SCE/DMM Alternatives: Potential Issues

Jim Bushnell and Ben Hobbs
Market Surveillance Committee of the California ISO
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Potential concerns with SCE/DMM proposals

- Technical Issues
  - Allocation and auction process originally intended to work together, would allocation need to be redesigned also?
- Institutional Issues
  - Some, particularly regulated, LSEs face regulatory limitations and incentive issues that influence their ability and willingness to participate in auctions.
  - Would “third party” firms offer significant unhedged counterflow CRRs at reasonable prices?
- Legal Issues (not our expertise)
  - Is transmission access defined as more than just buying “non-firm” on the day-of?
  - Does the DMM/SCE auction provide adequate access to long-term hedges?

Technical Issues

- "Voluntary" auction proposals would restrict constraint flows to those emerging from the allocation process
- The allocation process differs from the auction process
  - Additional restrictions on eligible sink-source pairs
  - Requirements intended to relate nominations to physical operations
  - Different objective function (maximize awarded MW)
- Even if there is large scale willing participation by sellers, forming desired new CRRs out of offered counterflow CRRs may be difficult or unlikely

Why difficult or unlikely? Technical analysis

Assume:

- N buses that are eligible to be sinks or sources of CRRs, and K transmission constraints.
- No capacity is made available on the transmission constraints (i.e., incremental flow has to be precisely zero on every constraint)
- Flows are calculated with a linearized DC load flow model
- An obligation CRR i is defined by a column vector of injections $\underline{A}_i = \{A_{in}\}$ [MW] (vector at each of the n= 1,..,N buses such that their sum = 0 (balanced). The bid to purchase such a CRR is B_i [\$]. The amount x_i of that CRR that is awarded can be between 0 and $+UB_i<+\infty$ if it is a "nonnegative bounded" CRR; between 0 and $+\infty$ if it is a "nonnegative unbounded" CRR; and between $-\infty$ and $+\infty$ if it is an "unrestricted" CRR.

The CRR auction problem can be simply stated as:

MAX $\Sigma_i \; B_i x_i$

s.t. $\underline{PTDF}\;(\Sigma_i \underline{A}_i \; x_i) = 0$

$0 \le x_i \le UB_i$ for nonnegative bounded CRRs

$0 \le x_i$ for nonnegative unbounded CRRs; x_i unrestricted for an unrestricted CRR

Where the matrix $\underline{PTDF} = \{PTDF_{k,n}\}$ describes the flow on each line k resulting from a unit injection at bus n and a unit withdrawal at the swing bus.

Why difficult or unlikely? Technical analysis, Cont.

Theorem 1: Worse Case. An arbitrary nonnegative CRR *i* can be guaranteed to fully clear the market **only if there are offers of N-1 other unrestricted CRRs *j*** whose <u>*A*</u>*j* vectors are linearly independent

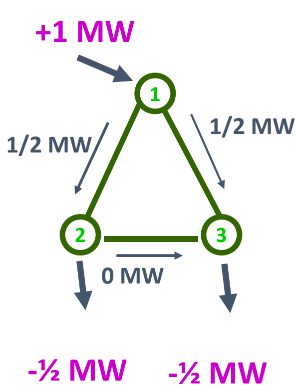
- 'Sufficiently large' means
- Why is this true? The PTDF equations define N-1 independent conditions, so if one CRR is fixed at a nonzero value (e.g., set x_1 =1), then up to N-1 of the other x_j's will need to be nonzero in order for all the conditions to be satisfied.
- But if only nonnegative unbounded CRRs are bid in, then up to 2(N-1) might be needed. If only nonnegative bounded CRRs are bid in, then even more may be needed, depending on the magnitude of their A_{jn} terms.

Theorem 2: Exact Counterflow To clear a CRR *i*, **it is possible that only one other nonnegative bounded CRR offer *j* is needed.** Such an offer *j* can be constructed by defining $A_{jn} = -\alpha A_{in}$, for some $\alpha \geq 1$

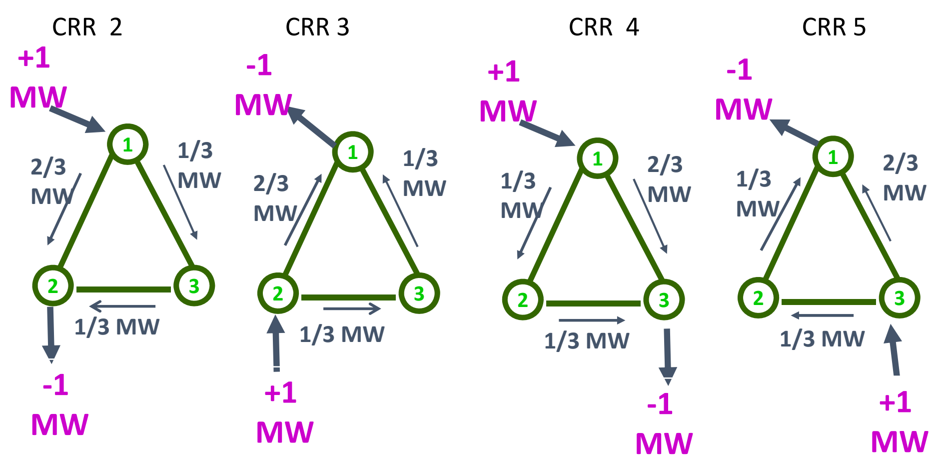
Why difficult or unlikely? Example of worst case

CRR 1

(desired CRR)



Example of 2(N-1) = 4 offered nonnegative unbounded CRRs that would be needed to guarantee that an arbitrary CRR 1 could clear



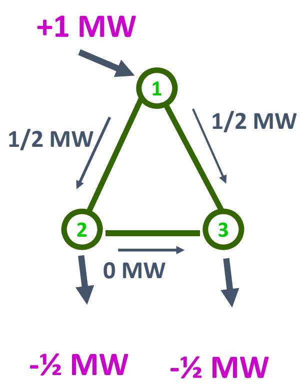
To produce the exact counterflow, accept:

$x_1 = 0.5$ $x_2 = 0$ $x_3 = 0.5$ $x_4 = 0$

Why difficult or unlikely? Example of exact match

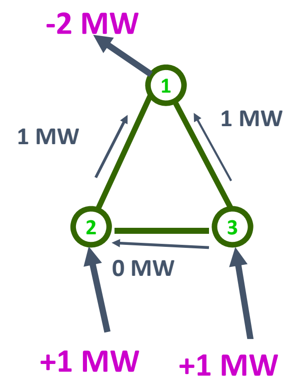
CRR 1

(desired CRR)



Best case: Exact counterflow offered

CRR 6



To produce the exact counterflow, accept x_6 = 0.5 of CRR 6

Appendix: Math of the 3 Node Example

Let n = 1,2,3, and the swing bus for the PTDF calculations be bus 1. Let the 3 lines have equal reactances. The resulting PTDFs for lines 1-2, 1-3, and 2-3 with respect to injections are:

Circuit k \ Injection Bus n	1 (Swing)	2	3
1→2	0	-2/3	-1/3
1→3	0	-1/3	-2/3
2→3	0	-1/3	-1/3

Let CRR i = 1 be the arbitrary CRR that we want to clear the market. In this case, we'd need an additional (N-1) = 2 linearly independent unrestricted offered CRRs to ensure that CRR i =1 clears. (Or 4 unbounded positive offers, as below)

(Example of Application of Theorem 1) For instance:

CRR 1: $\underline{A}_1^T$ = {+1, -.5, -.5} (Note: T means "transpose")

{i.e., Source 1 MW at bus 1, and sink half of that at bus 2 and the other half at bus 3}

CRR 2: $\underline{A}_2^T$ = {+1, -1, 0}

CRR 3: $\underline{A}_3^T$ = {-1, +1, 0} (counterflow of CRR 2)

CRR 4: $\underline{A}_4^T$ = {+1, 0, -1}

CRR 5: $\underline{A}_5^T$ = {-1, 0, +1} (counterflow of CRR 4)

Then if we force x_1 =1, the unique solution that makes that award possible is $x_2 = x_4 = 0.5$, and $x_3 = x_5 = 0$.

If CRRs 2 and 4 each had bounds of UB_2 , $UB_4 < 0.5$, then it would not be feasible to award x_1 =1.

(Example Theorem 2): However, if someone offered the exact counterflow of CRR 1, say:

CRR 6: $\underline{A}_6^T$ = {-2, +1, +1}

Then x_6 = 0.5 by itself would allow the full CRR 1 to clear.