Pivotal Supplier Analysis
Internal Interfaces

FERC

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Market Monitoring Unit

- In an LMP-based market, constraints create smaller, local markets with different structural characteristics than the aggregate market.

- Internal interfaces are constraints that affect larger areas than local constraints.

- Internal interfaces define relatively broad local markets when these interfaces are binding constraints.

- Western, Central and Eastern interfaces are examples in PJM.

Eastern, Central and Western Interface Components

- The key difference between the aggregate market and a local market is that all units do not have an equivalent ability to compete in a local market.

- The ability to compete is a function of:
  - Unit offer price or cost
  - Unit impact on the constrained facility.
  - Unit electrical proximity to the constrained facility.

- The local energy market includes only resources that can deliver relief to specific constraints.

- Consider two units with the same 100 MW capacity and identical energy offers of $150 at a time when the PJM LMP is $100.

- Unit A is located electrically close to the constrained facility and has a distribution factor of 90 percent, while unit B is electrically distant with a 5 percent distribution factor.

- Unit A is able to provide (100 MW * (-0.90)) = -90 MW of relief at an effective cost of ($100 - $150)/(-0.90) = $55.56 per MW

- Unit B can provide (100 MW * (-0.05)) = -5 MW of relief at an effective cost of ($100 - $150)/(-0.05) = $1000
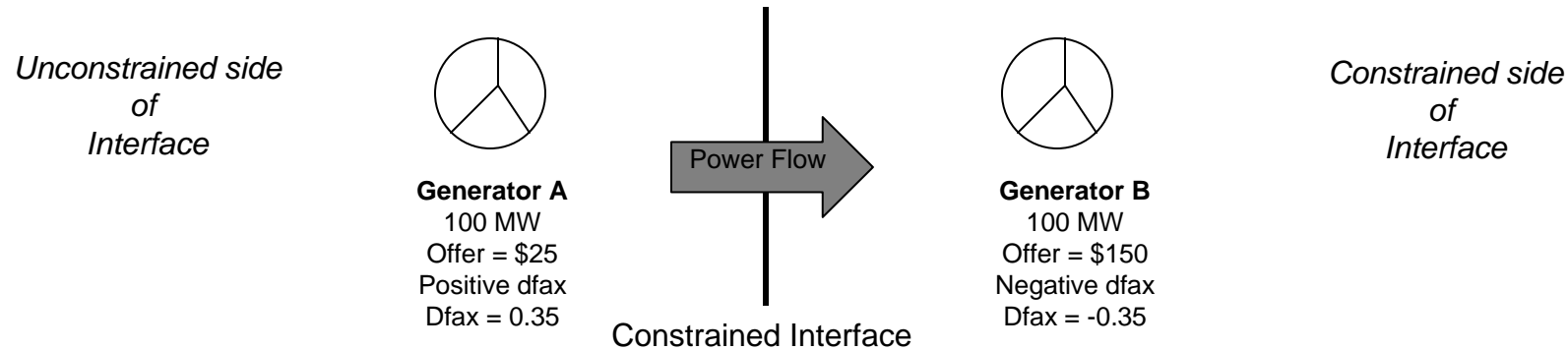
- The analysis is fully consistent with the way that PJM actually dispatches units to solve a constraint.

- Detailed unit characteristics are explicitly accounted for:
  - distribution factors;
  - operational status;
  - fuel type;
  - start and notification time;
  - minimum run time;
  - steam units' ramp rates;
  - economic maximum and economic minimum limits.

- The most general form of the analysis considers a range of system conditions
- These conditions represent seasonal and load conditions consistent with the FERC delivered price test
  - Real time analysis is an alternative
- The analysis includes units whose decreased or increased output would relieve the constraint.
- The higher the system price, the higher the effective cost of units for which lowering the output could relieve the constraint.

- In at least one of the system conditions, only units whose increased output would relieve the constraint are included.

- In this case, the constraint is in effect and the system price is high enough that units whose output could be lowered to relieve the constraint would not be competitive.

*Unconstrained side
of
Interface*

Generator A
100 MW
Offer = $25
Positive dfax
Dfax = 0.35

Power Flow

*Constrained side
of
Interface*

Generator B
100 MW
Offer = $150
Negative dfax
Dfax = -0.35

Constrained Interface

PJM system marginal price is $125

- Generator A is operating in merit order and increased production increases flow across constrained facility

- An increase in production from Generator B reduces flow across constrained facility

- Generator A contributes 100 MW * (0.35) = 35 MW of energy flow across constrained facility at a cost of (125-25)/0.35 = $285.71 per MW

- Generator B can provide 100 MW * (-0.35) = -35 MW of relief to constraint at a cost of (125-150)/(-0.35) = $71.43 per MW

- In this example, raising Generator B results in a lower cost to relieve the constraint than lowering Generator A

- The analysis considers units whose increased output relieves the constraint.
  - Based on supply curve quartiles
- PJM analysis includes more supply than FERC delivered price test
  - Based on portion of supply curve with marginal cost below 105% of market clearing price.

Hypothetical Effective Supply Curve
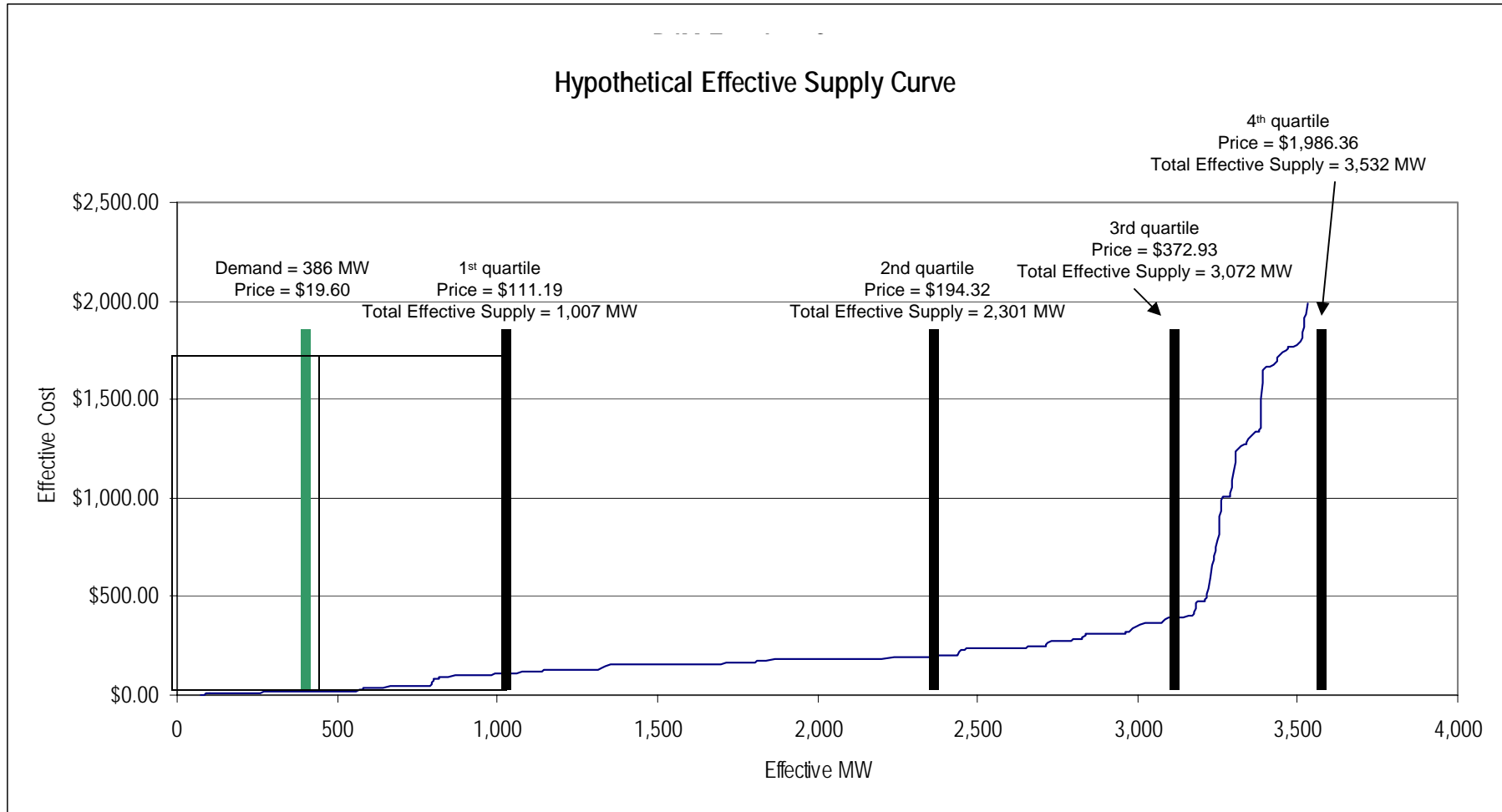
- Marginal unit effective cost = $19.60
- Effective cost at top of first quartile of supply curve = $111.19 per MWh
- Price Spread = 467%
- Required supply = 386 MW
- First quartile available supply = 1,007 MW

Company	Owner Total Relief MW	Cumulative Relief MW	System Total Relief MW	Owner Market Share	HHI	Joint RSI	Joint Pivotal
Company B	310	310	561	55%	3936	0.65	Yes
Company G	144	454	561	26%	3936	0.28	Yes
Company A	77	531	561	14%	3936	0.08	Yes
Company H	30	561	561	5%	3936	0.00	Yes

*Example assumes demand of 386 MW

Structural Test Results – Using First Quartile Cutoff

Company	Owner Total Relief MW	Cumulative Relief MW	System Total Relief MW	Owner Market Share	HHI	Joint RSI	Joint Pivotal
Company B	644	644	1007	64%	4571	0.94	Yes
Company A	162	806	1007	16%	4571	0.52	Yes
Company G	144	950	1007	14%	4571	0.15	Yes
Company H	30	980	1007	3%	4571	0.07	Yes
Company F	23	1003	1007	2%	4571	0.01	Yes
Company C	3	1007	1007	0%	4571	0.00	Yes

*Example assumes demand of 386 MW

- FERC considers a supplier to have market power if the FERC screens are failed for any one of the identified demand conditions.

- The PJM analysis will include a range of demand conditions which are likely to occur for a significant number of hours.

- This approach is consistent with the FERC delivered price test that looks at a variety of demand conditions.

- Market share
  - Output$_1$ / Total output
  - Ownership$_1$ / Total Supply

- Market concentration
  - HHI

- Pivotal supplier

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- A generation owner is pivotal when output of its units required to meet demand
- $RSI = (\text{Total supply} - \text{supply}_1) / (\text{Total demand})$
- If RSI < 1.0, owner is pivotal
- Generation owners are jointly pivotal when output of owners' units required to meet demand
- $RSI = (\text{Total supply} - \text{supply}_{1,2,3}) / (\text{Total demand})$
- If RSI < 1.0, owners are jointly pivotal

- Determination of relevant system conditions for study

- Determination of requirements to resolve constraint (demand)

- Obtain system dispatch data, operational status, offer parameters and distribution factors

- Apply PJM operations resource selection criteria

- Define supply curve

  - Effective MW

  - Effective costs

  - Ownership shares

- Calculate market structure indices

- Three examples of application of FERC delivered price test and pivotal supplier analysis
  - Different data than prior examples
  - Hypothetical examples
  - Illustrate possible ranges of outcomes

Structural Test Results – Example 1

Company	Owner Total Relief MW	Cumulative Relief MW	System Total Relief MW	Owner Market Share	HHI	Joint RSI	Joint Pivotal
Company A	1274	1274	3680	35%	2171	6.23	No
Company B	850	2124	3680	23%	2171	4.03	No
Company C	625	2749	3680	17%	2171	2.41	No
Company D	320	3069	3680	9%	2171	1.58	No
Company E	200	3269	3680	5%	2171	1.06	No
Company F	180	3449	3680	5%	2171	0.60	Yes
Company G	160	3609	3680	4%	2171	0.18	Yes
Company H	40	3649	3680	1%	2171	0.08	Yes
Company I	30	3679	3680	1%	2171	0.00	Yes
Company J	1	3680	3680	0%	2171	0	Yes

*Example assumes demand of 386 MW

- HHI results are below 2500 but indicate high levels of concentration

- Market share test is failed

- Single pivotal supplier test is passed

- Three pivotal supplier test is passed

- Local market fails market share tests
- In absence of mitigating factors, local market would not be competitive under FERC test
- Three-pivotal supplier results demonstrate diversity of excess supply ownership
- Three-pivotal results permit exemption from offer capping rules

Company	Owner Total Relief MW	Cumulative Relief MW	System Total Relief MW	Owner Market Share	HHI	Joint RSI	Joint Pivotal
Company A	800	800	4215	19%	1332	8.85	No
Company B	650	1450	4215	15%	1332	7.16	No
Company C	575	2025	4215	14%	1332	5.67	No
Company D	550	2575	4215	13%	1332	4.25	No
Company E	500	3075	4215	12%	1332	2.95	No
Company F	475	3550	4215	11%	1332	1.72	No
Company G	390	3940	4215	9%	1332	0.71	Yes
Company H	200	4140	4215	5%	1332	0.19	Yes
Company I	50	4190	4215	1%	1332	0.06	Yes
Company J	25	4215	4215	1%	1332	0	Yes

*Example assumes demand of 386 MW

- Market concentration test is passed
- Market share test is passed
- Single pivotal supplier test is passed
- Three pivotal supplier test is passed

- Local market deemed competitive under FERC test

- Three-pivotal supplier results demonstrate diversity of excess supply ownership

- Three-pivotal results not required to examine potential exemption from offer capping rules

Company	Owner Total Relief MW	Cumulative Relief MW	System Total Relief MW	Owner Market Share	HHI	Joint RSI	Joint Pivotal
Company A	130	130	676	19%	1439	1.41	No
Company B	125	255	676	18%	1439	1.09	No
Company C	120	375	676	18%	1439	0.78	Yes
Company D	90	465	676	13%	1439	0.55	Yes
Company E	60	525	676	9%	1439	0.39	Yes
Company F	55	580	676	8%	1439	0.25	Yes
Company G	50	630	676	7%	1439	0.12	Yes
Company H	40	670	676	6%	1439	0.02	Yes
Company I	5	675	676	1%	1439	0.00	Yes
Company J	1	676	676	0%	1439	0	Yes

*Example assumes demand of 386 MW

- Market concentration tests are passed
- Market share test is passed
- Single pivotal supplier test is passed
- Three pivotal supplier test is failed

- Local market deemed competitive under FERC test

- Three-pivotal supplier results demonstrate lack of diversity of excess supply ownership

- Three-pivotal results do not override passage of basic market structure tests