Revised Draft Final Proposal - Dynamic Competitive Path Assessment

Department of Market Monitoring

July 5, 2011

1 Summary of proposal

This paper focuses on the proposed dynamic CPA methodology and implementation specifically. Several refinements to the calculation of the pivotal supplier test and implementation are included in the proposal. The material provided is more detailed in the specification of how the pivotal supplier test will be calculated for the three market applications.

2 Preliminary Items

Phased implementation

The California Independent System Operator Corporation (ISO) has committed to implementing the dynamic competitive path assessment in the day-ahead market and the new local market power mitigation in both the day-ahead and hour-ahead markets in the Spring of 2012. Development of the full real-time application of both the dynamic competitive path assessment and new local market power mitigation in both the hour-ahead and real-time pre-dispatch markets requires additional development and testing, particularly due to computation time and the timing of these markets. The information available in the hour-ahead market for predicting congestion in real-time dispatch as well as system and resource conditions is less accurate than is the information available in the real-time pre-dispatch run. This has implications on the accuracy of mitigation applied in hour-ahead (for real-time dispatch) compared to if it is applied in real-time pre-dispatch.[1] Because of this and the phased implementation, we are proposing to keep the static competitive path assessment in the real-time market until the full dynamic competitive path assessment and local market power mitigation can be implemented in both the hour-ahead and real-time pre-dispatch runs. Using the static (current methodology) competitive path assessment retains the default designation of uncompetitive which we are more comfortable with compared to using dynamic path testing in the hour-ahead scheduling process for mitigation 70+ minutes later in real-time dispatch. Below is the timeline of implementation for new enhancements.

April 2012

- New local market power mitigation in day-ahead and hour-ahead, no local market power mitigation in real-time pre-dispatch.
- Static competitive path assessment used for local market power mitigation in day-ahead and hour-ahead scheduling process.

May 2012

- Dynamic competitive path assessment in day-ahead.
- Continue to use static competitive path assessment in hour-ahead scheduling process.

[1] See prior white paper on the dynamic competitive path assessment "Draft Final Proposal - Dynamic Competitive Path Assessment" at http://www.caiso.com/2b88/2b8871044e720.pdf for graphic of real time market timeline.

Q4 2012

- Dynamic competitive path assessment in the hour-ahead scheduling process.
- Add new local market power mitigation and dynamic competitive path assessment in real-time pre-dispatch.

Timing of execution and constraints tested

The following indicate when the dynamic competitive path assessment will be run when fully implemented.

- Day-ahead: After the all constraints run prior to the day-ahead market.
- Hour-ahead: After the all constraints run prior to the hour-ahead scheduling process.
- Real-time pre-dispatch: After the last real-time pre-dispatch run that procures ancillary services from internal resources just prior to the real-time dispatch runs for the same trade intervals.

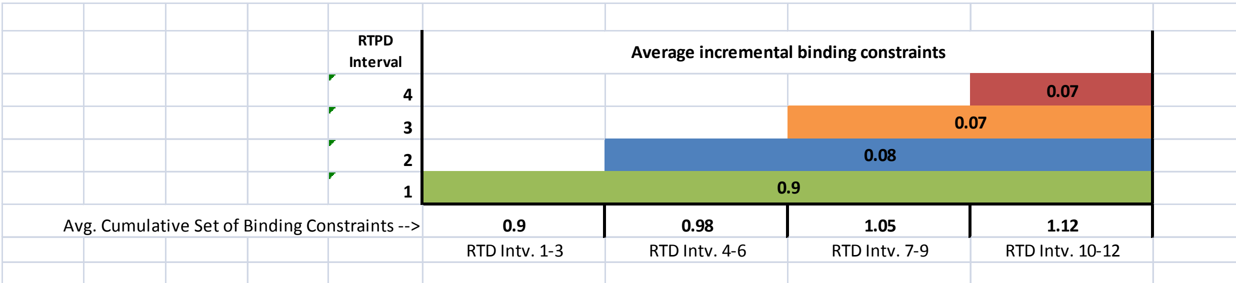
The ISO proposes to test only binding constraints in all three applications of the dynamic competitive path assessment and new local market power mitigation. Table 1 shows statistics for the accuracy of using hour-ahead and real-time pre-dispatch to predict congestion in real-time dispatch. The scoring for the hour-ahead market counts congestion in any interval of the all constraints run in the hour-ahead trade hour against congestion in any interval in the real-time dispatch trade hour. This is the broadest application of prediction using hour-ahead information. The scoring for real-time pre-dispatch takes into account the proposed "balance of hour" mitigation rule for real-time dispatch where a bid will be mitigated for the 15-minute real-time dispatch period corresponding to the first real-time dispatch interval it failed the local market power mitigation test AND for all subsequent real-time dispatch intervals in that trade hour. This is illustrated in Figure 1. There is a substantial gain in accuracy to detecting real-time dispatch congestion in real-time pre-dispatch compared to detecting it in hour-ahead scheduling process.

Table 1 Accuracy of HASP and RTD in predicting congestion in RTD

		HASP		RTPD
Under Identified		4.8%		1.7%
Consistent		23.4%		27.3%
Over Identified		9.5%		8.5%

Figure 1 illustrates how a constraint detected in a real-time pre-dispatch interval matches to the same constraint detected in a real-time pre-dispatch interval. For example, if constraint A is binding for the first time in the second 15-minute real-time pre-dispatch interval (represented on the vertical axis and blue bar) then it will count as a correct match if that same constraint is binding any of real-time dispatch intervals 4 – 12 (represented on the horizontal axis). The numbers in the colored bars show the average number of binding constraints in real-time dispatch and the numbers on the horizontal (real-time dispatch) axis show the cumulative average number of binding constraints in the real-time dispatch. Note that the average is taken on censored data – only hours where there is a binding constraint in real-time dispatch are considered.

Figure 1 Applying the "balance of hour" mitigation approach to scoring the accuracy of predicting congestion in real-time dispatch using real-time pre-dispatch congestion



Accounting for changes in control – tolling agreements

Resources will be assigned to a supplier's portfolio based on the Schedule Coordinator ID associated with that resource unless information has been submitted to indicate that a different market participant has operational or bidding control of the resource through a tolling agreement. In that event, the resource will be assigned to the portfolio of the market participant that contractually has operational or bidding control of the resource.

Market participants will be required to register their tolling agreements with the ISO on a monthly basis. Participants will submit to the ISO in the RDT the resource ID, Schedule Coordinator ID from which the control is being transferred, and the Schedule Coordinator ID to which the control is being transferred. The ISO will verify the submitted information by comparing submissions from both Schedule Coordinators involved in the contract.

Following is the proposed process for obtaining and incorporating information about tolling agreements:

- Parties to a tolling agreement will provide tolling agreement information to the ISO on a monthly basis using a form and/or interface provided by the ISO.
- Data provided will be subject to both the ISO confidential data policy as well as Tariff provisions governing provision of accurate information.
- Submitted data will be validated by matching information submitted by stated counterparties.
- This data will be stored in the ISO Master File and used when calculating the residual supply index through the market software.

Resources and suppliers considered

All resources that are available to the day-ahead market will be considered, whether committed in the all constraints run or not. In other words, we consider the effective available capacity for all resources bid into the day-ahead market regardless of their commitment / dispatch in that hour. Because of the flexibility provided by the multi-period optimization and the potential difference in commitment and dispatch between all constraints run and day-ahead, using the total effective available capacity is appropriate in the day- ahead. In this fashion, ramp constraints are ignored since the multi-period optimization can adjust dispatch in an earlier hour to achieve the dispatch it needs in the current hour if that was economic or necessary.

For the hour-ahead and real-time pre-dispatch applications, available capacity from all online resources can be considered as well as all available short-start resources that are not online at the time of the mitigation run but have sufficiently short start time that they can be online during the binding market / trade interval considered by the competitive path assessment and local market power mitigation.

There are instances where more than one Schedule Coordinator ID is used across generation assets owned or controlled by the same supplier. Accurate assembly of supplier portfolios requires a mapping of generation assets, Schedule Coordinator IDs, and affiliated companies. Market participants who own or control generation assets in the ISO control area will be required to provide this information and update monthly if there are changes.

For determination of the top three potentially pivotal suppliers, only suppliers who are net sellers of electricity at the affiliate level will be considered. Net buyers of electricity do not have an incentive to strategically bid their generation resources to exercise local market power and increase spot wholesale prices. Identification of net buyers to exclude from the set of potentially pivotal suppliers will be determined by the Department of Market Monitoring and will be based on historical market participation.

Treatment of Convergence Bids

Cleared virtual supply bids are included in the demand for counterflow and effective supply calculations for potentially pivotal and fringe competitive suppliers.[2]

The pivotal supplier test used to determine the competitiveness of constraints will be based on market bids for dispatchable physical resources and virtual bids that cleared in the pre-market run on which the assessment is based. Including “in-market” virtual supply bids is appropriate for two reasons. First, the calculation of the demand for counterflow will include virtual supply and demand bids on the system side of the constraint and virtual demand bids on the constrained side. Second, cleared virtual supply bids are revealed to be useful in managing congestion in the (day-ahead) market run and as such should be considered as part of the effective supply and the demand for counterflow. Excluding virtual supply bids on the constrained side that did not clear is necessary to avoid the potential for large quantities of relatively high priced virtual supply bids in the day-ahead market to cause a constraint to be deemed competitive.

[2] Fringe competitive suppliers are the set of (net) suppliers that are not considered potentially pivotal for purposes of applying the pivotal supplier test.

3 Application in the day-ahead market

This section presents the equations and interpretation for identifying the top three potentially pivotal suppliers, calculating the residual supply index, and determining path competitiveness.

The following indices are used in the equations presented below:

i is an index on supply resources,

j is an index on supplier portfolios, and

k is an index on binding transmission constraints.

Pivotal supplier test

The pivotal supplier test for constraint k will evaluate the ability of effective supply to relieve congestion after the removal of effective supply from the three largest potentially pivotal suppliers. The test metric for this residual supply index for binding constraint k is expressed as

RSI_k = (Supply of counterflow to k from potentially pivotal suppliers +

Supply of counterflow to k from fringe competitive suppliers) /

Demand for counterflow on k, or

$= (SCF^{PPS}_k + SCF^{FCS}_k) / DCF_k$,

where SCF^{PPS}_k is the total effective supply of counterflow to binding constraint k from all ***potentially pivotal suppliers*** that is not withheld including physical and cleared virtual supply,

SCF^{FCS}_k is the total effective supply of counterflow to biding constraint k from all ***fringe competitive fringe suppliers*** (those not identified as potentially pivotal suppliers) including physical and cleared virtual supply, and

DCF_k is the total demand for counterflow to binding constraint k.

Equations for SCF^{PPS}_k, SCF^{FCS}_k, $VSCF_k$, and DCF_k are provided later in this section.

The proposed test will evaluate RSI_k for each binding constraint k considering the largest three potentially pivotal suppliers withheld from the supply of counterflow. The method for identifying the three largest potentially pivotal suppliers is provided later in this section.

Constraint k is deemed competitive if $RSI_k >= 1$ and is deemed uncompetitive if $RSI_k < 1$.

Application of Mitigation

Resources that are identified as having local market power in an hour as a result of the dynamic competitive path assessment and local market power decomposition tests are run will have their bids mitigated to the higher of their default energy bid or the competitive LMP as calculated by the LMP decomposition process. Bids will be mitigated for the hour that the resource failed the LMP decomposition test.

Demand for counterflow

The demand for counterflow to binding constraint k is the sum of all dispatched energy that will flow on k in the counterflow direction. The demand for counterflow to binding constraint k is expressed as

$$DCF_k = \Sigma_i -SF_{k,i} * DOP_i$$

for physical resources and virtual supply resources i with $SF_{k,i} < 0$

where DOP_i is the dispatch operating point for physical or virtual supply resource i.

Effective supply of counterflow

It is easiest to view the effective supply of counterflow as comprised of two parts: the highest possible output from the fringe competitive suppliers that do not withhold any capacity and the lowest possible output from the three potentially pivotal suppliers which reflects the capacity they could withhold. In the case of the day-ahead application, the entire output of physical resources belonging to the potentially pivotal suppliers can be withheld. This is not the case in the real-time, and the dynamic competitive path assessment accounts for ramping constraints in the real time application which is discussed later in this paper.

Physical resources

The effective supply of physical counterflow (SPCF) to constraint k from a physical resource i belonging to ***fringe competitive supplier*** (FCS) j is the highest possible output from the fringe competitive suppliers. Fringe competitive suppliers do not withhold any capacity. For the day-ahead market, this is measured as the highest available output that is effective in relieving congestion on constraint k accounting for resource outages and derates. The (location-level) supply of counterflow is expressed as

$$SPCF^{FCS}_{k,j,i} = -SF_{k,i} * ENGYMAX_i$$

for resources i in fringe competitive supplier portfolio j with $SF_{k,j} < 0$

Where $SF_{k,i}$ is the shift factor from location i to constraint j, and

ENGYMAX is the highest output the resource can be dispatched to on energy bids given unit outages and derates and respecting ancillary service awards.[3]

$ENGYMAX_i = MAXCAP_i – DERATE_i – OR_i – RU_i$

MAXCAP is the maximum output of the resource or the upper bound of the regulation range if the resource has sold regulation to the ISO,

DERATE is the reduction in potential output from MAXCAP resulting from unit outage or derate,

OR is the operating reserve award (spinning reserve and non-spinning reserve), and

RU is the regulation up award.

The effective supply from resources belonging to fringe competitive suppliers can be summed within supplier j's portfolio to calculate total effective supply from supplier j to constraint k and summed again to calculate total effective supply to constraint k.

The available supply of effective counterflow from fringe competitive supplier j to constraint k is

$SPCF^{FCS}_{k,j} = \Sigma_i SPCF^{FCS}_{k,j,i}$ for i all in portfolio j.

And similarly, the total available supply of effective counterflow (not withheld) from all fringe competitive suppliers to constraint k is

$SPCF^{FCS}_{k} = \Sigma_j SPCF^{FCS}_{k,j}$ for all fringe competitive suppliers in j.

The effective supply of counterflow to constraint k from a physical resource i belonging to ***potentially pivotal supplier*** j is zero. Suppliers are not ramp constrained in their withholding from the day-ahead market. As we do not account for ramping constraints in the day-ahead market for the fringe competitive supply of counterflow (above), we also do not account for ramping constraints in the capacity that can be withheld. This is different in the real-time market application which is discussed in a later section. The (location-level) supply of counterflow in the day-ahead market is expressed as

$SPCF^{PPS}_{k,j,i} = 0$

for resources i in potentially pivotal supplier portfolio j with $SF_{k,i} < 0$.

Virtual resources

The effective supply of counterflow to constraint k from cleared virtual supply resource i in supplier j's portfolio is expressed as

$SVCF_{k,j,i} = -SF_{k,i} * DOP_i$

[3] DMM will further consider whether to adjust available capacity for ancillary service awards made in the all constraints run of the day-ahead market process. While it is important to account for capacity needed to meet ancillary service requirements, the ancillary service procurement made in the day ahead all constraints run may be re-optimized in the actual day-ahead run, freeing up some capacity effective in relieving congestion on an uncompetitive constraint that would have impacted the residual supply index calculation that led to the uncompetitive designation. This refinement will be considered prior to implementation.

for virtual resources i in supplier portfolio j with $SF_{k,i} < 0$.

where DOP_i is the dispatch operating point for virtual supply resource i.

Combined

The combined effective physical and virtual supply of counterflow to constraint k (from the RSI equation above) from physical and cleared virtual supply resources i held by supplier j is

$$SCF_{k,j,i} = SPCF_{k,j,I} + SVCF_{k,j,i}$$

This is aggregated to the supplier portfolio level by summing across physical and cleared virtual resources i, and to the constraint level by summing across portfolios j. This is represented in the residual supply index equation earlier in this section with a superscript distinguishing between potentially pivotal suppliers (PPS) and fringe competitive suppliers (FCS).

Identification of top three potentially pivotal suppliers

Identification of the top three potentially pivotal suppliers in the day-ahead market will be based on the total available effective supply that can be withheld by each supplier. This withheld capacity (WC) from supplier j to binding constraint k is the sum across j's resources, which is expressed as

$$WC_{k,j} = \Sigma_i \ -SF_{k,i} * ENGYMAX_i + \Sigma_i SVCF_{k,j,i}$$

for resources i in supplier portfolio j with $SF_{k,i} < 0$.

Other variables are as defined earlier in this section.

For each binding constraint k, suppliers are ranked on WC from highest to lowest and the top three suppliers are identified as the set of potentially pivotal suppliers for that constraint.

4 Application in hour-ahead scheduling process

This section presents the equations and interpretation for identifying the top three potentially pivotal suppliers, calculating the residual supply index, and determining path competitiveness for the application in the hour ahead scheduling process. The formulas and discussion follow what was presented for the day-ahead case closely.

The following indices are used in the equations presented below:

i is an index on supply resources,

j is an index on supplier portfolios, and k is an index on binding transmission constraints.

Pivotal supplier test

The pivotal supplier test for constraint k will evaluate the ability of effective supply to relieve congestion after the removal of effective supply from the three largest potentially pivotal suppliers. The test metric for this residual supply index for binding constraint k is expressed as

$$RSI_k = (SCF^{PPS}_k + SCF^{FCS}_k) / DCF_k ,$$

where SCF^{PPS}_k is the total effective supply of counterflow to binding constraint k from all ***potentially pivotal suppliers*** that is not withheld,

SCF^{FCS}_k is the total effective supply of counterflow to biding constraint k from all ***competitive fringe suppliers*** (those not identified as potentially pivotal suppliers), and

DCF_k is the total demand for counterflow to binding constraint k.

Equations for SCF^{PPS}_k, SCF^{FCS}_k, and DCF_k are provided later in this section.

The proposed test will evaluate RSI_k for each binding constraint k considering the largest three potentially pivotal suppliers withheld from the supply of counterflow. Constraint k is deemed competitive if $RSI_k >= 1$ and is deemed uncompetitive if $RSI_k < 1$.

Application of Mitigation

Resources that are identified as having local market power after the dynamic competitive path assessment and local market power decomposition tests are run in the hour ahead scheduling process will have their bids mitigated to the higher of their default energy bid or the competitive LMP as calculated by the LMP decomposition process. Bids will be mitigated if the resource fails this test in any of the four hour-ahead all constraints run 15-minute trade intervals. Mitigated bids will be used in the hour-ahead market run and all subsequent short-run unit commitment and real-time ancillary service runs prior to the 5-minute real-time dispatch market. Path competitiveness and the LMP decomposition test will be re-applied in the last real-time pre-dispatch run. At that time, mitigation will be applied to the set of unmitigated bids that were submitted prior to the hour-ahead scheduling process.

Demand for counterflow

The demand for counterflow to binding constraint k is the sum of all dispatched energy that will flow on k in the counterflow direction. The demand for counterflow to binding constraint k is expressed as

$$DCF_k = \Sigma_i -SF_{k,i} * DOP_i$$

for resources i with $SF_{k,i} < 0$

where DOP_i is the dispatch operating point for resource i.

Effective supply of counterflow

It is easiest to view the effective supply of counterflow as comprised of two parts: the highest possible output from the fringe competitive suppliers that do not withhold any capacity and the lowest possible output from the three potentially pivotal suppliers which reflects the capacity they could withhold.

Physical resources

The effective supply of physical counterflow (SPCF) to constraint k from a physical resource i belonging to ***fringe competitive supplier*** (FCS) j is the highest possible output from the fringe competitive suppliers. Fringe competitive suppliers do not withhold any capacity. This is measured from the last dispatch operating point taking into account the ramp rate of the resource and any limitations on the available capacity. The (location-level) supply of counterflow is expressed as

$$SPCF^{FCS}_{k,j,i} = -SF_{k,i} * \min (LDOP_i * (1 + RR_i * 15) , ENGYMAX_i)$$

for resources i in fringe competitive supplier portfolio j with $SF_{k,j} < 0$

Where $SF_{k,i}$ is the shift factor from location i to constraint j,

$LDOP_i$ is resource i's dispatch operating point from the prior interval,

RR_i is resource i's ramp rate in MW/minute, and

ENGYMAX is the highest output the resource can be dispatched to on energy bids (not accounting for ramp rate) given unit outages and derates and respecting ancillary service awards.

$$ENGYMAX_i = MAXCAP_i – DERATE_i – OR_i – RU_i$$

MAXCAP is the maximum output of the resource or the upper bound of the regulation range if the resource has sold regulation to the ISO,

DERATE is the reduction in potential output from MAXCAP resulting from unit outage or derate,

OR is the operating reserve award (spinning reserve and non-spinning reserve), and

RU is the regulation up award.

The effective supply from resources belonging to fringe competitive suppliers can be added to get total effective capacity from supplier j to constraint k. This is done for potentially pivotal suppliers below, and the same additive property applies to $SPCF^{FCS}_{k,j,i}$.

The effective supply of counterflow to constraint k from a physical resource i belonging to ***potentially pivotal supplier*** j is the lowest output this supplier can achieve given the dispatch operating point, resource ramp rates, and minimum output limits. This calculation reflects that a supplier is constrained in how much capacity it can withhold by the physical ability of its resources to ramp down (and consequently withhold). The (location-level) supply of counterflow is expressed as

$SPCF^{PPS}_{k,j,i} = -SF_{k,i} * \max (LDOP_i * (1 - RR_i * 15) , ENGYMIN_i)$

for resources i in potentially pivotal supplier portfolio j with $SF_{k,i} < 0$

Where ENGYMIN is the lowest output the resource can be dispatched to on energy bids (not accounting for ramp rate) given unit outages and derates and respecting ancillary service awards.

$ENGYMIN = MINCAP + RD,$

MINCAP is the minimum load output or the lower regulation range if awarded regulation down,

RD is the regulation down award, and

All other variables are as defined for $SCF^{FCS}_{k,j,i}$

These location-level supply calculations are additive to the portfolio and constraint level. The remaining available supply of effective counterflow (not withheld) from potentially pivotal supplier portfolio j to constraint k is

$SPCF^{PPS}_{k,j} = \Sigma_i SPCF^{PPS}_{k,j,i}$ for i all in portfolio j.

And similarly, the total available supply of effective counterflow (not withheld) from all potentially pivotal suppliers to constraint k is

$SPCF^{PPS}_{k} = \Sigma_j SPCF^{PPS}_{k,j}$ for all potentially pivotal suppliers in j.

Virtual resources

Convergence bids liquidate in the real time market. Therefore there are no virtual resources to consider in the dynamic competitive path assessment executed in hour-ahead (or real-time pre-dispatch).

Identification of top three potentially pivotal suppliers

Identification of the top three potentially pivotal suppliers will be based on the most ramp-constrained capacity a supplier can withhold.[4] We measure this capacity as the distance between the highest and lowest output levels a resource can ramp to in the test period based on their dispatch point in the prior period. This withheld capacity (WC) from supplier j to binding constraint k is the sum across j's resources, which is expressed as

$$WC_{k,j} = \Sigma_i \; -SF_{k,i} * [\min (LDOP_i * (1 + RR_i * 15) , ENGYMAX_i) - \max (LDOP_i * (1 - RR_i * 15) , ENGYMIN_i)]$$

[4] We note that this measure of potential withheld capacity does not directly account for a resource fully withholding by shutting down. We recognize that this potential exists but note that some of the withheld capacity will be accounted for in the proposed measure and the market will detect after a few intervals that the resource is now off-line and that absence of capacity will be reflected in the measure. In addition, the Department of Market Monitoring monitors for physical withholding.

for resources i in supplier portfolio j with $SF_{k,i} < 0$.

Other variables are as defined earlier in this section.

For each binding constraint k, suppliers are ranked on WC from highest to lowest and the top three suppliers are identified as the set of potentially pivotal suppliers for that constraint.

5 Application in RTPD

Application of the three pivotal supplier test is the same in real-time pre-dispatch as described for hour-ahead scheduling process with the following changes.

Frequency and Inputs

The pivotal supplier test will be run every 15 minutes in the last applicable real-time pre-dispatch run prior to the corresponding real-time dispatch intervals. The competitive path assessment calculations will use the market outcomes from this real-time pre-dispatch run.

Mitigation of bids

For resources identified as having market power via the LMP decomposition test, bids will be mitigated for the balance of the trade hour beginning the first 5-minute real-time dispatch interval corresponding to the 15-minute real-time pre-dispatch interval where the resource first failed the LMP decomposition test.

6 Process

This material will be presented at the July 6, 2011, stakeholder call on the local market power mitigation enhancements market initiative. The dynamic competitive path assessment and new local market power mitigation will be presented to the ISO Board of Governors at the July 13-14 meeting as a decisional item.

Formal comments on this version of the proposal will not be compiled and presented in a separate document. However, please feel free to contact Jeff McDonald in the Department of Market Monitoring with questions or comments at JMcDonald@caiso.com or (916) 608-7236.