Comparing Lossy v. Lossless Shift Factors in the ISO Markets

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What are Shift Factors?

- Also called Power Transfer Distribution Factors
- For any network node n and transmission line j the shift factor SFnj is the amount of flow across line j when one MW is injected at n to be withdrawn at the designated slack bus.
- SF depend on the topology of the network model and the designation of the slack bus.
- SF are calculated within the market software, and are used by the software to determine:
  - Which resources to adjust by how much to relieve congestion on each congested transmission line
  - The Marginal Congestion Components (MCC) of the LMPs

Lossless and Lossy Shift Factors

- Lossless SF are calculated assuming the network has no transmission losses, so that when one MW injected at node n, one MW is withdrawn at the slack.
- Lossy SF are calculated assuming that some energy is lost in transmission, so that when one MW is injected at node n, somewhat less than one MW is withdrawn at the slack.
- In either case, SF are numbers between -1 and +1, where the sign (+/-) indicates the flow direction with respect to the reference direction for each line.
- ISO markets use lossless shift factors, as do all other ISOs and RTOs in the US.

Comparing Lossless and Lossy Shift Factors

- Properties of Lossless SF
  - Depend only on network topology and slack
  - Congestion between any two nodes (MCCa – MCCb) is independent of choice of slack
- Properties of Lossy SF
  - More accurate: flow on each line from injection at node n diminishes due to the effect of losses
- Practical effect: two areas of transmission grid connected radially by a single interface
  - Using lossless SF, all resources on the same side of the interface have the same SF on the interface
  - Using lossy SF, each resource will have slightly different SF due to different losses from each resource to the slack.

Market case: Technical Bulletin 2009-05-02

- 4/19/09, Hour Ending 16, Interval 1 (1500-1505)
- SDGE Default LAP 5-minute price = $3984
- Congested radial interface between SDGE and rest of grid, supply exhausted on SDGE side
- Constraint shadow price = $3928, last accepted re-dispatch prior to relaxing constraint at $5000 penalty
- Two units outside SDGE identified as marginal
  - Using lossless SF, Units D and E have the same SF
  - But D has higher loss impacts than E
  - Software can therefore reduce system losses and obtain 1 MW congestion relief by reducing D by 75 MW (at -$10/MWh) and increasing E by 64 MW (at $49.5/MWh)

Other impacts

- See examples in Technical Bulletin 2009-06-03
- Three radially-connected nodes, two lines
- Negative net market congestion revenues can result from using lossless SF
- Negative net market energy revenues can result from using lossless SF.