Briefing on stepped constraint parameters initiative

Market Impacts of Shift Factor Truncation

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OVERVIEW

Some market participant comments regarding possible impacts of shift factor truncation suggest some misunderstandings.

- Shift factor truncation is applied to shift factors calculated relative to the distributed load bus. It is not applied to shift factors calculated relative to the other resource that would be moved to reduce flows on a constraint.
- Because shift factor truncation is applied to shift factors calculated relative to the distributed load reference bus, a low shift factor does not necessarily mean that generation with a low shift factor is ineffective in reducing flows on the constraint in question.
- The generator dispatched up could have a shift factor around 0 and the generator moved down could have a shift factor around +1, so in combination, the resource with a low shift factor on a constraint could be very effective in relieving congestion.

TRUNCATION AND DISPATCH EFFECTIVENESS

It is also possible that all the resources able to impact flows on a constraint could have low shift factors, so that even in combination the resources are not very effective.

- If this is the case, it can be expensive to control the constraint but shift factor truncation has the potential to materially distort the dispatch and raise the cost of controlling the constraint.
- Finally, it is also possible that all the resources able to be moved to impact the flows on a constraint have large shift factors but the difference in shift factors between the resources moved up and down is small, so that the resources are not very effective in controlling the constraint, yet shift factor truncation would not be triggered.

TRUNCATION WITH SMALL AND LARGE SHIFT FACTORS

In the situation in which one resource being dispatched has a low shift factor on the constraint and other resources have a high shift factor, shift factor truncation has the potential to result in a slight inefficiency in the dispatch.

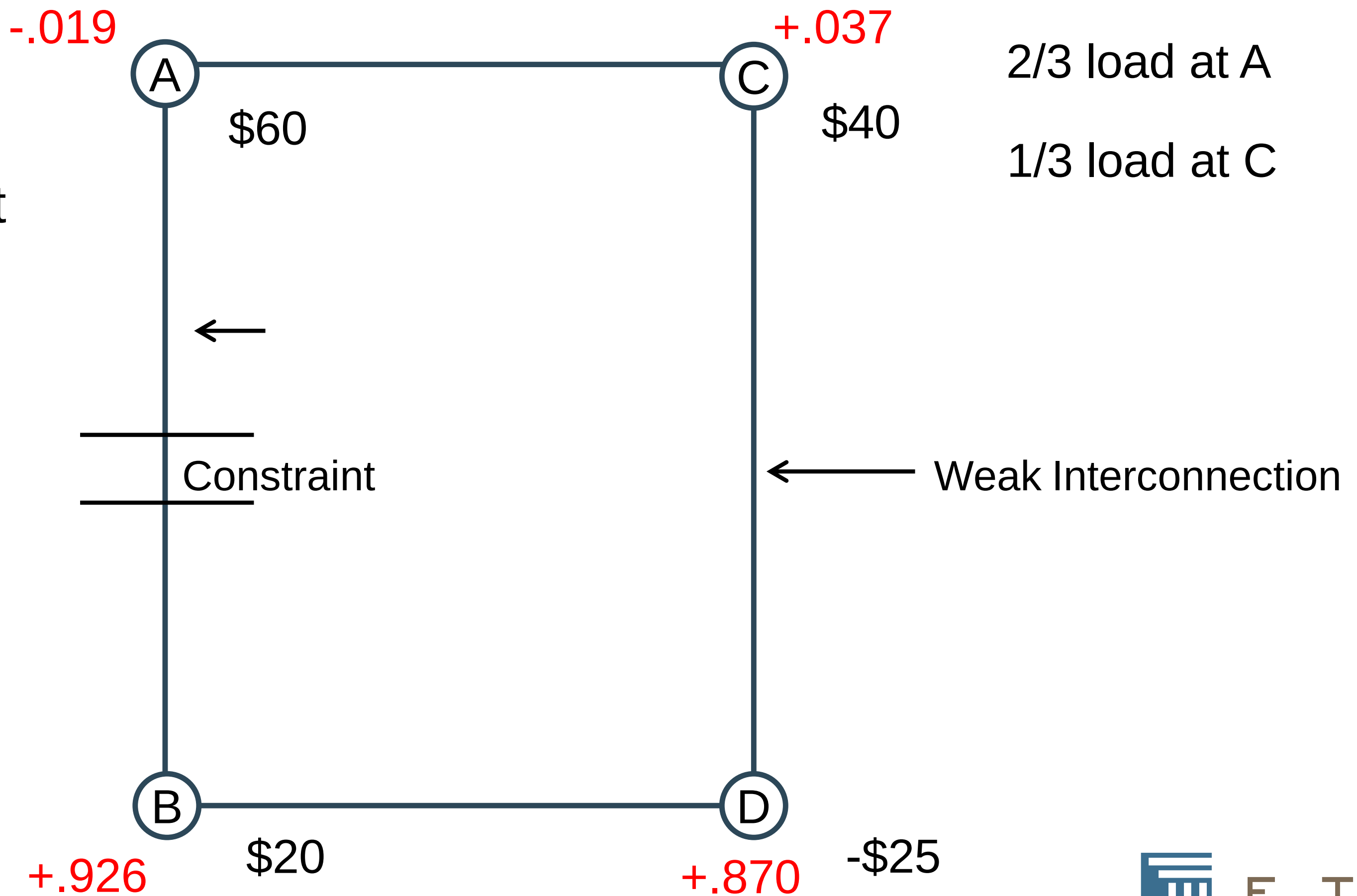
- For example, if the generation being moved had shift factors of -.019 and +.926, truncation that changed the -.019 shift factor to zero would very slightly understate the congestion relief provided.

TRUNCATION WITH SMALL AND LARGE SHIFT FACTORS

The impact of shift factor truncation can be illustrated with a simple example. Line A-B is a high voltage line on which most power flows. D is the location of a wind farm that creates flows on the weak D-C line.

Example 1

Red is the shift factor on line B-A



2/3 load at A

1/3 load at C

TRUNCATION WITH SMALL AND LARGE SHIFT FACTORS

The real-time dispatch would calculate the cost of reducing flows on the line B-A based on the truncated shift factor for generation at A.

Apparent Cost with Truncation

Cost	Up	Cost	Down	Impact	Cost/MW dispatch	Cost/MW Impact
$40	C	-$25	D	-0.83333	$65	-$78
$40	C	$60	A	0.037037		
$40	C	$20	B	-0.88889	$20	-$22.5
$20	B	-$25	D	0.055556		
$60	A	-$25	D	-.087037	$85	-$97.7
$60	A	$20	B	-0.92593	$40	-$43.2
$60	A	$40	C	-0.03704	$20	-$540

TRUNCATION WITH SMALL AND LARGE SHIFT FACTORS

The actual cost of reducing flows on the line B-A using generation at A and B would be slightly lower than calculated based on the truncated shift factor for generation at A, but the difference would not have a material impact on the dispatch.

Actual Cost

Cost	Up	Cost	Down	Impact	Cost/MW dispatch	Actual Cost/MW Impact	Truncated Cost/MW Impact
$40	C	-$25	D	-.83333	$65	-$78	-$78
$40	C	$60	A	0.055556			
$40	C	$20	B	-0.88889	$20	-$22.5	-$22.5
$20	B	-$25	D	0.055556			
$60	A	-$25	D	-0.88889	$85	-$95.6	-$97.7
$60	A	$20	B	-0.94444	$40	-$42.4	-$43.2
$60	A	$40	C	-0.05556	$20	-$360	-$540

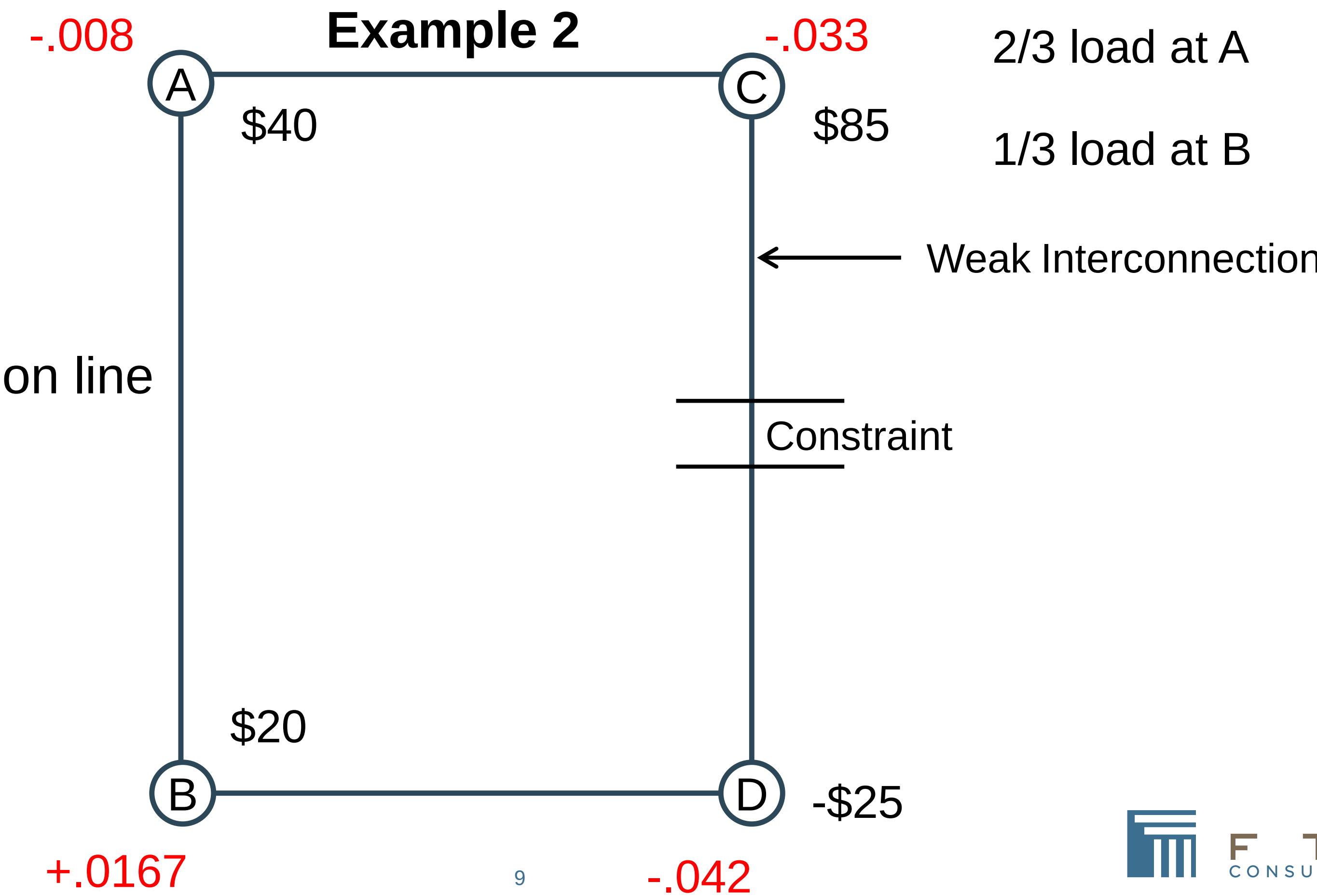
TRUNCATION WITH SMALL SHIFT FACTORS

A core problem with shift factor truncation occurs when it is applied to generation shift factors on constraints on low voltage transmission lines on which all most all generation has a low shift factor.

- If all the generation able to control a constraint has a shift factor between -.04 and +.04, setting values between +.02 and -.02 to zero could lead to a very inefficient dispatch in which some units might even be dispatched in the wrong direction and the least cost dispatch could appear completely ineffective.

TRUNCATION WITH SMALL SHIFT FACTORS

The impact of shift factor truncation in the dispatch to relieve constraints on weak lines can be illustrated with a simple example. This example is similar to that used above but load has been shifted from C to B, so the distributed load reference bus is at A and B.



Red is the shift factor on line D-C

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TRUNCATION WITH SMALL SHIFT FACTORS

With a dispatch based on truncated shift factors for locations A and B, it appears that the lowest cost redispatch to reduce congestion on the line D-C is to dispatch resource B up and wind at D down.

Apparent Redispatch Cost with Truncation

Cost	Up	Cost	Down	Impact	Cost/MW dispatch	Cost/MW Impact
$85	C	-$25	D	-0.075	$110	-$1466.67
$85	C	$40	A	-0.03333	$45	-$1350
$85	C	$20	B	-0.03333	$65	-$1950
$20	B	-$25	D	-0.04167	$45	-$1080
$40	A	-$25	D	-0.04167	$65	-$1560
$40	A	$20	B	0	$20	nc

TRUNCATION WITH SMALL SHIFT FACTORS

If the dispatch is based on the actual shift factors, however, the lowest cost dispatch is to dispatch down generation at B and dispatch up generation at A.

Cost	Up	**Actual Cost** Cost	Down	Impact	Cost/MW dispatch	Actual Cost/MW Impact	Truncated Cost/MW Impact
$85	C	-$25	D	-0.075	$110	-$1466.67	-$1466.67
$85	C	$40	A	-0.025	$45	-$1800	-$1350
$85	C	$20	B	-0.05	$65	-$1300	-$1950
$20	B	-$25	D	-0.025	$45	-$1800	-$1080
$40	A	-$25	D	-0.05	$65	-$1300	-$1560
$40	A	$20	B	-0.025	$20	-$800	nc

TRUNCATION WITH LARGE SHIFT FACTORS

In this example, shift factor truncation would significantly change the pattern of prices. Prices would not take extreme values with or without shift factor truncation because all generators have low shift factors on the constraint.

	Truncated Price	Actual Price
A	$20	$40
B	$20	$20
C	$56	$60
D	-$25	$0
Reference Bus	$20	$33.33

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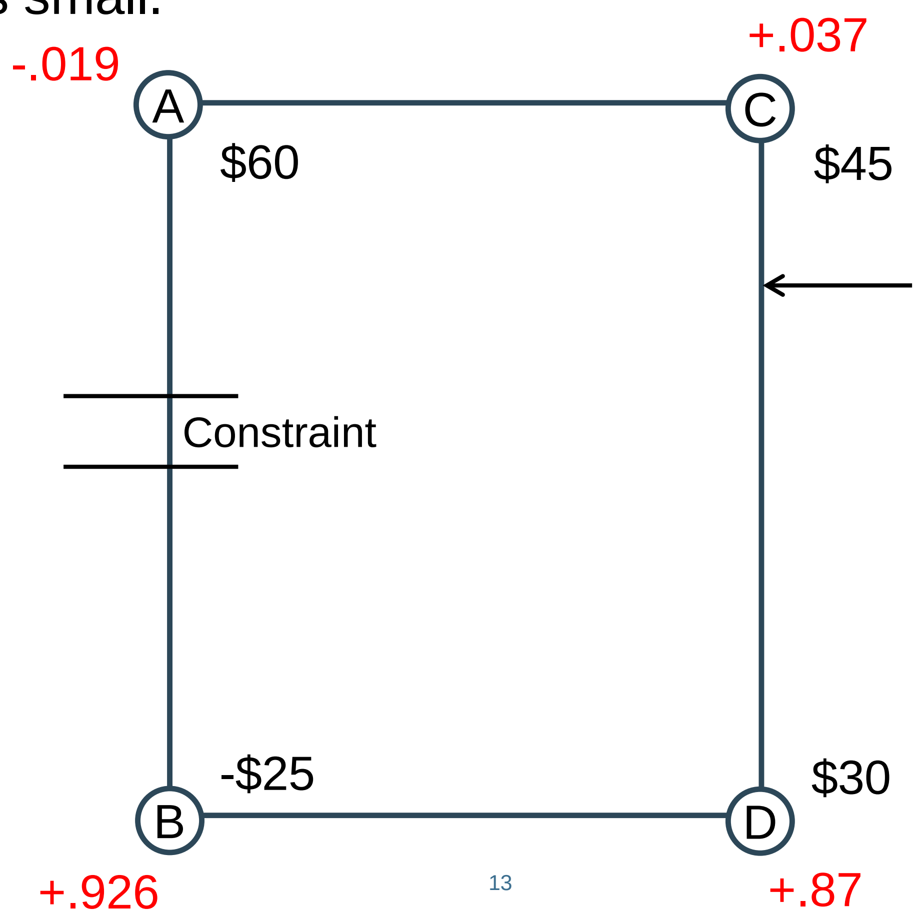
TRUNCATION WITH LARGE SHIFT FACTORS

In example 3, the units at A and C are ramp constrained up and the only units that can be dispatched up and down are the units and B and D. The resources at B and D have large shift factors on the constraint that are far above the level for shift factor truncation but the difference between them is small.



Red is the shift factor on line B-A

2/3 load at A

1/3 load at B

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TRUNCATION WITH LARGE SHIFT FACTORS

Because the resources at B and D that would be moved to control the constraint have large but similar shift factors on the constraint B-A, the cost of controlling the constraint can be very high, resulting in a very high constraint shadow price.

Cost	Up	Cost	Down	Impact	Cost/MW Dispatched	Cost/MW Impact
$30	D	-$25	B	-.05556	$55	$990

TRUNCATION WITH LARGE SHIFT FACTORS

The prices at B and D will be set by the offers of the resources that are moved to control the constraint, but prices at the locations of the ramp constrained units at A and C could be very high. Truncating small shift factors would have little impact on prices.

	Truncated Price	Actual Price
A	\$892	\$910
B	-\$25	-\$25
C	\$855	\$855
D	\$30	\$30

TRUNCATION WITH LARGE SHIFT FACTORS

If there is a concern that the cost of controlling a constraint would exceed the cost of small violations, the way to address this potential inefficiency is through the application of appropriate penalty factors for violating the constraint.

- Truncating shift factors will not necessarily avoid the potential inefficiency and can contribute to other inefficiencies as illustrated in examples 1 and 2.

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CONCLUSIONS

- Low shift factors on a particular constraint does not mean that generation is ineffective in controlling flows on the constraint.
- High shift factors on a particular constraint does not mean that generation will be effective in controlling flows on the constraint.
- It is the difference in shift factors between the generation dispatched up and down that determines how effective the redispatch will be.
- If the shift factors of either the generation being dispatched up or down is large, shift factor truncation will not materially undermine the economics of the dispatch.
- Shift factor truncation can materially undermine the economics of the dispatch and hinder congestion management if all the generation being dispatched up and down has relatively low shift factors on the constraint.
- Hence, shift factor truncation does not avoid ineffective dispatch nor does it avoid extreme constraint shadow prices.

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