# CRR Revenue Adequacy, Auction Values, and Settlement Rules

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# TOPICS

- CRR Valuation in the CAISO
- CRR Pricing Example
- CRR Pricing Impacts
- Alternative CRR Designs

# CRR VALUATION IN THE CAISO

CAISO data for December 2016 show a remarkable level of CRR revenue inadequacy and also show a low overall auction valuation of CRRs relative to the actual payout.

**Table 20: Summary of CRR performance for December 2016**

| Metric | Amount |
|---|---|
| DA Congestion Rents | $15,066,599 |
| Perfect Hedge | -$1,100,593 |
| CRR Clawback | $84,822 |
| CRR Payments [Auction + Allocation] | -$31,400,209 |
| CRR Payments to Auction CRRs | -$14,511,510 |
| CRR Payments to Monthly Auction CRRs | - $8,459,523 |
| CRR Payments to Annual Auction CRRs | -$6,051,987 |
| CRR Payments to Allocation CRRs | -$16,888,698 |
| CRR Auction Revenue Monthly | $6,048,734 |
| CRR Auction Revenue Annual | $2,754,467 |
| Revenue Adequacy | -$17,349,381 |
| Revenue Adequacy with Auction Revenues | -$8,546,180 |
| Net payment to auction CRRs | -$5,708,310 |

Source: California ISO, CRR Auction Analysis Report, November 21, 2017 p. 135

# CRR VALUATION IN THE CAISO

Revenue adequacy and auction valuation are distinct metrics, but they are not necessarily completely independent.

- There may be features of a CRR allocation, auction and settlement design that contribute both to high CRR payouts relative to auction revenues and to CRR revenue inadequacy.

- Allocating and auctioning CRRs based on auction shift factors while settling based on day-ahead market shift factors will contribute to revenue inadequacy.

- Moreover, pricing CRRs in the auction based on auction shift factors while settling them based on day-ahead market shift factors can enable non-hedgers to buy CRRs that entitle them to CRR payouts from a given constraint at a fraction of the price paid by hedgers and increase the overall level of revenue inadequacy.

# CRR VALUATION IN THE CAISO

- The fundamental issue is that an auction participant may be able to buy CRRs in the auction that will cause low flows over a given constraint in the auction model, and hence sell at a low price, but have much larger flows on the constraint on days when a particular outage is modeled in the day-ahead market.

- The consequence of these CRR pricing and settlement rules can be a high level of CRR revenue inadequacy accompanied by many CRRs purchased by non-hedgers at a significant discount to the expected payout because the CRRs are valued as very risky financial instruments rather than as hedges.

# CRR VALUATION IN THE CAISO

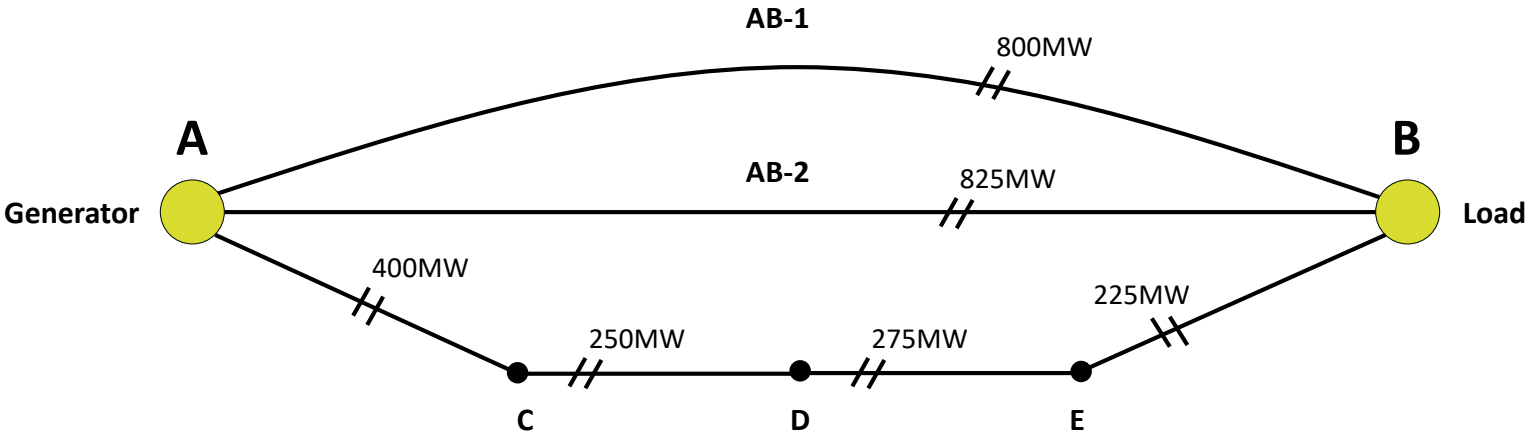
With such a difference between auction pricing and day-ahead market settlement rules, competition between hedgers and CRR traders may not drive price convergence because CRR traders may be able to buy a dollar of CRR payout at a fraction of the price paid by hedgers.

- The CRRs purchased by the CRR traders will have no value as hedges so will be valued in the auction as extremely risky, hard to value financial instruments.
- The valuation problem cannot be corrected simply by modeling all outages during the month in the auction. Not only would such a modeling change greatly overstate the actual reduction in transfer capability due to outages, it would enable a converse strategy of buying counterflow CRRs that would have high prices in the auction when the outage is modeled, but require minimal CRR payments in the day-ahead market when the outage is not modeled.
- We illustrate the potential CRR purchase strategy using a simple grid model.

# CRR PRICING EXAMPLE

Figure 1 portrays the all lines in configuration of the simple transmission grid used for the example. There are two major parallel circuits AB-1 and AB-2 and a third weak line A-C –D-E-B.

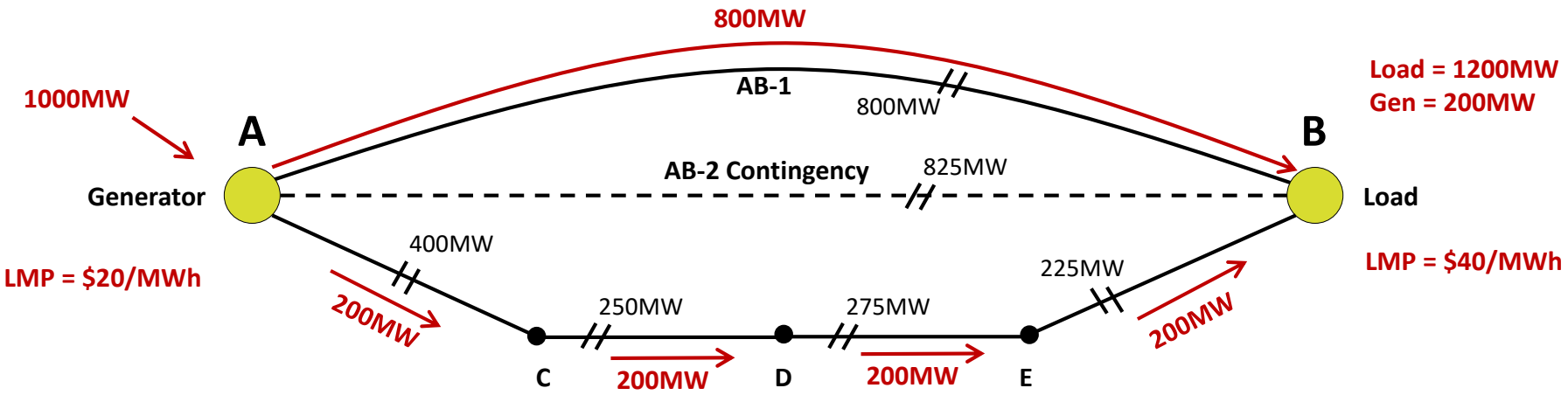
Figure 1



# CRR PRICING EXAMPLE

Figure 2 shows the day-ahead market dispatch. The dispatch would account for the outage of the AB-2 line as the binding contingency with Figure 2 showing the post contingency flows. All of the transmission segments are assumed to have equal reactance. The transfer capability from A to B is 1000 megawatts with a price at B of $40 and a price at A of $20. An A to B CRR would be worth $20 in this hour.

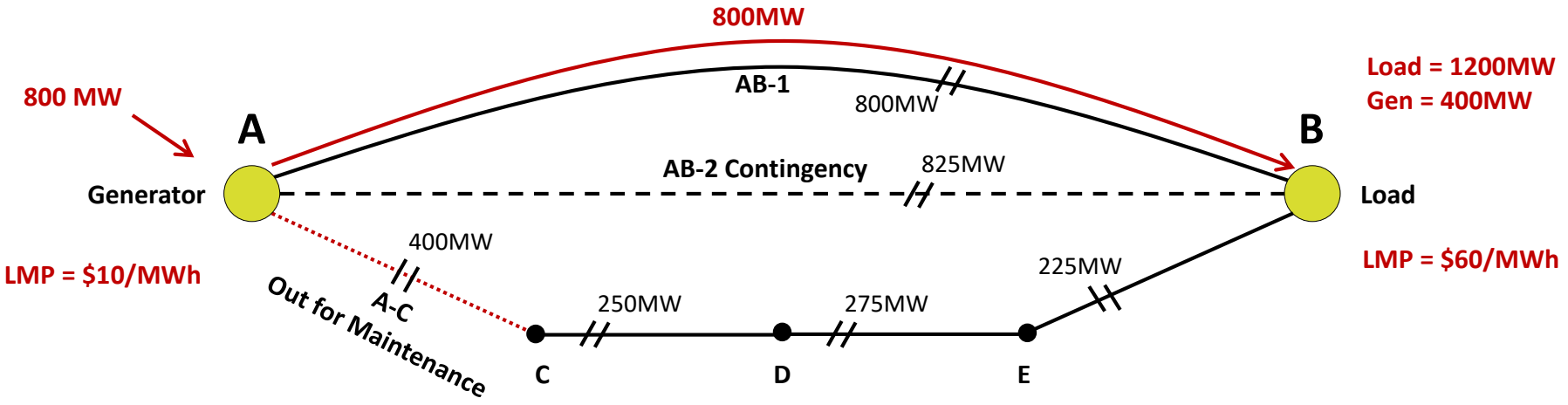
Figure 2



# CRR PRICING EXAMPLE

Figure 3 shows the dispatch and post contingency flows on a day on which the line A-C is out of service for maintenance. With this line out of service, the transfer capacity from A to B falls to 800 megawatts, the price falls to $10 at A and rises to $60 at B. With the A-C line out of service, an A to B CRR is worth $50.

Figure 3



# CRR PRICING EXAMPLE

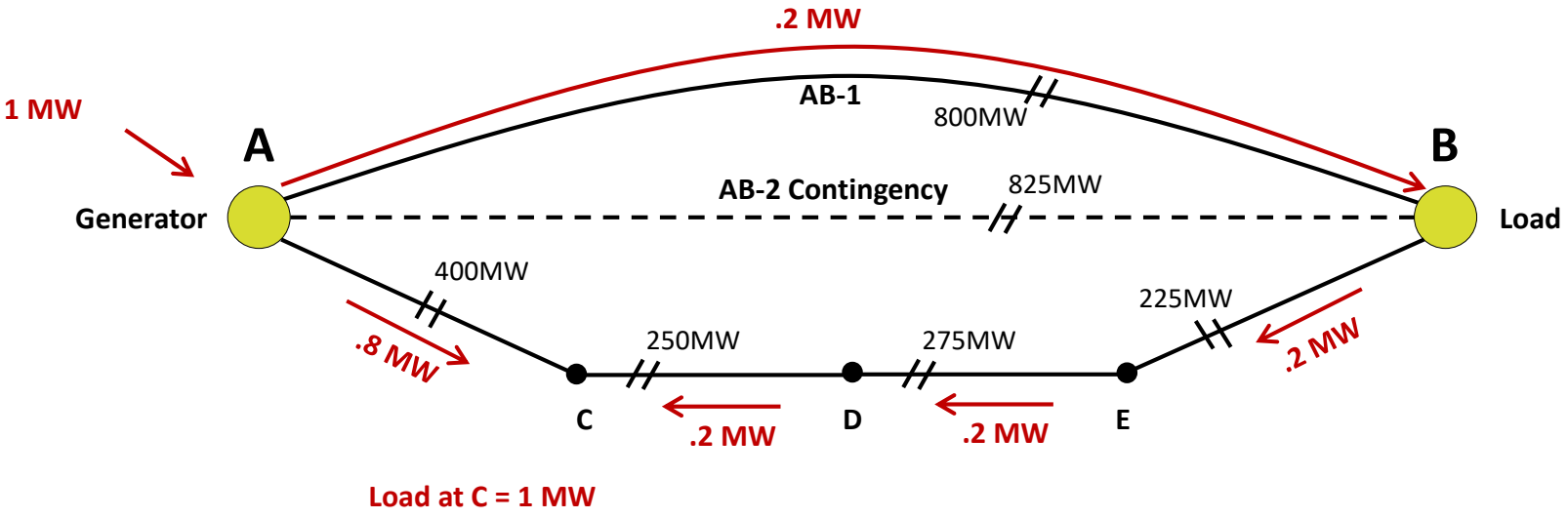
Suppose that line A-C is expected to be out of service for half the hours in the month.

- An A-B CRR would be expected to be worth $20 in the hours A-C was in service and $50 in the hours line A-C was out of service, for an average expected payout of $35 per hour.
- Suppose that risk averse traders with contracts to deliver power to consumers at B that were willing to pay $36 per hour or more for CRRs from A to B bought 1000 CRRs from A to B in the auction.
- Since a CRR from A to B would have a .8 shift factor on line AB-1, the shadow price in the auction of the constraint on AB-1 would be $45.
- The outage would cause the ISO to be revenue inadequate on these CRRs, collecting an average of $30,000 an hour in congestion rents while paying out $35,000.
- This revenue inadequacy would not adversely impact transmission customers if the CRRs were sold for a price of $36 an hour, reflecting an auction premium as assumed in the example.

# CRR PRICING EXAMPLE

Suppose that instead of buying an A-B CRR that would hedge the cost of serving load at B, a CRR trader purchased an A-C CRR. 80% of the flow of this CRR would be over the line A-C in the auction solution, while only 20% would flow around over the line AB-1. If the shadow price of the AB-1 constraint in the auction was $45 as assumed, the CRR trader would be able to buy an A-C CRR for $9.

Figure 4



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# CRR PRICING EXAMPLE

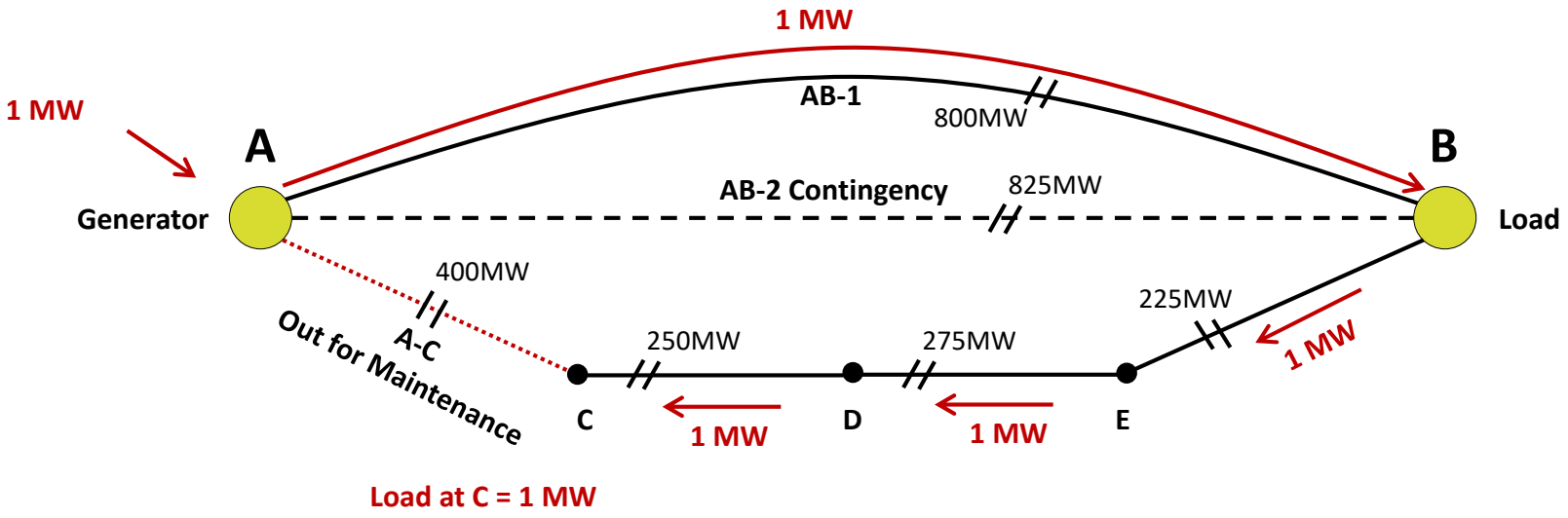
During the hours in which the line A-C was in service, the shadow price of AB-1 would be $25 in the day-ahead market, and an A-C CRR would have a .2 shift factor on the constraint. The payout to an A-C CRR would be $5 per hour, a little more than half what was paid for the A-C CRR.

- However, as shown in Figure 5, with A-C out of service, an A-C CRR would have a 1 shift factor on AB-1 in the day-ahead market.
- With a $50 shadow price in the day-ahead market, the A-C CRR would be paid $50 in the hours with the outage.
- The A-C CRR would be paid an average of $27.5 per hour over the month as a whole.
- Hence, while hedgers would pay $36 in the auction for an CRR with an expected payout of $35, the CRR trader could pay $9 to acquire a CRR with a an expected payout of $27.5 from the same day-ahead market constraint.

# CRR PRICING EXAMPLE

With A-C out of service an A-C CRR would have a 1 shift factor on A-B.

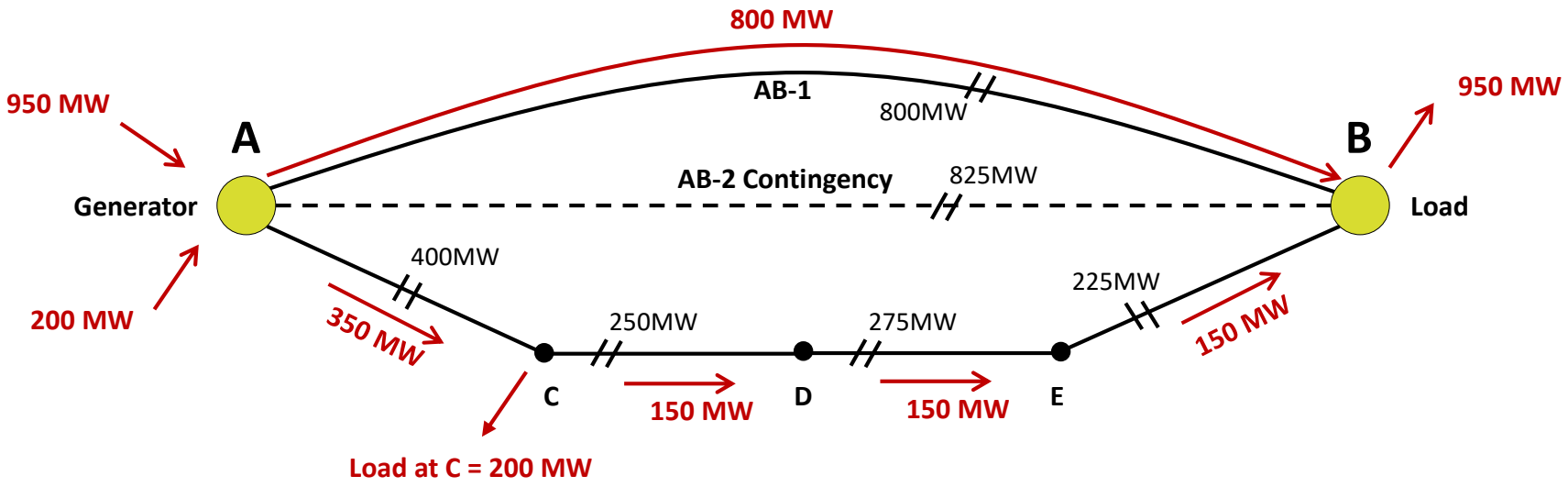
Figure 5



# CRR PRICING EXAMPLE

To further understand the impacts of such a CRR purchase strategy suppose that CRR traders bought 200 A to C CRRs in the auction, displacing 50 A to B CRRs and driving the price of an A to B CRR up to $37 as shown in Figure 6.

Figure 6



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# CRR PRICING EXAMPLE

In example portrayed in Figure 6, the purchases of A to C CRRs drives up the price of A to B CRRs from $36 to $37 and total auction revenues rise from $36,000 to $37,000.

- However, the total payout to CRR holders rises from $35,000 to $38,750, while congestion rent collections are still only $30,000.

- Thus, the purchase of these non-hedging CRRs simultaneously caused auction revenues to rise, the price of an A-B CRR to rise, CRR revenue inadequacy to rise and CRR payouts to rise above auction revenues.

# CRR PRICING EXAMPLE

While it might be thought that these pricing inconsistencies could be addressed by modeling the outage in the auction, this is not the case.

- If the A-C line outage were modeled in the auction, there would still be a difference between the auction model and day-ahead market model.
- The difference would now exist on the days the line AC is in service.
- CRR traders could profit from the modeling of the outage by purchasing C to A CRRs in the auction. With C – A modeled as out of service in the auction, a C-A CRR would have a -1 shift factor in the auction, entitling the buyer to be paid $36 for holding it.

# CRR PRICING EXAMPLE

On the days when line A-C was out of service in the day-ahead market, the CRR buyer would have to pay $50 a megawatt for holding the CRR.

- However, it would only have to pay $5 on the days A-C was in service.
- On average the CRR buyer would pay $27.5 for holding the CRR it was paid $36 to hold.
- So modeling the outage does not solve the pricing problem, it only changes which CRRs are mispriced.

# CRR PRICING EXAMPLE

An important feature of this example is that the revenue adequacy, and the mis-pricing of CRRs in the auction is entirely a result of settling CRRs based on day-ahead market shift factors, rather than auction shift factors.

- If the CRRs in Figure 6 were settled based on day-ahead market shadow prices and auction shift factors, the payout to A-B CRRs would be $40 with the line A-C out of service (.8 *$50) and the payout to A-C CRRs would be $10 (.2 * $50).

- The total payout would be $20,000 an hour (950 * $40 + 200 * $10), which would be equal to the congestion rent collections 800 MW * $50.

- With the reduced payout, the purchase of A-C CRRs would no longer be profitable if A-B CRRs were valued as hedges.

# CRR PRICING IMPACTS

In reflecting on this example it is noteworthy that despite the large proportion of the transfer capability of the CAISO transmission system that is made available to support the award of allocated CRRs, the proportion of the total CRR payout going to allocated CRRs was only 54.6% over the period January 2015 through May 2017.

- A very large proportion of the CRRs sold in the auction are generator node to generator node CRRs that are sold at a large discount to the expected payout.

- CAISO simulations have shown that eliminating generator to generator CRRs causes some CRR prices to fall, total auction revenues to fall and CRR payouts to fall more than auction revenues.

- This pattern of large numbers of generator to generator CRRs that displace hedging CRRs is consistent with CRRs purchased to take advantage of the current design in which CRRs are priced using the auction model and settled using the day-ahead market model.

# CRR PRICING IMPACTS

The rather stunning level of CRR revenue inadequacy in CAISO CRR markets could be a result of purchases of large numbers of CRRs that do not serve as hedges but are expected to generate payouts when transmission outages that were not reflected in the annual or monthly auction model are modeled in the day-ahead market.

- CRRs whose payout depends on differences between the transmission model used in the CRR auction and the day-ahead market may sell at a particularly large discount to the expected payout because they are very complex to value and have little or no value in hedging forward contracts.

- While the limits on CRR sources and sinks proposed by the CAISO would not completely eliminate the impact of the current settlement rules on revenue adequacy and CRR payouts, they should serve to limit the purchase of the kind of CRRs that profit most from these settlement rules.

# CRR PRICING IMPACTS

The current CAISO CRR design utilizes a different set of load distribution factors to award and price CRRs in the allocation and auction from the load distribution factors used to settle the CRRs in the day-ahead market.

- The current design creates the potential for predictable differences between the load weights used in the auction and those used in the day-ahead market during hours when transmission constraints impacted by load zone load bind.

- Such predictable differences would allow auction participants to buy a combination of point to point, and point to load zone, CRRs that create little or no net flows on transmission constraints in the auction (and hence have a low auction price), but are entitled to CRR payments in the day-ahead market when transmission constraints bind and load distribution factors differ from those used in the auction.

# CRR PRICING IMPACTS

It is not known if there are predictable differences in CAISO zonal load distribution factors during hours in which transmission contrainst are binding that contribute materially to revenue adequacy or low auction valuation of CRR payouts.

However, the CAISO's proposed limits on CRR sources and sinks would tend to limit, but likely would not eliminate, the ability of auction participants to buy combinations of CRRs that generate profits from predictable differences in load distribution factors between the auction and they day-ahead market.

# ALTERNATIVE CRR DESIGNS

A long run approach to improving auction revenue adequacy and improving auction valuation would be to revisit the way CRRs are settled.

- The design in which CRRs are settled by the CAISO and other ISOs based on day-ahead market shift factors and load distribution factors is not intrinsic to the concept of financial transmission rights and is not consistent with FTR revenue adequacy theorems.

- CRRs could instead be settled based on shift factors calculated for the auction grid and using auction zonal load distribution factors, applied to day-ahead market constraint shadow prices.

# ALTERNATIVE CRR DESIGNS

A design in which CRRs are settled based on auction shift factors would be more complex to implement than the current settlement rule as it would be necessary to calculate shift factors on the auction grid for all of the constraints that bound in the day ahead market during the month.

- This calculation would be similar to the process the NYISO has used since 2005 to calculate the shift factors used to assign the day-ahead market cost of transmission outages to the responsible transmission owner.
- Such a design would eliminate most of the congestion rent shortfalls in the day-ahead market as it would remove the impact of transmission outages and differences in zonal load distribution factors from CRR settlements.
- Such a design would not eliminate congestion rent shortfalls due to deratings, differences in loop flows, or differences in loss flows.

# ALTERNATIVE CRR DESIGNS

A design in which CRRs were settled based on auction shift factors would likely also improve the valuation of CRRs in ISO auctions.

- It would no longer be possible for non-hedgers to outbid hedgers for flows on binding constraints by purchasing CRRs between nodes on the auction transmission grid model that would have much larger shift factors on binding transmission constraints on the day-ahead market grid than the same constraint on the auction grid.
- A CRR design in which CRRs were settled based on auction shift factors could also use the same nodal weights to define load zones in the auction and to settle FTRs in the day-ahead market (PJM has used this design for many years).
- Such a change in the settlement of CRRs would not eliminate the ability of auction participants to purchase CRRs that do not hedge day-ahead market transactions but create flows on transmission elements that would bind during particular outages.

# ALTERNATIVE CRR DESIGNS

The use of auction shift factors and auction zonal load weights would mean that CRRs would not always be  a perfect hedge for purchases of power at the load zone in the day-ahead market, but this would be the case because the transmission system supporting the CRR award do not provide a perfect hedge.

A potential concern with any design in the which the congestion rent shortfalls associated with planned maintenance outages are allocated to particular CRR holders is that the transmission owner scheduling the outage and controlling its duration, would know the specific market participants that would be impacted by the outage.

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