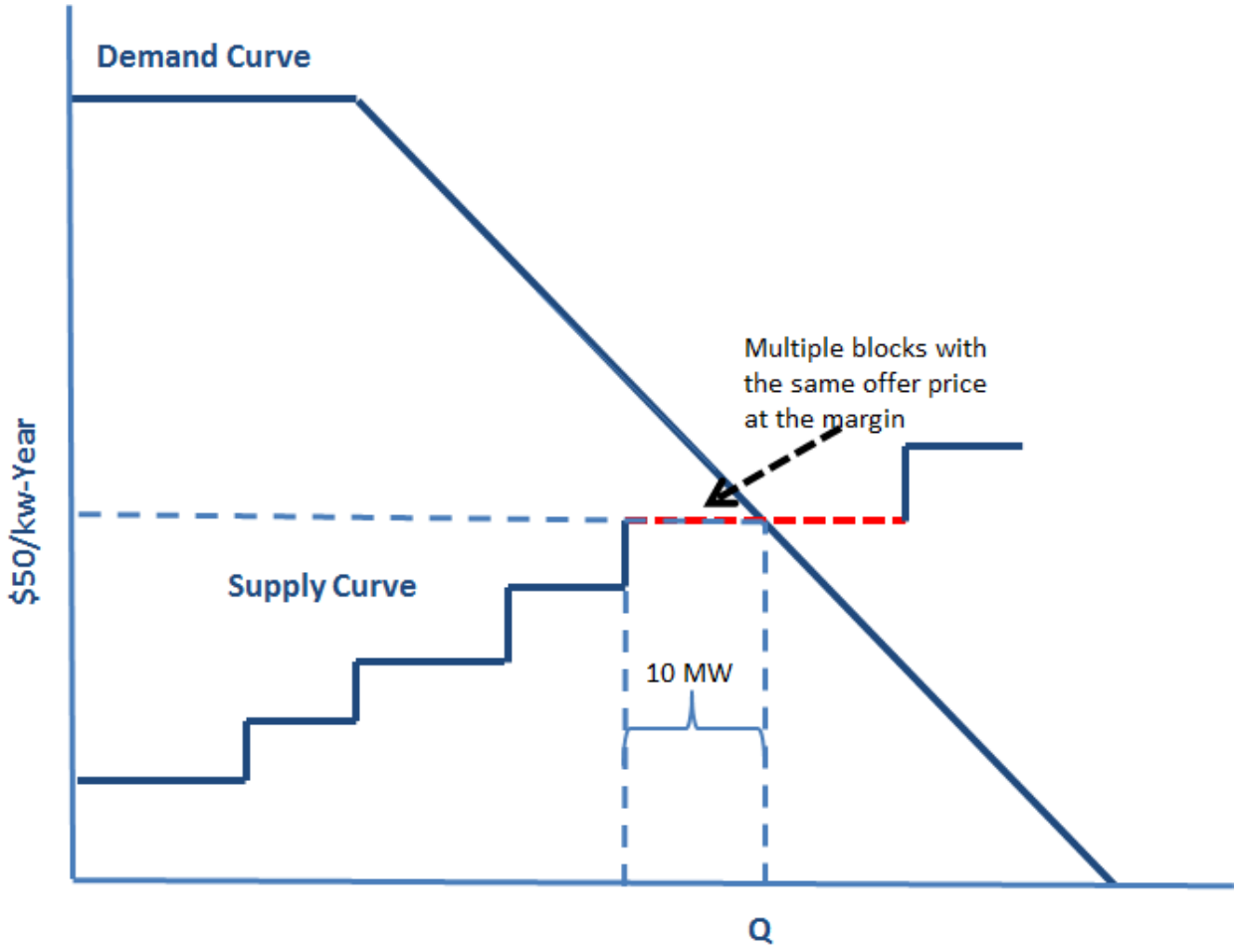


Table 1 is an example that the total volume offered at $50 from flexible blocks is greater than the 10 MW and the flexible blocks need to be prorated.

Table 1: Total Volume Offered at $50 from Flexible Blocks is Greater than the 10 MW

Asset	Capacity Block Price	Capacity Block Volume	Flexible/Inflexible	Outcome
A	50	3	Flexible	Pro-rata clearing
B	50	2	Flexible	Pro-rata clearing
C	50	4	Flexible	Pro-rata clearing
D	50	7	Flexible	Pro-rata clearing
E	50	10	Inflexible	Not cleared

In this example:

1. Flexible blocks will be cleared first. 10 MW will be cleared from the flexible blocks in order to meet the requirement of maximizing social surplus.
2. Because assets A, B, C and D offer at the same price and the total volume offered from asset A, B, C and D is greater than 10 MW, their offers will be prorated so that the total volumes cleared from assets A, B, C and D will be 10 MW.
    a. Asset A clears 3/(3+2+4+7)=1.9 MW, rounded to 2 MW
    b. Asset B clears 2/(3+2+4+7)=1.3 MW, rounded to 1 MW
    c. Asset C clears 4/(3+2+4+7)=2.5 MW, rounded to 3 MW
    d. Asset D clears 7/(3+2+4+7)=4.4 MW, rounded to 4 MW
3. The inflexible block from asset E will not be cleared.

Table 2 is an example that the total volume offered at $50 from flexible blocks is greater than the 10 MW and the flexible blocks require proration and randomization.

Table 2: Total Volume Offered at $50 from Flexible Blocks is Greater than the 10 MW

Asset	Capacity Block Price	Capacity Block Volume	Flexible/Inflexible	Outcome
A	50	3	Flexible	Pro-rata clearing
B	50	2	Flexible	Pro-rata clearing
C	50	6	Flexible	Pro-rata clearing, may be rounded down
D	50	6	Flexible	Pro-rata clearing, maybe rounded down
E	50	10	Inflexible	Not cleared

In this example:

1. Flexible blocks will be cleared first. 10 MW be cleared from the flexible blocks in order to meet the requirement of maximizing social surplus.
2. Because assets A, B, C and D offer at the same price and the total volume offered from asset A, B, C and D is greater than 10 MW, their offers will be prorated so that the total volumes selected from assets A, B, C and D will be 10 MW.
    a. Asset A clears 3/(3+2+7+7)=1.6 MW, rounded to 2 MW
    b. Asset B clears 2/(3+2+7+7)=1.1 MW, rounded to 1 MW
    c. Asset C clears 4/(3+2+7+7)=3.7 MW, rounded to 4 MW
    d. Asset D clears 7/(3+2+7+7)=3.7 MW, rounded to 4 MW

However, the total volume out of the proration is 11 MW, greater than 10 MW needed to maximize social surplus. In this situation, a random process will be used to determine whether asset C or D should be rounded down from 3.7 MW to 3 MW.

3. The inflexible block from asset E will not be cleared.

Table 3 is an example that the total volume offered at $50 from flexible blocks is less than the 10 MW and an inflexible block is required.

Table 3: Total Volume Offered at $50 from Flexible Blocks is Less than the 10 MW

Asset	Capacity Block Price	Capacity Block Volume	Flexible/Inflexible	Outcome
A	50	3	Flexible	Pro-rata clearing
B	50	2	Flexible	Pro-rata clearing
C	50	2	Inflexible	Random: may or may not be cleared
D	50	2	Inflexible	Random: may or may not be cleared
E	50	2	Inflexible	Random: may or may not be cleared
F	50	2	Inflexible	Random: may or may not be cleared
G	50	6	Inflexible	Not cleared
H	50	6	Inflexible	Not cleared
I	50	10	Inflexible	Not cleared

In this example:

1. Flexible blocks will be cleared first. However, no more than 4 MW can be cleared from the flexible blocks in order to meet the requirement of maximizing social surplus.

2. Because assets A and B offer at the same price and the total volume offered from asset A and B exceeds 4 MW, their offers will be prorated so that the total volumes selected from asset A and B will be 4 MW.
    a. Asset A clears 3/(3+2)=2.4 MW, rounded to 2 MW
    b. Asset B clears 2/(3+2)=1.6 MW, rounded to 2 MW
3. The remaining 6 MW will be selected from inflexible blocks and the smallest inflexible blocks will be considered first.
    a. 3 inflexible blocks of 2 MW will be cleared.
    b. A random draw will determine which three offer blocks from C, D, E, F will be cleared
4. The inflexible blocks of assets G, H, I will not be cleared.

Table 4 is an example that two inflexible blocks with the same size will provide the same social surplus.

Table 4 More than one Inflexible Block with the Same Size will Provide the Same Social Surplus.

Asset	Capacity Block Price	Capacity Block Volume	Flexible/Inflexible	Outcome
A	50	3	Flexible	Pro-rata clearing
B	50	2	Flexible	Pro-rata clearing
G	50	6	Inflexible	Random: may or may not be cleared
H	50	6	Inflexible	Random: may or may not be cleared
I	50	10	Inflexible	Not cleared

In this example:

1. Flexible blocks will be cleared first. However, no more than 4 MW can be cleared from the flexible blocks in order to meet the requirement of maximizing social surplus.
2. Because assets A and B offer at the same price and the total volume offered from asset A and B, their offers will be prorated so that the total volumes selected from asset A and B will be 4 MW.
    a. Asset A clears 3/(3+2)=2.4 MW, rounded to 2 MW
    b. Asset B clears 2/(3+2)=1.6 MW, rounded to 2 MW
3. The remaining 6 MW will be selected from inflexible blocks and the smallest inflexible blocks will be considered first.
    a. There are two inflexible blocks, both 6 MW in size, will provide the same social surplus. One inflexible block of 6 MW will be cleared.

b. A random draw will determine which offer blocks from G or H will be cleared.

4. The inflexible block from I will not be cleared.

Table 5 is an example where an inflexible block clears before the flexible blocks as this maximizes social surplus

Table 5: Select an Inflexible Block before the Flexible Blocks

Asset	Capacity Block Price	Capacity Block Volume	Flexible/Inflexible	Outcome
A	50	3	Flexible	Not cleared
B	50	2	Flexible	Not cleared
C	50	10	Inflexible	Cleared

In this example, the inflexible block from asset C will be cleared because clearing any of the flexible blocks from assets A and B will not maximize social surplus.

Revision History

Posting Date	Description of Changes
	Initial Release