California Independent
System Operator Corporation

Competitive Path Assessment for MRTU
Final Results for MRTU Go-Live

Department of Market Monitoring

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1 Executive Summary

The final path designations resulting from the Competitive Path Assessment (CPA) will be used to establish the set of transmission paths applied in the two market passes of MRTU where Local Market Power Mitigation (LMPM) is applied. This white paper is intended to provide the final set of competitive path designations that will be in effect on day-one of MRTU as well as information to Stakeholders and Regulatory Agencies on the results of the CPA along with a detailed description of modeling, data, and testing practices used in performing simulations and ultimately making competitive path designations.

This current release of CPA results evaluates path competitiveness across four seasons, three load scenarios (high, medium, and low), three hydroelectric production scenarios (high, medium, and low), and combinations of the nine largest suppliers' internal generation withdrawn from the model. The methodology, input data, and simulation model are functionally the same as in the third release of preliminary results except for two items. For this release, the CAISO selects representative load dates on seasonal basis instead of yearly basis. The representative winter, spring, summer, and fall seasons are picked up first based on historical data, and then representative dates are selected within each season. In the previous method, a representative load year was picked up first, and all representative dates of four seasons are from the same year. Also, the pool of suppliers considered is based on a reduced 500MW threshold for the portfolio of internal generation from previous 1000MW threshold. For more information, please refer to Section 4.6 of this report.

As with the simulations used to produce prior sets of preliminary results[1], simulations for this release do not include explicit use of N-1 contingencies via Security Constrained Unit Commitment (SCUC). The California ISO (CAISO) intends to apply additional N-1 security constraints through the SCUC feature of the MRTU market optimization on an as-needed basis as dictated by grid conditions. Note that while not explicitly enforced through SCUC each interval, the CAISO will be using corridor limits that have been established by off-line security analysis to ensure that the pre-contingency limits are such that if a contingency occurs the CAISO is operating in a secure state. Given the situational application of N-1 security constraints in SCUC, the CAISO's Department of Market Monitoring (DMM) did not feel it would be appropriate to apply additional security constraints on a consistent basis in the CPA simulations while those constraints will be applied differently (possibly a subset of the full set of security constraints) and less frequently during actual market operation.

Results for seasonal benchmark cases are presented in addition to summary results for 2304 one-day simulation runs, 576 simulation runs for each of four seasons reflecting the various load and hydro scenarios as well as withdrawn capacity for combinations of potentially pivotal suppliers. This paper presents the calculated Feasibility Index (FI) metric and results of the competitive test for each season under two different test thresholds.

[1] Previous release results can be found here: http://www.caiso.com/docs/2005/07/01/200507011120583480.html

There are 27 aggregated candidate paths which are composed of multiple transmission segments as well as 59 single candidate paths which are made up of individual transmission segments (not associated with aggregated candidate paths) tested in this release. Using a zero-tolerance threshold where any negative FI value constitutes failure of the competitive test, no individual candidate path failed any test in this study. However, In the Spring and Summer scenarios, 1 of 27 aggregated candidate path failed the competitiveness test. Due to relatively lower demand, none of the candidate paths failed in the Fall and Winter seasons. Overall, 26 of 27 aggregated candidate paths and all 59 single candidate paths passed the test and were deemed competitive paths in this study.

It is important to note that by default, all paths are deemed uncompetitive except for "grandfathered" paths (existing branch groups). Aside from existing branch groups, only paths that are selected as candidate competitive paths AND pass the test for competitiveness will be deemed competitive. Of the 4,860 individual transmission segments in the CRR FNM, 3.2% (154/4,860) are selected as candidates for testing, and 152 individual lines are deemed competitive through testing. Conversly, roughly 97 percent of the individual transmission segments that comprise CRR FNM are deemed uncompetitive.

List of Simulation Condition Change:

- Threshold to identify pivotal supplier is reduced to 500MW from 1000MW, which adds more suppliers to the list for three-pivotal suppliers test.
- Pivotal suppliers capacities are adjusted based on the latest tolling agreement survey (June/July 2008) covering October 2008 to December 2009 from major generation companies and load serving entities.
- Full Network Model is based on the latest 2008 release CRR model for DB32, while previous results are based on CRR model for DB18 released in 2006.
- Intertie transactions with Integrated Balancing Authority Areas (IBAA) is modeled based on CAISO IBAA model.
- 1600MW projected new gas fired generation is added into the model.
- Candidate path list is updated based on 2008 operating data.
- System load is updated based past 5 years of historical load data.
- Years representing high, medium, low hydro production are updated to be year 2006, 2005, 2007, while previous designation of high, medium, low hydro years are 2006, 2005, 2004.
- Internal generation output (non-gas fired units) and intertie schedules are updated according to the updated load scenario dates and hydro scenarios dates, respectively.

2 Background for Competitive Path Assessment

Local Market Power Mitigation and Reliability Requirement Determination (LMPM-RRD) under MRTU requires prior designation of network constraints (or paths)[2] into two classes, “competitive” and “non-competitive.” Under the MRTU LMPM-RRD procedures, generation bids that are dispatched up to relieve congestion on transmission paths pre-designated as “non-competitive” are subject to bid mitigation.[3] In its MRTU Tariff Filing, the CAISO proposed to designate all of today’s existing zonal transmission branch groups as “competitive” and undertake a study prior to MRTU implementation to determine whether additional transmission paths could be designated as “competitive” for day one of MRTU. Thereafter, the CAISO proposed to reevaluate path designations on an annual basis or sooner if system or market conditions changed significantly.[4]

LMPM-RRD in MRTU will be applied in a two-step process that is used to identify specific circumstances where local market power exists. This process occurs just prior to running the market (day-ahead or real-time) and applies mitigation to resources that have been identified as having local market power. All transmission facilities that are modeled in the FNM have a designation of “competitive” or “non-competitive.” The first step of this process clears supply against forecast demand, with thermal limits enforced only on the set of competitive constraints (the “Competitive Constraint Run (CCR)”). This provides a benchmark dispatch that reflects competition among suppliers since only those transmission constraints deemed competitive are applied in the network model. The second step applies all constraints, competitive and non-competitive, and re-dispatches all resources to meet forecast load. In this second step, the “All Constraint Run (ACR),” some resources will be dispatched further up (compared to the CCR) to relieve congestion on the non-competitive constraints now that they have been applied in the market solution. Those resources that have been dispatched up in the ACR relative to the competitive benchmark dispatch from the CCR are deemed to have local market power since they were needed to relieve congestion on a non-competitive constraint and will have their bid curve mitigated to their Default Energy Bid from the CCR dispatch point to the full bid-in output for that resource.

The Competitive Path Assessment is based on a Feasibility Index (FI) methodology that was developed through an extensive stakeholder process in 2005. Alternative approaches, including those used by PJM Interconnection (PJM) and Midwest ISO (MISO), were considered and reviewed at Stakeholder Working Group meetings held in the latter part of June through mid-July 2005. Among all the options considered, the FI methodology had certain conceptual advantages as well as the greatest support within

[2] The term path is used synonymously with transmission constraints in this context, and includes all transmission constraints that are enforced in Pass 1 and Pass 2 of Pre-IFM. A path is by definition directional.

[3] A detailed description of the MRTU LMPM-RRD procedures can be found in the MRTU Tariff and MRTU Business Process Manuals on the CAISO web site at http://www.caiso.com/docs/2001/12/21/2001122108490719681.html.

[4] Specifically, the CAISO may perform additional competitive assessments during the first year if changes in transmission infrastructure, generation resources, or load in the CAISO Control Area and adjacent Control Areas suggest material changes in market conditions, or if market outcomes are observed that are inconsistent with competitive market outcomes.

the Stakeholder Working Group and thus was the approach adopted and filed with FERC.

Over the past year, DMM has developed the modeling tools and input data for conducting the CPA and has completed some initial demonstration results. This draft report provides a review of the study approach and demonstration results.

A detailed description of the FI methodology is provided in the next section. This is followed by a review of the various modeling assumptions and input data. The testing and determination results, along with analysis, are provided next.

3 The Feasibility Index Methodology

Transmission constraints increase the potential for exercising market power by raising the level and decreasing the elasticity of effective demand curves facing generators. There are several distinct types of market power opportunities that transmission constraints can present. The most familiar is high concentration of supply within load pockets. In that case, by withholding capacity, local generation can induce congestion on connecting paths, creating an uncompetitive situation for the residual demand in that location. Another example involves the interaction of generation controlled by a single supplier in different parts of the network; in certain situations, market power can be exercised by pricing a generator at one location below marginal cost in order to deliberately create congestion that raises prices for other generators at other locations.[5]

The focus of this competitive path analysis is the identification of transmission constraints that result in the first type of uncompetitive conditions: high concentration in the supply-deficit areas. This is arguably the most prevalent and well-known set of market power problems caused by transmission.

Pivotal supplier analysis is central to competitive path assessment. It is a common feature of the MISO and PJM methodologies, although those ISOs have different methods of determining the relevant supply and demand for pivotal supplier analysis. They both use generation shift factors, but their choice of the slack bus(es) for determination of generation shift factors is different. In general, and specifically in both cases of MISO and PJM, the choice of the slack bus(es) for determining the shift factors is rather arbitrary and has a potentially important impact on the outcome of the pivotal supplier analysis. The Feasibility Index methodology used here addresses the pivotal supplier analysis without the need to designate a slack bus(es) for the determination of the shift factors. In fact, the FI approach does not even use the shift factors. This is advantageous, because the choice of shift factors will always be somewhat arbitrary, and the location of the INC (DEC) that matches the assumed DEC (INC) of a resource in question will depend on system conditions and economics. An additional advantage of the proposed method is that the method is comprehensive in that it considers the interacting effect of all constraints at once.

[5] J. Cardell, C.C. Hitt, and W.W. Hogan, "Market Power and Strategic Interaction in Electricity Networks," *Resource and Energy Econ*., *19*(1-2), 1997, 109-137.

The methodology for CPA starts by selecting one or more representative system conditions, load levels (and load distribution), and supply resources that would normally be available (not on forced or maintenance outage) under the assumed seasonal conditions. For a given set of load, network, and supply conditions, the question is whether there are pivotal suppliers in the sense that without their combined supply participation congestion will exist and cannot be resolved on the path in question (and thus some load would potentially be unserved in some local area). If there are such pivotal suppliers, the path in question is non-competitive under the given set of conditions.

The general concept underlying the FI methodology is to take out all supply resources of one or more specific suppliers and determine if the remaining suppliers' resources can be scheduled to meet the load subject to the transmission constraints, i.e., if a feasible solution exists with the remaining supply. This is done simultaneously for the entire system's set of loads, resources, and transmission facilities. if a feasible solution does exist, the supplier(s) in question are not pivotal for congestion relief on any path under the set of supply/demand/system conditions. Otherwise the supplier(s) in question are pivotal for congestion relief on the paths that cause solution infeasibility.[6]

To identify those paths and quantify the relative degree of infeasibility each causes, we define a Feasibility Index for each transmission constraint with respect to each supplier. To define the FI index, we modify the production cost optimization, which is based on a FNM of the CAISO Control Area, by treating all non-grandfathered transmission constraints as soft constraints with very high penalties (orders of magnitude higher than the highest bid price or the prevailing bid cap) for violating the constraint. Thus, instead of getting no solution, we would get a "least cost" solution in which some transmission flows exceed the transmission (constraint) limit. As discussed earlier, the current inter-zonal branch groups are considered "competitive" and therefore are enforced as hard constraints in the optimization.

For a single supplier i whose resources are removed, we define the FI (i,j) of Path j with respect to Supplier i as follows:

Let

Limit (j) = Transmission Limit on Path j

Flow (i,j) = Power Flow on Path j without Supplier i's Resources (with soft limits)

Then

FI (i,j) = [Limit (j) - Flow (i,j)] / Limit (j)

[6] This is equivalent to the effective demand curve for the supplier's generation becoming vertical at some positive quantity at some location. Therefore, it is appropriate to view competitive path analysis as simply being a logical generalization of pivotal supply analysis to a market with transmission constraints. An important implication is that methods based on complex manipulations shift factors and which don't consider all interacting constraints (such as the MISO approach) may actually fail to identify all situations where a generator is pivotal due to transmission constraints. This can be shown on simple two node networks.

If FI (i,j) is negative, supplier i is pivotal for congestion relief on the system, in particular on Path j. If FI (i,j) is positive, supplier i is not pivotal for congestion relief on Path j (in combination with the other constraints), but if FI (i,j) is small, it is possible that the supplier j could be jointly pivotal with another supplier k having a small feasibility index FI (k,j) on the same path j. The pivotal supplier criteria that the CAISO adopted and filed with FERC is a "no three pivotal supplier" criteria (i.e., candidate paths that have a negative FI when up to three suppliers are removed from the market are considered "non-competitive").

The following generic matrix demonstrates the single pivotal supplier test results for n candidate paths. Table 1 shows a matrix of Feasibility Index results for n candidate paths (P1 – Pn across the top of the matrix) with various suppliers removed from the model (individually). In this case, the sign of FI (i,j) indicates whether supplier i is pivotal with respect to any of the candidate constraints.

Table 1. FI Matrix

Paths ⇨ Suppliers ⇩	P1	P2	…..	Pj	….	Pn
S1	FI(1,1)	FI(1,2)				FI(1,n)
S2	FI(2,1)	FI(2,2)				FI(2,n)
.						.
Si				FI(i,j)		FI(i,n).
.						.

If a FI (i,j) entry is negative for any Supplier i, Path j is non-competitive. If all FI(i,j) entries are positive for Path j, but some are small (below a designated threshold), then the test is repeated with the supply resources of both suppliers removed. The test will be repeated again with the supply resources of three suppliers removed if all FI(I,j)n entries are positive for path j if two suppliers' resources are removed.

For any candidate path that shows FI < 0 for a specific test case (supplier combination removed, load scenario, hydro scenario), that path is designated *Non-Competitive* for purposes of applying LMPM-RRD in MRTU. Such a designation means the path limit will not be enforced in the CCR and will be enforced in the subsequent ACR where identification of local market power is performed.[7] Any candidate path that has FI ≥ 0

[7] See prior section for description of CCR and ACR in the context of applying LMPM-RRD.

under all test conditions is designated *Competitive* for purposes of applying LMPM-RRD in MRTU and the thermal limit for that candidate path will be applied in both the CCR and ACR where LMPM-RRD is performed.

4 Implementation of the FI Methodology for MRTU

4.1 Simulation Methodology

The simulation follows the basic power flow concept and is being developed to most closely match the market design and optimization that will be used in MRTU. Simulations for this round of preliminary CPA results were performed in PLEXOS.[8] Specifically, the CPA simulation includes the following features:

- Unit commitment: An inter-temporal optimization is used that selects resources to be committed over the single day (24 hour) simulation period based on their start-up cost, minimum load cost, minimum run time, minimum down time, ramping up/down limits, and energy bids (cost-based in this simulation) compared to potential revenues available to that resource if committed across some or all of the hours in that day. The approach applied in this simulation is the Rounded Relaxation (RR) algorithm.[9] The primary reason for using this approximation (compared to mixed-integer algorithm) is its computational efficiency, which is important in light of the number of simulations that must be run to reflect the various supplier combinations withdrawn from the model and the various load and hydro scenarios.

- Co-optimization of Energy and Ancillary Services (A/S): The simulation co-optimizes energy procurement and A/S procurement. A/S prices in MRTU will reflect both the capacity price for the service as well as the opportunity cost for energy. Because the CAISO does not have a cost basis for A/S capacity bids, a capacity price of zero is used in the simulation and only the opportunity cost of selling A/S is reflected in the optimization.[10]

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[8] Additional information on PLEXOS is available at http://www.energyexemplar.com/main.asp?page=overview.

[9] The RR algorithm converts the unit commitment decisions into a two-pass optimization. In the first pass, the unit commitment on/off integer decision variables are relaxed and linear relaxation results are found. Then the unit commitment decision variables are fixed at the nearest round-up integer point without violating any integer constraints. In the second pass, the final optimization solution is obtained with the fixed unit commitment integer variables. The main reason to choose RR algorithm is due to performance issues. The RR is much faster compared to a full Mixed-Integer Program (MIP) algorithm because it uses two passes of linear programming rather than a full blown integer programming. The MIP algorithm may take up to twenty times longer to solve one case while the objective function improvements are usually negligible.

[10] While the use of $0 / MW capacity bids for A/S may not reflect actual bids observed in MRTU and consequently introduce a deviance from expected procurement resulting from the co-optimization of energy and A/S. However, we believe this will not impact the competitiveness test via the likelihood of observing a negative FI. The reason for this is that the FI test is a physical feasibility test where pass/fail is triggered by line overflow that is allowed through the use of a soft constraint on the candidate transmission paths and discourages through the use of an extremely high penalty price for violating the soft constraint. In cases where a soft constraint may be violated, unit commitment, energy procurement, and A/S procurement will be driven by cost avoidance (avoiding the extremely high penalty price) rather than the relatively trivial difference between one A/S capacity bid price and another. The simulation model will necessarily commit a new unit, procure additional energy from a unit, or procure A/S from any unit that can reasonably aid in penalty price avoidance.

- Transmission Constraints: The simulation models inter-zonal transmission interface (branch groups) limits as hard constraints, and all other transmission facility limits, such as individual transmission lines and candidate paths, as soft constraints (as described in the FI methodology section) with a penalty price of $50,000/MW/hr for constraint violation.

- Penalty for Dropped Load: A penalty price of $1,000,000/MW/hr is used for load curtailments. This (relatively) high penalty price, along with the $50,000/MW/hr transmission constraint penalty price, ensures that no reasonable economic substitution would take place between the options of dropping load, dispatching additional generation, and violating a transmission soft constraint. It allows the simulation model to find solutions with dropped load in cases when the amount of load at some nodes within a region or regions could not be met since too much generation capacity is removed from the region/regions and the importing capabilities from adjacent/nested control areas are restricted by branch group hard limits.

- Economic dispatch with Direct Current Optimal Power Flow (DC-OPF) that mimics the MRTU day-ahead (DA) market process. Note that the DC-OPF approach does not explicitly model losses or reactive power flows. Losses are implicitly accounted for in the model through the use of load values (in the simulations) that come from final metered load data, which are net of losses.

- Zonal Ancillary Service Procurement: A/S are procured with zonal requirements enforced, where an approach of “concentric” zones is used when requirements are overlapping. The simulation, however, does not explicitly account for A/S procurement from outside the CAISO control area due to limitations in the simulation software for reserving transmission on the inter-ties for the potential import of energy from A/S procured outside the control area. To account for A/S imports, an implicit approach was taken where a portion of the total (calculated) A/S requirement is assumed to come from imports based on historical procurement, so that (a) the total A/S requirement is adjusted down to account for historical A/S imports and (b) individual inter-tie interface (Branch Group) transmission capacities are reduced by the historical seasonal hourly average A/S procured from across those interfaces. The simulation model only procures the upward regulation services (i.e., no Regulation Down) since procurement of downward reserves would not impact the feasibility of the power flow model with any amount of capacity removed.

DMM had originally intended to include multiple contingency-based Security Constrained Unit Commitment (SCUC) and Dispatch in the optimization routine so that the resulting optimization more closely reflected market optimization under MRTU. While the MRTU software will have the capability to run a SCUC optimization, the CAISO intends to apply additional N-1 security constraints individually on an as-needed basis as dictated by grid conditions. Note that while not explicitly enforced through SCUC each interval, the CAISO will be using corridor limits that have been established by off-line security analysis to ensure that the pre-contingency limits are such that if a contingency occurs the CAISO is operating in a secure state. Given the situational application of N-1 security constraints in SCUC, DMM did not feel it would be appropriate to apply additional security constraints on a consistent basis in the CPA simulations while those constraints will be applied differently (possibly a subset of the full set of security constraints) and less frequently during actual market operation. DMM does not intend to apply SCUC optimization in the CPA.

4.2 Network Model

The network model used for the final competitive path assessment studies will be very similar to the proposed full network model (FNM) that will be used in the MRTU market design. For the CPA Results presented here, the network model used for the CPA is the same as the Congestion Revenue Rights Full Network Model (CRR FNM) that the CAISO released to market participants in late July, 2008 (named DB32 version 0) and later applied the patches released on August and September (DB32 version 1 and version 2). This model was developed with the intention to be as consistent as possible to the proposed FNM that will be used in the MRTU market design in terms of the transmission connectivity with adjacent and embedded control areas as well as the transmission outside of the CAISO control area that is part of the CAISO Controlled Grid. This CRR FNM is a bus-branch oriented network model which is derived directly from MRTU FNM software using the CRR FNM exporting interface developed by Siemens. The exported network model was then examined by the CRR team to ensure all elements in the model reflect typical conditions in our system (see the Business Practice Manual for Managing the Full Network Model[11] for additional information). This base PTI format bus-branch model was then imported into the PLEXOS simulation model for competitive path assessment effort.

Along with the CRR FNM, related data such as thermal branch limits, the load distribution factor, Pricing Node (PNode) and Aggregated Pricing Node (APNode) mapping, and transmission corridor and nomogram/interface constraint definitions were also imported into the simulation model. This data is consistent with the data the CAISO will use in the first annual CRR Allocation and Auction production processes (i.e., in the simultaneous feasibility test (SFT) processes). The thermal branch limits data is comprised of the summer and winter thermal limits (normal and emergency MVA limits) for a selected set of branches.[12] For the competitive path assessment study, we only enforced normal thermal branch limits for branches with both ends at 60kV or above and that reside completely within the CAISO control area. Minor changes were made to the limits of a handful of individual transmission lines within the CAISO control area on ad-hoc basis so that the base case power flow resembles the actual flow in the system. In these limited cases, the line ratings were relaxed from normal operating limits to their emergency limits to calibrate baseline flows for the Summer Medium Hydro Medium Load case.

[11] Please refer to http://www.caiso.com/1840/1840b27422f60.html for detailed information.

[12] Note that the thermal branch limits are scaled by a factor of 97% to account for losses and additional factor of 97% to account for reactive power since the CRR FNM is a lossless DC FNM. The effect is to reduce thermal limits by just under 6%.

The nomogram/interface constraints were enforced with the simultaneous flow limits that the CAISO currently anticipates enforcing in the MRTU markets. The same weighting factors for each line or transformer that make up the constraints in the CRR FNM are also incorporated in the CPA simulation model.[13]

It has been suggested that the transmission limits across the interties be adjusted downward in the simulation to reflect historical decline rates for import bids across the interties that effectively limit the amount of energy the CAISO can import (in real time) beyond the limits of the interties. The CAISO is currently pursuing changes to the market rules for the start of MRTU that will impose an additional charge on declined dispatches across the interties that is intended to deter SCs from declining import dispatches. An effective deterrent for declined import dispatches is a more direct means of addressing this modeling issue.

More specifically, all of the 4,838 transmission lines/transformers, 3,936 buses, 50 inter-zonal interfaces, and 88 local area transmission corridor/nomogram constraints from the CRR FNM are imported into the simulation model for this initial competitive path assessment study.

4.2.1 Integrated Balancing Authority Areas (IBAA)

A significant change of the 2008 FNM is the model of Integrated Balancing Authority Areas, in SMUD/WAPA/MID/TID areas. These areas are mostly embedded in CAISO control areas, with some intertie exchanges with Pacific Northwest. The physical lines of IBAA are modeled in the CRR FNM release, with a few fictitious buses representing current scheduling points. No flow limits will be enforced for transmission facilities in IBAA, and CAISO will only enforce the transmission limits on intertie exchanges.

There are multiple interties between IBAA and CAISO control grids. Under the latest IBAA modeling approach, intertie import and export schedules are modeled separately. IBAA imports into CAISO are modeled at a proxy bus at Captain Jack, and IBAA exports from CAISO are distributed into buses close to SMUD load[14].

4.2.2 Projected Transmission Upgrade

Since the Competitive Path Assessment is a forward-looking study, potential major transmission upgrades and corresponding operating procedure changes are incorporated. Mosslanding-Metcalf transmission upgrade project is a major transmission upgrade for 2009 operating year. The project consists of re-conducting two 230KV transmission lines, and as a result, the transmission limit of individual lines will be increased. Currently the re-conducting work of one 230KV is finished, and the transmission limit is increased from 324MVA to 694MVA. The second 230KV line is still in the re-conducting process, which is scheduled to be finished before 2009.

[13] The CPA, CRR, and MRTU applications will be using the same FNM, albeit versioned depending on the FNM available at the time the application requires it. The FNM is available to market participants and their agents through the CRR Dry Run process and requires signature of a Non Disclosure Agreement. Please refer to the CAISO web site for more details on obtaining the CRR FNM.

[14] http://www.caiso.com/1f50/1f50ae5b32340.html#1f638d994b250

In addition to the individual line limit increase, the project may also affect the aggregated constraint of Mosslanding-Metcalf nomogram, because these two 230KV lines are also the components of the nomogram. DMM seeks help from CAISO Transmission & Operating engineers for evaluation of potential impact on nomogram, and decides to put unlimited transmission capacity to the Mosslanding-Metcalf nomogram, since transmission engineers believe most likely the nomogram will be removed in the next round review of operating procedures.

So for the ongoing Mosslanding-Metcalf transmission upgrade project, DMM adjusts the FNM in two steps:

1. Increase both 230KV transmission lines limits from 324MVA to 694MVA, and adjust line impedances and reactances accordingly

2. Increase the Mosslanding-Metcalf nomogram limits to unlimited capacity

4.3 Grandfathered Competitive Paths

According to the competitive path methodology filing, all CAISO's current inter-zonal interfaces (i.e., branch groups) are considered grandfathered competitive paths and will be applied as hard constraints (i.e., constraints that can not be relaxed by using a soft-constraint with a penalty price) in the simulation. Table 16 (later in this document) shows the current inter-zonal branch groups and the Operating Transfer Capability (OTC) limits on both import and export directions that are incorporated in the current competitive path study network model (figures shown are for the spring base case simulation). These grandfathered paths are selected from the predefined CRR FNM interface/nomograms, most of which correspond to the current Branch Group definition found here.[15]

4.4 Additional Transmission Limits

In addition to the transmission interfaces discussed above, additional transmission constraints, which are also adopted from the CRR FNM, are included in this model and modeled as soft constraints for the competitive path assessment. Some transmission constraints define import/export limits to areas within existing congestion zones, such as the San Francisco, Fresno, and North Bay areas, while others limit network flows but do not surround geographic areas, such as Miguel substation in San Diego, Vincent substation, and simultaneous flow limits within the Bay Area. In addition to all individual line/transformer limits at 60 kV and higher voltages and interfaces, the transmission constraints used in this study include the transmission constraints listed below.

Regional Import Limits

- Southern California Import Transmission (SCIT).

[15] http://www.caiso.com/1c10/1c10d95330250.xls

Southern California Edison Area

SCE Transmission Constraints	SCE Transmission Constraints
ANTLPE_VINCENT_NG	SOUTHLUGO_BG
BARRE_LEWIS_NG	SSONGS_BG
BARRE_VLPRK_NG	STHMAGUNDEN_BG
CAMINO_IRN_MTN_TOR	SYLMAR-AC_MSL
INYO_BG	VICTVL_MSL
MAGUNDEN_VESTAL2_BG	VICTVLUGO_EDLG_NG
MIRALOMA12_XFBG	VICTVLUGO_HANG_NG
MIRALOMA34_XFBG	VICTVLUGO_LGMH_NG
NSONGS_BG	VICTVLUGO_LGVNDLO_NG
SERRANO_ORANGECTY_BG	VICTVLUGO_PVDV_NG
SERRANO_XFBG	VINCNT_XFBG

San Diego Gas and Electric Area

SDGE Transmission Constraints
IVALLYBANK_XFBG
MIGUEL_IMP_BG
MIGUEL_MAXIMP_LXNF_NG
SDGE_CFEIMP_BG
SDGEIMP_BG

Pacific Gas and Electric Area

PGAE Transmission Constraints	PGAE Transmission Constraints
BOGUEIMP_BG	PITSBRG_SANMAT_NG_SUM
COLGATE_NG_SUM	PITSBRG_SANMAT_NG_WIN
COLGATE_NG_WIN	PITSBRG_XFMR_BG
DRUMRIOSO_1_NG_SUM	PLACER_GOLDHIL12_BG
DRUMRIOSO_1_NG_WIN	PLACER_GOLDHIL2_BG
DRUMRIOSO_2_NG_SUM	PNOCHE_DAIRYLND_NG
DRUMRIOSO_2_NG_WIN	RAVENSWD_NG_SUM
GATES_PNOCHE_NG_SUM	RAVENSWD_NG_WIN
GATES_PNOCHE_NG_WIN	RAVENSWDSANMAT_NG_SUM
GATESHELM-MCCALL_NG	RAVENSWDSANMAT_NG_WIN
HUMBOLDT_BG	RIOSO_XFBG
HUMBOLDT_XFBG	SCHULT_KASN_TESLA_NG
LLAGAS_GILROY_BG	SCHULTE_KASSON_BG
MARTIN_C_POTRPP_NG	SOBRANTE_GRIZLY_NG
MCCALL23_XFNG	TABLEMT_RIOSO_NG
METCALF_MORGANHL_BG	TABLMT_RIOSPALERM_NG_SUM
MONTAVISTA_JEFSN_BG	TABLMT_RIOSPALERM_NG_WIN
MOSSLNDMETCALF_NG_SUM_OFFPK	TABLMT_RIOVACADX_NG_SUM
MOSSLNDMETCALF_NG_SUM_ONPK	TABLMT_RIOVACADX_NG_WIN
MOSSLNDMETCALF_NG_WIN	TESLA_DELTASWYRD_BG
N_GEYSEREXP_NG_SUM	TESLA_PITSBURG_BG
N_GEYSEREXP_NG_WIN	TESLA46_XFNG
OAKLAND_NG	TESLA64_XFNG
PALERMO_BG	TESLAMANTECA_NG
PALERMO_COLGT_NG	VACADX_TESLA_XFNG

4.5 Assumptions about System Conditions

4.5.1 Demand Forecast

The purpose of the studies is to assess the competitiveness of the candidate paths using a wide range of system supply and demand conditions. For this purpose, we construct three demand forecast scenarios as follows. First, actual historical load for PG&E, SCE, and SDG&E transmission areas have been obtained from telemetry data. From this data, a seasonal CAISO system-wide daily peak load duration curve is created to represent the peak load condition in that season. Then four seasons/years pairs are selected based on seasonal peak load. Three load scenarios are chosen for each season by selecting individual days within a season that corresponds to specific points on the daily peak hour load duration curve for that season. Currently, the high, medium, and low load scenarios are chosen based on the 95th percentile, 80th percentile, and 65th percentile respectively for the daily peak hour load duration curve for each season.

The table below shows the historical peak load for the four seasons since 2002. Based on the daily peak load, the season/year is selected as the representing season in the studies. Then three days are picked up for high load, medium load, and low load scenarios.

Table 2. Historical Seasonal Peak Load

YEAR	SEASON	DAILY_PEAK_LOAD
2007	Fall	34,067
2006	Fall	34,218
2004	Fall	34,320
2002	Fall	35,168
2005	Fall	35,184
2003	**Fall**	**36,480**
2005	Spring	38,694
2003	Spring	40,117
2004	Spring	40,476
2007	Spring	40,839
2002	Spring	41,023
2006	Spring	43,719
2008	**Spring**	**46,789**
2002	Summer	42,352
2003	Summer	42,581
2008	Summer	44,660
2005	Summer	45,380
2004	Summer	45,562
2007	Summer	48,535
2006	**Summer**	**50,198**
2003	Winter	31,151
2006	Winter	31,791
2004	Winter	32,554
2005	Winter	32,611
2008	Winter	33,155
2002	Winter	33,182
2007	**Winter**	**34,008**

For example, the summer season has 92 daily peak values, one for each day during July, August, and September. A cumulative distribution is calculated for these daily peak load values during the summer, and the low, medium, and high load scenarios for summer are identified by the three individual days where 95%, 80%, and 65% of daily peak load values are below the load value for those days. These three days are identified as July 26, July 15, and August 24 in year 2006, respectively. The following table summarizes the days identified for various load scenarios in each season.

Table 3. Selection of Typical Day for Seasonal Load Scenario

Load Scenario	Spring	Summer	Fall	Winter
High	5/15/2008	7/26/2006	10/27/2003	1/11/2007
Medium	6/12/2008	7/15/2006	12/18/2003	1/3/2007
Low	4/29/2008	8/24/2006	12/23/2003	1/13/2007

The following table shows the assumed CAISO system daily peak load for various load scenarios in each season for this initial study.

Table 4. System Daily Peak Load for Three Load Scenarios by Season (MW)

Load Scenario	Spring	Summer	Fall	Winter
High	41,545	47,604	33,784	32,831
Medium	36,069	42,637	32,398	31,939
Low	31,832	40,611	31,501	31,356

Since the loads calculated from telemetry data are actually the sum of loads plus losses, for simulation purposes the estimated losses of 5% have been subtracted to produce local area loads net of losses at the take-out points to accommodate use of lossless DC-OPF simulation approach. Fixed load distribution factors from the CRR FNM are incorporated in the CPA simulation model.

4.5.2 A/S Modeling and A/S Requirements

Co-optimizing A/S and energy in the day-ahead market (DAM) is an important feature of the CAISO's new market design. In the MRTU DAM, suppliers can provide both energy bids and A/S bids, and the DAM will procure 100% of the requirements. A/S requirements are closely related to load forecasts. In this initial competitive path assessment study, a simplified A/S and energy co-optimization process is adopted. First of all, unlike the 10 A/S regions that may be considered in the initial release of the MRTU DAM,[16] we simply consider two A/S regions: System, and South of Path 26 (SP26), because these two are the most important A/S regions based on the ISO historical operation experiences. The minimum requirements for each of these two A/S regions are calculated using the following rules.

System A/S Region:

- Regulation Up (RU) Minimum Requirement: 400 MW.
- Operating Reserve (OR) Minimum Requirement: 7% of system load minus historical DA final OR imports to CAISO.

[16] The 10 A/S regions implemented initially for MRTU Release 1 are: Expanded System, System, South of Path 15, Expanded South of Path 15, South of Path 26, Expanded South of Path 26, North of Path 15, Expanded North of Path 15, North of Path 26, Expanded North of Path 26.

SP 26 A/S Region:

- Operating Reserve (OR) Minimum Requirement: 40% of (7% of system load) minus historical DA final OR imports to SP26.

The simplified A/S zonal model used in the CPA simulations is a deviation from both the 10 zone model that can be accommodated by MRTU and the system wide procurement model that may be used during the first year of MRTU until additional experience with A/S procurement under MRTU evolves. It is important to note that the 10 zone model involves concentric zone definitions with NP26 and SP26 remaining the primary procurement zones. The CAISO recognizes that the simplified model of A/S procurement zones will affects the simulation results, however we believe that the small amount of historical A/S procurement across the interties coupled with the primary procurement zones of NP26 and SP26 represented in the simulation model will minimize any distortionary impacts of the simplified A/S procurement model used in the CPA simulation. Furthermore, the software currently used to perform the CPA simulations is limited in its ability to mimic A/S procurement across the interties as modeled in MRTU. Once this capability is further developed, the CAISO will model A/S procurement across the interties as well as consider more granular A/S procurement zones should it become clear that the CAISO is taking that direction.

Spinning Reserve and Non-spinning Reserve are combined into a single product, Operating Reserve, for the CPA simulations. Any resource certified to provide Spinning Reserve or Non-spinning Reserve is certified to provide OR in the simulation model. With this approach, we do not distinguish between units that are running and those that are not when procuring OR. However, in cases where suppliers have their portfolios removed from the model, most if not all remaining internal resources are up and running. Combining Spinning and Non-spinning reserves is done to simplify the simulation model and improve computational efficiency. This simplification may result in lower unit commitment as some resources certified only for Non-spinning reserve may be used to provide Spinning reserve. This effect is dependent on the amount of certified Non-spinning capacity that can be substituted for Spinning reserve requirement, which is currently only about 325 MW system wide. For perspective, the combined OR requirement can be as much as 3,100 MW on a peak summer day (see Table 5 below). The procurement rules for Ancillary Services do allow substitution of Regulation Up Service for OR Service. So, for example, the model allows additional Regulation Up capacity to be procured to satisfy the OR requirement if that solution was least-cost. This type of substitution is called Cascading in MRTU.[17]

Note again that A/S requirements are correlated with load forecast scenarios in this study. For example, the summer high load scenario day is identified to be July 26, 2006. Thus the hourly system OR requirement corresponding to the high load scenario is calculated as 7% of the hourly system load (from July 26, 2006, load data) less the hourly DA final OR imported to the CAISO control area on that day.

[17] Please refer to Market Operation Business Practice Manual for detail information. BPM can be found at: http://www.caiso.com/17e9/17e9d7742f400.html .

The following table shows assumptions for System and SP26 regional minimum operating reserve requirements in various seasons under various load scenarios at the daily peak hour.

Table 5. Minimum Operating Reserve Requirement at Daily Peak Hour (MW)

Load Scenario	Region	Spring	Summer	Fall	Winter
High	System	2,614	3,332	2,365	2,213
	SP 26	948	1,333	945	919
Medium	System	2,353	2,735	2,289	2,235
	SP 26	956	1,092	916	894
Low	System	2,157	2,768	2,205	2,130
	SP 26	884	1,137	882	877

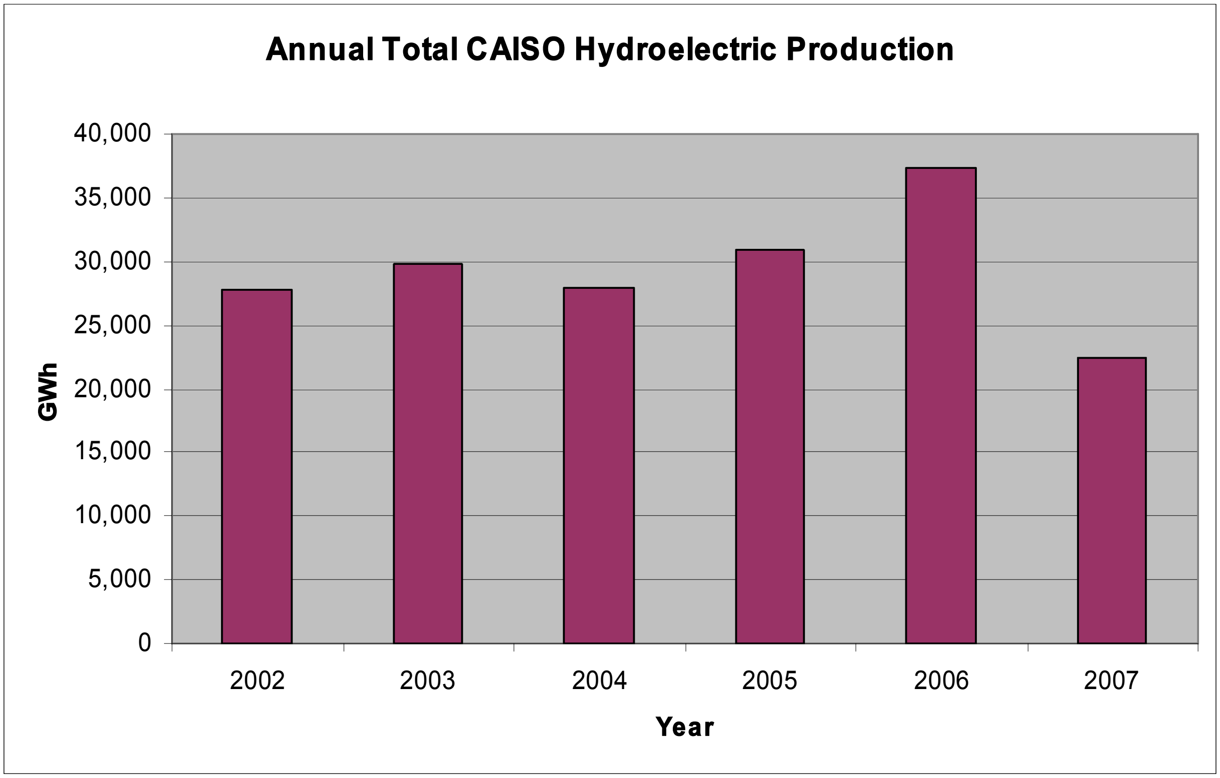
Generation units that are certified for providing RU and OR are identified using the CAISO internal database, and their maximum capabilities for providing RU and OR are calculated using their historical bid quantities. Bid prices are assumed to be zero as a simplification to the MRTU DAM so that there will be no capacity pricing for the service and only the opportunity cost (of not selling A/S capacity as energy) of providing reserve is calculated during the optimization process.[18] In other words, the market would at least have to compensate the generation unit providing A/S for the profit forgone in the energy market.

4.5.3 Prediction of Hydroelectric Generation

Three hydro scenarios (wet, medium, and dry) will be simulated based on California's historical hydroelectric production data for the purpose of preparing DAM bids for hydro units. The chart below shows the hydroelectric production level of hydroelectric resources within the CAISO control area from 2002 through 2007.

[18] Non-zero A/S bid prices essentially reflect the desired additional compensation to cover, for example, the cost of operating generation unit at lower efficiency to provide reserve, i.e., a premium on top of opportunity cost for providing A/S.

Figure 1. Annual Total CAISO Hydroelectric Production



From Figure 1 we see that 2007 is a low hydroelectric production year, 2005 is a medium production year, and 2006 is a high production year.

After the low, medium and high hydro years are identified, a hydro daily production duration curve was constructed for each season and each year. The 95th percentile date was then determined in each season as the hydro scenario date for the actual 24-hour simulation. Table 6 summarizes the days identified for various load scenarios in each season.

Table 6. Selection of Typical Day for Seasonal Hydro Scenario

Hydro Scenario	Winter	Spring	Summer	Fall
High	3/23/2006	5/19/2006	7/3/2006	11/30/2006
Medium	3/30/2005	5/25/2005	7/7/2005	12/26/2005
Low	1/5/2007	5/22/2007	7/24/2007	11/8/2007

The identification of hydro scenarios is again solely for the purpose of preparing hydro generation bids, pump storage facility bids and inter-tie import/export bids. Simulating hydro generation units' optimal bids with regard to hydro resources' energy limits and other constraints is beyond the scope of this study. In the section below we will discuss how we construct bids for hydro generation units that reasonably reflect hydrology conditions as well as the opportunity cost of hydro production.

CAISO control area import and export patterns are highly affected by the hydrology conditions not only within California, but in the Pacific Northwest as well. Hydrology conditions can be consistent across the West Coast, and in the CAISO control area inter-tie bids are generally correlated with hydro scenarios. In the next section we will also discuss how we construct inter-tie import and export bids that are consistent with the hydro condition in the West Coast.

4.5.4 Internal Supply

Supply can be broken out into the following categories: gas fired non-peaking generation, peakers, nuclear, hydroelectric/pump storage units, and qualifying facilities (i.e. wind, solar, geothermal, biomass, and cogeneration).[19]

4.5.5 Gas Fired Non-peaking Generation

The model contains 115 thermal units with installed capacity of roughly 26,000 MW, including new generation that has come online over the past few years. In the CPA simulations, all gas fired non-peaking units bid their marginal cost (plus an adder for variable operating and maintenance cost) as determined by the unit's heat rate and natural gas prices. The incremental heat rates are calculated from latest average heat rate data stored in the CAISO master file database. The "Option 2 cap with average heat rate" method is adopted in incremental heat rate calculation.[20] Other unit characteristics that are included in the economic dispatch process are minimum stable level, start-up cost, minimum up and down time, and maximum ramp up and ramp down rates. Gas fired non-peaking generation units are fully optimized in terms of a 24-hour unit commitment and hourly economic dispatch.

The minimum stable level, heat rate, start-up cost, minimum up/down time, and ramping rates for these units are all obtained from the CAISO internal database and the gas price forecast is obtained from historical data and will be discussed in a later section.

4.5.6 Peakers

There are 63 peaking generation units included in the model with total installed capacity roughly 3,000 MW. Similar to thermal units, all peakers are assumed to bid their marginal cost for energy, start-up cost for unit commitment, and the following physical operation parameters as reported to the CAISO: minimum up/down time, and maximum ramp up/down rate. Peakers are also fully optimized in terms of a 24-hour unit commitment and hourly economic dispatch.

4.5.7 Nuclear

There are four nuclear generating units (two San Onofre units and two Diablo Canyon units) included in the model with installed capacity of 4,450 MW. Bid quantities for nuclear resources are based on actual metered output for selected load scenario dates described in Table 4. The bid price for nuclear resources is $0/MWh. Unit commitments

[19] RMR and RA resources are treated the same as other resources for purposes of this analysis.
[20] More information about this method can be found at http://www.caiso.com/1ba0/1ba0885c5fea0.pdf

for nuclear resources are predefined according to their actual metered output and are not determined by the simulation software.

4.5.8 Hydroelectric Generation and Pump Storage Units

There are 197 hydroelectric resources included in the model.

Hydroelectric resources are committed and dispatched by the simulation software in the CPA. Bids are determined by two factors for these resources. First, the resource's final hour-ahead schedule for the chosen hydro scenario date in Table 6 is used to create the first bid segment at a price of $0/MWh. Second, the resource's real-time offer quantity is used for the second step of the bid curve, with the bid price for this second step calculated as the quantity-weighted average bid price from bids for that resource on the selected hydro scenario date. The two segments are combined together to form the final bidding quantity and price for hydro units. If a hydro unit has neither hour-ahead schedule nor real-time bids in the historical data for the identified hydro scenario year, no capacity is offered by that resource in the simulation.

Five pump storage units are considered in the model.

The generation of each of the pump storage units is already included in the hydro units' offer quantity/offer prices, as described above. The load side of the pump storage units is modeled as an energy purchaser in the simulation software, or, in effect, as load resources that buy energy from the pool. Each pump storage unit has a 2-step demand curve. For the first step of the demand curve, bid quantity is calculated as the final historical hour-ahead load schedule with a $5,000/MWh bid price which makes this bid segment a price-taking load bid segment. The second step of the pump-load bid curve has total real-time historical bid quantity for the quantity portion and the quantity-weighted average bid price for the price component. Similar to hydro units, if a pump storage unit does not have historical data for the identified hydro scenario years, that resource will not be bid into the simulation model.

4.5.9 Qualifying Facilities

Qualifying Facilities (QF) include wind, solar, geothermal, biomass, and co-generation units. Basically all the remaining internal units fall into this category. All QF units are assumed to bid in their actual 2006 (metered) generation level with zero price (i.e., self schedule). The same load scenario dates are used to construct their self-schedules.

4.5.10 Imports and Exports

Imports are not considered pivotal in this analysis: that is, no import resources are removed in any of the CPA simulation runs. External resources are modeled using their historical inter-tie bids at various scheduling tie-points. A tie-point connects a node inside the CAISO to a node outside of the CAISO. Each tie-point's outside node is considered to be both a generation node (for the purpose of modeling imports to the CAISO) and a load node (for the purpose of modeling exports from the CAISO). The imports are modeled as generators and the exports as purchasers (demand bids) in PLEXOS models.

Since hydro conditions and imports/exports are highly correlated, inter-tie bids are constructed using actual data from the specific hydro scenario dates. A multi-step bid curve is established for imports and exports across each tie-point separately using the approach described for hydroelectric resources (imports) and pump load (exports). Since more than one Scheduling Coordinator can submit their bids on each tie-point, all the historic hour-ahead schedules and real-time bids are grouped on the tie-point level and uniformly divided into a standard 11-segment format according to the aggregated price curve. Note that the $5,000/MWh price is to ensure self-scheduled export will be dispatched in the simulation.

Most of the tie-points in the CRR FNM also exist in the current RTMA system. Only a few tie-points have had name changes with the new CRR FNM release. In these cases, adjustments were made to the historical import bids to match the historical footprint to the new FNM footprint. For new tie-points which are not in the current system, no bids/offers are modeled. Note that despite having to make adjustments in schedule/bid origin or destination, the total quantity available across an interface or logical grouping of interfaces within a region remains the same as found in the historical data so that no import capability is lost in these adjustments.

4.5.11 Dynamic Schedules

Dynamic schedules are modeled in the same fashion as hydroelectric resources. There are a total of 12 dynamic units modeled in the system.

Table 7. Dynamic Scheduling Units

Dynamic Resource Name
APEX_2_MIRDYN
BCTSYS_5_PWXDYN
BLYTHW_1_APSDYN
DWPHOV_2_HOOVER
FCORNR_5_SCEDYN
HOOVER_2_VERDYN
MALIN_5_BPADYN
MRCHNT_2_MELDYN
MSQUIT_5_SERDYN
NGILAA_5_SDGDYN
PVERDE_5_SCEDYN
SCEHOV_2_HOOVER

4.5.12 Projected New Generators

New gas fired generators scheduled to be in operation 2009 are added in to the current analysis. The total capacity of such new generators is over 1600MW. The zones, generator names, capacities, and effective day in the model are listed below.

Table 8. Projected Gas Fired Generators

Zone	Generator	Capacity (MW)	Modeled Effective Day
NP26	GATWAY_2_PL1X3	530	Jul-09
NP26	Panoche	401	Oct-09
NP26	Starwood	119	Oct-09
SP26	OtayMesa	561	Oct-09

4.6 Generation Ownership and Pivotal Supply Permutations

In the previous CPA studies, the threshold capacity to identify large generation ownership was set to be 1000MW. In the current study, the threshold is lowered to 500MW, so that the impact from more suppliers can be tested. As a result of the lowered generation capacity threshold, 9 largest generation owners are identified instead of 5 in the previous studies.

Those generation capacities with tolling agreement are excluded from the owners' portfolio. A new round of tolling agreement survey has been done in June/July of 2008 for large generation companies and load serving entities, for the survey period between October 2008 to December 2009.

This study focuses specifically on the impact of withdrawn capacity by these 9 largest owners in the CAISO control area who are net sellers and have an installed generator capacity over 500 MW with the consideration of tolling agreement adjustments. Note that the CPA considers only net sellers in the selection of potentially pivotal supplers since net buyers are less likely to benefit from increasing prices through withholding supply.

In order to accurately represent supplier's portfolios in CPA study, the CAISO adjusted the installed capacity portfolios of existing suppliers to account for transfers of operational and bidding control via tolling contracts. The CAISO surveyed suppliers having an installed capacity portfolio greater than 500 MW (the potentially pivotal suppliers considered in the last analysis) to collect data regarding tolling contracts that were in effect during the 2008/2009 MRTU period and subsequently requested the same information from the named counterparties in a follow-up survey for verification. The CAISO verified these contractual arrangements itemized by both parties. A validated contractual arrangement was the one where both counterparties have independently itemized the same arrangement on their surveys.

There were 9 companies with an adjusted installed capacity over 500 MW. The adjusted capacity portfolios are listed in Table 9.

Table 9. Suppliers Considered and Their Generation Capacity Concentration, Adjusted for Tolling Agreements, by Zone

Supplier	NP26 Capacity	SP26 Capacity	Total Capacity	Percent of NP26 Zonal Capacity	Percent of SP26 Zonal Capacity
S1	4,344	751	5,094	14%	3%
S2	0	2,582	2,582	-	9%
S3	690	1,870	2,560	2%	6%
S4	1,208	0	1,208	4%	-
S5	0	1,120	1,120	-	4%
S6	1,036	0	1,036	3%	-
S7	0	781	781	-	3%
S8	0	727	727	-	2%
S9	552	0	552	2%	-

The eleven largest net suppliers were surveyed regarding tolling agreements in effect during the 2008/2009 MRTU period, and the CAISO received survey responses from six of those seven suppliers. A total of 34 tolling contracts, representing 8,372 MW of installed capacity, were itemized by suppliers in their survey responses and verified by itemized contracts from the named counterparties.

The 3-pivotal supply test is a time-consuming process since it tests market outcome under multiple combinations of supplier withdrawal. The number of potential permutations increases exponentially as the number of the pivotal supplier increase. In the previous CPA studies, there are 26 ($C^1_5 + C^2_5 + C^3_5 + 1 = 26$) supplier permutations (per load/hydro/season scenarios) with 5 pivotal suppliers; however, as total number of pivotal suppliers increase from 5 to 9, the total permutation number would be 5 times of the previous one if the brute force combination is still used ($C^1_9 + C^2_9 + C^3_9 + 1 = 130$), which may lead to required simulation time alone to over 2 weeks.

To reduce the simulation time, the current study is based on permutations separately on NP26 and SP26 zonal basis, instead of system-wide permutation. Out of 9 pivotal suppliers, there are 5 suppliers having generation in NP26 zone and 6 suppliers having generation in SP26 zone. Therefore under zonal basis, there are 26 supplier permutations for NP26 zone and 52 supplier permutations for SP26 zone, and the total supplier permutation is only 63 (some supplier combination exists in both NP26 and SP26 zonal permutation). The zonal supplier permutation significantly reduces the simulation time (actual simulation time still be over one week), and since locational market power concerns are typically in relatively small concentrated area, permutation study based on larger zonal analysis is a good balance between acceptable simulation time and large number of pivotal suppliers combinations.

The top suppliers in terms of adjusted installed capacity in the NP26 area are S1, S3, S4, S6, and S9. The top suppliers in the SP26 area are S1, S2, S3, S5, S7, and S8. For the CPA study, the FI values are calculated for candidate paths for all combinations of up to three of these suppliers, where the capacity of the supplier combinations is removed from the simulation model either individually or jointly. The total number of supplier combinations (for capacity withheld) for any one season, load scenario, and hydro production scenario is 64, which includes the base case with no suppliers withdrawn.

For each season, there are three load scenarios and three hydro scenarios. The total number of simulation runs for each season is 576 (64 supplier combinations * 3 load scenarios * 3 hydro production scenarios = 576).

For this release of CPA results, all four seasons are evaluated. The total number of simulation runs is 2304 (4 seasons * 576 simulation runs per season = 2304).

4.7 Natural Gas Prices

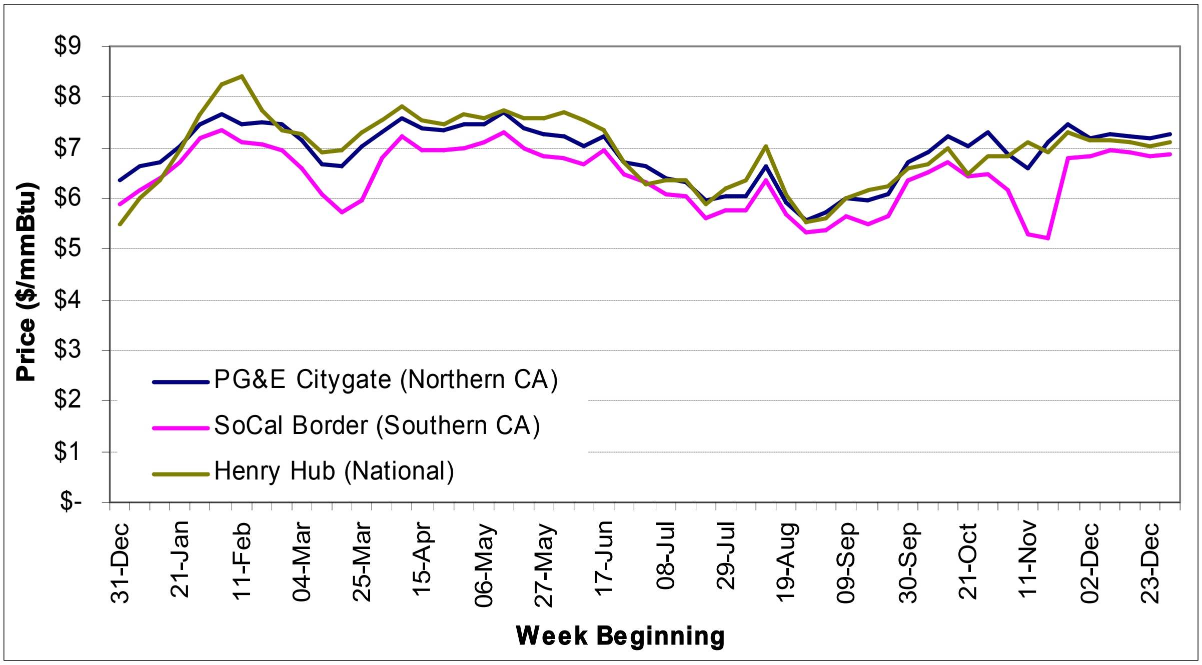
Natural gas prices are required to calculate the cost-based bids for thermal resources which have heat rate data in the CAISO master file database. The values used in the simulations for this CPA are seasonal average natural gas prices for the northern and southern regions of the CAISO control area from January 2007 to December 2007.

Table 10. Seasonal Natural Gas Prices by PTO Region

Season	PG&E	SCE	SDG&E
Winter	$7.07	$6.55	$6.55
Spring	$7.31	$6.92	$6.92
Summer	$6.10	$5.77	$5.77
Fall	$7.09	$6.44	$6.44

The following chart shows the actual nominal natural gas price in the CAISO control area for the year 2007.

Figure 2. Weekly Average Natural Gas Prices for 2007



4.8 Generation and Transmission Outages

For this preliminary study, we assume all thermal and peaking units are available for energy and A/S commitment and dispatch between Pmin and Pmax, subject to minimum up/down time and ramp rates as well as the certified A/S capacity. In other words, planned and forced generation outages are not modeled for thermal and peaking units. The availability of all hydro units and QF units are determined either by their historic hour-ahead schedule level plus real-time bid level, or determined by the historic production level, thus they may incorporate a historical pattern of planned and forced outages to some degree.

Incorporation of transmission outages has been limited in this preliminary study and the status of transmission lines/transformers are kept consistent in this study with the CRR FNM.

4.9 Identification of Candidate Competitive Paths

In evaluating whether or not paths are competitive, we focus on the subset of all transmission paths for which this designation is most likely to impact market outcomes. The criteria for identifying candidate competitive paths, i.e., those that will be tested in this assessment, focuses on the frequency of real-time operational mitigation that has occurred in the most recent 12 months of operation. For the set of path designations that will be made prior to implementation of MRTU, the metrics for real-time operational mitigation are real-time Reliability Must Run (RMR) dispatches and real-time out-of-sequence (OOS) dispatches.

For real-time operational mitigation using RMR resources, data was collected reflecting resources that received real-time RMR dispatch instructions over the period August 1, 2007, through July, 2008. For any hour where an RMR dispatch was made to a specific resource, that hour was counted toward all lines that are mitigated using that RMR resource as identified in the CAISO Operating Procedures. The line/resource relationships identified in the CAISO Operating Procedures were used to create the specific mapping to credit each hour of real-time RMR dispatch of a specific resource to an hour of operational mitigation for a specific line or path. The general regions that are frequently mitigated using RMR resources are: San Francisco & Greater Bay Area, North Geysers, Palermo – Rio Oso, and San Diego Area.

For out-of-sequence dispatches, operator log entries were used to identify the reason for each individual OOS dispatch, and in cases where the reason did not include a specific line or lines, transmission operating procedures were used to map the resource to a specific set of transmission facilities. As with the real-time RMR dispatches, any hour where a resource was dispatched out-of-sequence in real time was credited toward an hour of operational mitigation for all lines for which that resource was identified as providing operational mitigation unless a specific subset of those lines was identified in the operator log for that particular OOS dispatch.

The mitigation information resulting from this mapping of resource-specific real-time RMR and OOS dispatch to transmission lines was combined to calculate the number of hours each identified transmission facility was mitigated during the twelve months.

The following intra-zonal interfaces and individual transmission lines that are not part of any predefined interface/constraints had greater than 500 hours of real-time mitigation and consequently have been identified as candidate competitive paths.

Table 11. Candidate Competitive Paths that are Predefined Constraints

Operating Procedure	Zone	Constraint	Maximum Mitigation Hours
T-138	NP26	HUMBOLDT_BG	5086
T-138	NP26	HUMBOLDT_XFBG	5086
T-126	NP26	MARTIN_C_POTRPP_NG	921
T-133	NP26	MOSSLNDMETCALF_NG_SUM_OFFPK	586
T-133	NP26	MOSSLNDMETCALF_NG_SUM_ONPK	586
T-133	NP26	MOSSLNDMETCALF_NG_WIN	586
T-133	NP26	PITSBRG_SANMAT_NG_SUM	586
T-133	NP26	PITSBRG_SANMAT_NG_WIN	586
T-133	NP26	RAVENSWD_NG_SUM	586
T-133	NP26	RAVENSWD_NG_WIN	586
T-126	NP26	RAVENSWDSANMAT_NG_SUM	921
T-126	NP26	RAVENSWDSANMAT_NG_WIN	921
T-133	NP26	TESLA46_XFNG	586
T-133	NP26	TESLA64_XFNG	586
T-133	NP26	MONTAVISTA_JEFSN_BG	586
T-133	NP26	PITSBRG_XFMR_BG	586
T-133	NP26	TESLA_DELTASWYRD_BG	586
T-133	NP26	TESLA_PITSBURG_BG	586
T-133	NP26	VACADX_TESLA_XFNG	586
T-132	SP26	MIGUEL_IMP_BG	2073
T-132	SP26	MIGUEL_MAXIMP_LXNF_NG	2073
T-132	SP26	SDGE_CFEIMP_BG	2073
T-132	SP26	SDGEIMP_BG	2073
T-132	SP26	SSONGS_BG	2073
T-132	SP26	VICTVLUGO_HANG_NG	2073
T-132	SP26	IVALLYBANK_XFBG	2073
T-159	SP26	VINCNT_XFBG	690

Table 12. Candidate Competitive Paths that are Members of Predefined Constraints in NP26

Operating Procedures	Zone	Constraint	Line Name	Maximum Mitigation Hours
T-138	NP26	HUMBOLDT_BG	31015_BRDGVL 1_115.00_31010_LOWGAP 1_115.00_1_CKT	5086
T-138	NP26		31000_HUMBSB 1_115.00_31452_TRINTY 1_115.00_1_CKT	5086
T-138	NP26	HUMBOLDT_XFBG	31080_HUMBSB 4_60.00_31000_HUMBSB 1_115.00_1_CKT	5086
T-138	NP26		31000_HUMBSB 1_115.00_31001_HUMBSB 3_1.00_1_CKT	5086
T-126	NP26	MARTIN_C_POTRPP_NG	33207_BAYSHR 2_115.00_33208_MARTIN 1_115.00_1_CKT	921
T-126	NP26		28_LARKIN 2_115.00_33208_MARTIN 1_115.00_1_CKT	921
T-126	NP26		33205_HUNTER 1_115.00_33208_MARTIN 1_115.00_2_CKT	921
T-126	NP26		33206_BAYSHR 1_115.00_33208_MARTIN 1_115.00_1_CKT	921
T-126	NP26		33205_HUNTER 1_115.00_33208_MARTIN 1_115.00_1_CKT	921
T-126	NP26	MONTAVISTA_JEFSN_BG	30705_MNTVIS 2_230.00_30710_SLAC 2_230.00_1_CKT	586
T-126	NP26		30705_MNTVIS 2_230.00_30712_SLAC 3_230.00_1_CKT	586
T-126	NP26	RAVENSWDSANMAT_NG_SUM	30703_RAVENS 2_230.00_30700_SANMAT 8_230.00_2_CKT	921
T-126	NP26	RAVENSWDSANMAT_NG_WIN	30703_RAVENS 2_230.00_30700_SANMAT 8_230.00_1_CKT	921
T-126	NP26		33315_RAVENS 1_115.00_33310_SANMAT 1_115.00_1_CKT	921
T-133	NP26	MOSSLNDMETCALF_NG_SUM_OFFPK	30042_METCLF 5_500.00_30045_MOSSLD13_500.00_1_CKT	586
T-133	NP26	MOSSLNDMETCALF_NG_SUM_ONPK	30735_METCLF 4_230.00_30750_MOSSLD11_230.00_1_CKT	586
T-133	NP26	MOSSLNDMETCALF_NG_WIN	30735_METCLF 4_230.00_30750_MOSSLD11_230.00_2_CKT	586
T-133	NP26		36221_MOSSLD 3_18.00_30780_MOSSLD10_230.00_1_CKT	586
T-133	NP26		36222_MOSSLD 4_18.00_30780_MOSSLD10_230.00_1_CKT	586
T-133	NP26		36223_MOSSLD 6_18.00_30780_MOSSLD10_230.00_1_CKT	586
T-133	NP26		36224_MOSSLD 5_18.00_30787_MOSSLD12_230.00_1_CKT	586
T-133	NP26		36225_MOSSLD 2_18.00_30787_MOSSLD12_230.00_1_CKT	586
T-133	NP26		36226_MOSSLD 7_18.00_30787_MOSSLD12_230.00_1_CKT	586
T-133	NP26	PITSBRG_SANMAT_NG_SUM	30527_PITTSP 5_230.00_99100_PITTSP 7_230.00_1_CKT	586
T-133	NP26	PITSBRG_SANMAT_NG_WIN	30527_PITTSP 5_230.00_99102_PITTSP 6_230.00_1_CKT	586
T-133	NP26	RAVENSWD_NG_SUM	30630_NEWARK 3_230.00_30703_RAVENS 2_230.00_1_CKT	586
T-133	NP26	RAVENSWD_NG_WIN	30703_RAVENS 2_230.00_30624_TESLA 7_230.00_1_CKT	586
T-133	NP26		35349_AMES 2_115.00_35122_NEWARK 2_115.00_1_CKT	586
T-133	NP26	TESLA46_XFNG	30625_TESLA 6_230.00_30040_TESLA 8_500.00_1_CKT	586
T-133	NP26	TESLA64_XFNG	30640_TESLA 5_230.00_30040_TESLA 8_500.00_1_CKT	586
T-133	NP26	PITSBRG_XFMR_BG	32950_PITTSP 2_115.00_30527_PITTSP 5_230.00_1_CKT	586
T-133	NP26		32950_PITTSP 2_115.00_30527_PITTSP 5_230.00_2_CKT	586
T-133	NP26	TESLA_DELTASWYRD_BG	30580_ALTMID 1_230.00_38610_BANKPP 6_230.00_1_CKT	586
T-133	NP26	TESLA_PITSBURG_BG	30595_FLOWD2 2_230.00_30640_TESLA 5_230.00_1_CKT	586
T-133	NP26		30600_JVENTR 1_230.00_30640_TESLA 5_230.00_1_CKT	586
T-133	NP26	VACADX_TESLA_XFNG	30067_VACADX 1_1.00_30460_VACADX 7_230.00_1_CKT	586
T-133	NP26		30640_TESLA 5_230.00_30040_TESLA 8_500.00_1_CKT	586

Table 13. Candidate Competitive Paths that are Members of Predefined Constraints in SP26

Operating Procedures	Zone	Constraint	Line Name	Maximum Mitigation Hours
T-132	SP26	IVALLYBANK_XFBG	22356_IVALLY 1_230.00_22360_IVALLY 2_500.00_1_CKT	2073
T-132	SP26		22356_IVALLY 1_230.00_22360_IVALLY 2_500.00_2_CKT	2073
T-132	SP26	MIGUEL_IMP_BG	22464_MIGUEL 1_230.00_20149_TJUANA 1_230.00_1_CKT	2073
T-132	SP26		99_IVALLY 3_500.00_22468_MIGUEL 3_500.00_1_CKT	2073
T-132	SP26	MIGUEL_MAXIMP_LXNF_NG	22356_IVALLY 1_230.00_22998_LAROA2 1_230.00_2_CKT	2073
T-132	SP26		22356_IVALLY 1_230.00_22998_LAROA2 1_230.00_1_CKT	2073
T-132	SP26	SDGEIMP_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_3_CKT	2073
T-132	SP26		99_IVALLY 3_500.00_22468_MIGUEL 3_500.00_1_CKT	2073
T-132	SP26		22464_MIGUEL 1_230.00_20149_TJUANA 1_230.00_1_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22844_TALEGA 2_230.00_2_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22844_TALEGA 2_230.00_1_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22716_SANLUS 2_230.00_1_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22716_SANLUS 2_230.00_2_CKT	2073
T-132	SP26	SDGE_CFEIMP_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_3_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22844_TALEGA 2_230.00_1_CKT	2073
T-132	SP26		99_IVALLY 3_500.00_22468_MIGUEL 3_500.00_1_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22844_TALEGA 2_230.00_2_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22716_SANLUS 2_230.00_1_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22716_SANLUS 2_230.00_2_CKT	2073
T-132	SP26	SSONGS_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_1_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22716_SANLUS 2_230.00_2_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22716_SANLUS 2_230.00_3_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22844_TALEGA 2_230.00_1_CKT	2073
T-132	SP26		24131_SONGS 1_230.00_22844_TALEGA 2_230.00_2_CKT	2073
T-132	SP26	VICTVLUGO_HANG_NG	101_NGILA 2_500.00_15090_HASAMP 1_500.00_1_CKT	2073
T-159	SP26	VINCNT_XFBG	24248_VINCNT 3_1.00_24156_VINCNT 8_500.00_1_CKT	690
T-159	SP26		24188_VINCNT 1_1.00_24156_VINCNT 8_500.00_1_CKT	690
T-159	SP26		24155_VINCNT 7_230.00_24156_VINCNT 8_500.00_1_CKT	690

Table 14. Summary List of Candidate Competitive Paths that are Individual Lines

Operating Procedures	Zone	Line Name	Maximum Mitigation Hours
T-126	NP26	AHW-1 & -2 115kV Cables (Martin - Bayshore - Potrero)	921
T-126	NP26	AP-1 115kV Cable (Potrero - Hunters Point)	921
T-126	NP26	AX 115kV Cable (Potrero - Mission)	921
T-126	NP26	AY-1 & -2 115kV Cables (Potrero - Larkin)	921
T-126	NP26	East Grand - San Mateo & Martin - East Grand 115kV Lines	921
T-126	NP26	Eastshore - San Mateo 230kV Line	921
T-126	NP26	Jefferson - Martin 230kV Cable	921
T-126	NP26	Martin - Embarcadero 230kV #1 and #2 Cables	921
T-126	NP26	Martin 230/115kV Transformer Banks #7 and #8	921
T-126	NP26	Millbrae - San Mateo #1 & Martin - Millbrae 115kV Lines	921
T-126	NP26	Monta Vista - Jefferson #1 and #2 230kV Lines	921
T-126	NP26	PX-1 & -2 115kV Cables (Hunters Point - Mission)	921
T-126	NP26	Pittsburg - San Mateo 230kV Line	926
T-126	NP26	SF Airport - San Mateo & Martin - SF Airport 115kV Lines	921
T-126	NP26	San Mateo - Belmont 115kV Line	921
T-126	NP26	San Mateo - Martin #3 115kV Line	921
T-126	NP26	San Mateo - Martin #4 115kV Line	921
T-126	NP26	San Mateo - Martin #6 115kV Line	921
T-126	NP26	San Mateo - Martin 230kV Cable	921
T-126	NP26	San Mateo 230/115kV Transformer Banks #5, #6 and #7	921
T-126	NP26	XY-1 115kV Cable (Larkin - Mission)	921
T-132	SP26	Encina - Penasquitos	2073
T-132	SP26	Miguel - Mission Line 1 or 2	2073
T-132	SP26	Miguel - Old Town	2073
T-132	SP26	Miguel - Sycamore Canyon 1 or 2	2073
T-132	SP26	Mission - Old Town	2073
T-132	SP26	Mission - San Luis Rey	2073
T-132	SP26	Palomar - Escondido	2073
T-132	SP26	Penasquitos - Old Town	2073
T-132	SP26	San Luis Rey - Encina	2073
T-132	SP26	San Luis Rey - Encina - Escondido	2073
T-132	SP26	Sycamore - Palomar	2073
T-132	SP26	Talega - Escondido	2073
T-138	NP26	Bridgeville - Garberville 60 kV	5086
T-138	NP26	Humboldt - Maple Creek 60 kV Line	5086
T-159	SP26	Vincent 4AA 500/220 Transformer Bank	690

4.10 Simulation Process

Once model parameters (discussed above) are determined, a 24-hour unit commitment and hourly economic dispatch can be simulated for the typical day in each season under various scenarios discussed above, subject to a set of transmission constraints: hard transmission constraints on grandfathered paths, and soft constraints on all transmission lines/transformers/local area constraints that are not grandfathered. The model assumes each resource is available at its minimum load or greater and is available to be dispatched up or shut down in the initial hour of the simulation. The optimization engine chooses the best unit commitment/economic dispatch for the next 24 hours. The same process is repeated until all seasons, all scenarios, and all potentially pivotal supplier combinations are exhausted. For each simulation run that addresses withheld capacity, we remove the physical generating resources controlled by the suppliers considered from the simulation model and clear load based on the seasonal base case of load and hydro scenarios. We take the power flow results from the simulation model and calculate the FI for candidate paths using the line limits and flows from the output. For this release of CPA results, we present results for all load and hydro production scenarios and most supplier combinations for all four seasons.

5 Competitive Path Assessment

As stated above, typical days in four seasons are picked for the preliminary competitive path analysis. For each typical day, various potentially pivotal supplier combinations are evaluated for each of the nine load and hydro scenarios. In the following section, we first present the hourly system conditions for the base case, medium load and medium hydro scenario in the Spring without any suppliers' capacity removed. Next, we present FI results for the high load, low hydro scenario for all 64 supplier combinations for removed capacity for spring, and finally the results for all 576 load and hydro scenarios and supplier combinations for spring. The same is repeated for the summer, fall and winter seasons.

As noted in Section 4.9 on identification of candidate paths, there are separate categories of "candidate paths" considered in this analysis: broader aggregate (sub-regional) constraints that contain one or more individual line segments (Table 11), the line segments that comprise the broader constraints (Table 12 and Table 13), and independent line segments that are not specifically associated with any broader constraint (Table 14). All three categories of candidate paths are tested in this analysis. In the case of broader aggregate constraints comprised of individual line segments, these components are tested separately; however, if any element (broader constraint or any individual line segment that composed the broader constraint) fails the competitiveness test, all associated elements fail the competitiveness test. Otherwise, the broader constraint and all its associated individual line segments pass the competitiveness test. For individual independent line segments, they are tested separately and pass or fail based on that test.

Since no individual candidate paths failed the test, the FI results tables in this section show only the FI results for aggregated candidate paths.

5.1 Spring Season Results

5.1.1 Base Case Results

The base case results for spring are presented in Table 15 below for medium load, medium hydro, and no supplier capacity withdrawn. General simulation characteristics are presented including load, total generation internal to the CAISO, net import values,[21] and internal path flows (Path 15 and Path 26) for each of the 24 hours of the spring medium load medium hydro base case.

Table 15. Base Case: Model Output for Spring, Medium Hydro, Medium Load, and No Supply Withdrawn

	Load (MWh)		Generation (MWh)		Net Import (MWh)		Internal Path Flow (N->S)	
Hour	NP26	SP26	NP26	SP26	NP26	SP26	Path 15	Path 26
1	12,554	12,632	10,555	7,326	2,701	4,070	-1,588	1,241
2	12,126	12,076	10,720	7,581	1,786	3,538	-1,940	965
3	11,800	11,778	10,689	7,709	1,435	3,572	-1,933	956
4	11,749	11,724	10,689	7,314	1,722	3,576	-1,581	1,292
5	12,093	12,241	11,025	7,426	2,069	3,607	-1,386	1,664
6	12,415	12,770	11,131	7,434	1,961	4,064	-1,664	1,327
7	13,427	13,962	12,973	7,436	1,986	4,770	-2,110	1,878
8	14,029	14,971	13,083	8,819	1,819	5,145	-2,024	1,043
9	14,499	15,893	13,768	8,849	1,934	5,669	-2,097	1,306
10	15,137	16,810	14,294	9,512	1,920	6,187	-2,417	1,166
11	15,741	17,550	14,777	9,714	2,314	6,210	-1,968	1,609
12	16,140	17,979	16,013	9,756	2,203	6,053	-1,972	2,166
13	16,481	18,396	17,019	10,241	1,951	5,933	-1,777	2,319
14	17,034	18,856	16,825	11,172	1,953	6,248	-2,519	1,551
15	17,533	19,111	17,408	10,926	2,546	6,208	-1,660	2,094
16	17,785	18,902	17,795	10,849	2,371	6,069	-1,509	2,103
17	17,925	18,696	17,638	11,326	1,852	6,241	-1,803	1,247
18	17,790	18,008	17,151	10,562	2,522	6,222	-1,913	1,341
19	17,402	17,367	17,169	9,731	2,448	6,011	-1,466	1,710
20	16,686	17,209	15,874	9,537	2,837	6,124	-2,064	1,662
21	16,545	17,622	16,023	9,930	2,613	5,844	-1,910	1,914
22	15,683	16,403	14,485	9,530	2,370	5,871	-2,422	1,009
23	13,884	15,022	12,200	8,468	2,921	5,262	-1,355	1,365
24	12,570	13,738	11,050	7,304	3,186	4,566	-591	1,922

The SP26 area is a net importer from Path 26 and interties, and NP26 has relatively balanced generation and load. Flows on Path 15 are from south-to-north (ZP26 to NP15) and Path 26 is from north-to-south. The peak Northwest import from Malin and Cascade are over 3,000 MW, and peak import to SP26 is over 6,000MW from interties such as NOB, Mead, Palo Verde, etc.

Limits and hourly flows for existing Branch Groups for the spring, medium load, and medium hydro base case are shown in Table 16.

[21] The net imports into NP26 are calculated as the net intertie from Cascade and Malin. The net imports in the SP26 are calculated as the sum of NOB, BLYTHE, ELDORADO, Four Corner, .MCCLUG, MEAD, Palo Verde, Merchant, Parker, and TJUANA.

Table 16. Base Case: Branch Group Flows for Spring, Medium Hydro, Medium Load, and No Supply Withdrawn

Name	Min Flow (MW)	Max Flow (MW)	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24
ADLANTOSP_MSL	-2548	2014	-565	-570	-578	-573	-588	-592	-554	-623	-619	-668	-713	-669	-564	-562	-720	-648	-687	-637	-561	-595	-597	-603	-635	-608
ADLANTOVICTVL-SP_MSL	-4022	2522	-759	-764	-722	-717	-732	-736	-648	-767	-763	-787	-818	-761	-631	-611	-769	-697	-736	-686	-642	-676	-678	-684	-729	-752
BLYTHE_BG	-218	168	-35	-36	-36	-33	-34	-36	-38	-77	-91	-97	-98	-101	-103	-110	-107	-107	-109	-106	-103	-101	-102	-99	-87	-42
CASCADE_BG	-80	45	0	0	0	0	0	0	0	0	0	0	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	0	0	0	0
CFE_BG	-800	408	-75	-75	-75	-75	-75	-75	-84	-99	-113	-122	-87	-87	-183	-139	-59	-108	-108	-59	-59	-76	-75	-75	-150	-75
COTP_MSL	-1567	1199	-955	-849	-830	-876	-950	-924	-793	-652	-734	-750	-931	-904	-763	-758	-807	-921	-842	-798	-795	-866	-822	-759	-905	-996
COTPISO_MSL	-33	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTW230_BG	-1594	1594	-11	-6	0	8	1	1	-60	-53	-11	-16	28	-2	16	-25	-13	-5	0	-2	11	2	-51	-19	-49	4
ELDORADO_MSL	-1555	1555	-548	-579	-585	-575	-569	-555	-465	-488	-529	-505	-477	-490	-488	-580	-672	-559	-659	-642	-526	-586	-516	-529	-551	-490
FCORNER3_MSL	-840	840	435	451	445	455	461	450	375	352	361	335	333	348	322	373	448	392	427	449	335	384	324	311	384	390
FCORNER5_MSL	-1555	1555	-548	-579	-585	-575	-569	-555	-465	-488	-529	-505	-477	-490	-488	-580	-596	-559	-615	-642	-526	-586	-516	-529	-551	-490
GONDIPPDC_BG	-3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IID-SCE_BG	-600	100	-492	-492	-492	-519	-512	-512	-583	-528	-493	-451	-445	-403	-418	-373	-343	-329	-338	-348	-388	-418	-393	-443	-493	-493
IID-SDGE_BG	-225	225	33	33	33	33	33	33	82	82	82	82	82	82	132	132	132	132	132	132	132	132	82	82	33	33
IPPDCADLN_BG	-647	471	-374	-374	-374	-374	-374	-374	-377	-377	-377	-357	-357	-357	-326	-326	-401	-326	-326	-326	-326	-326	-357	-357	-369	-379
IPP-IPPGEN_MSL	-470	0	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274	-274
LAUGHLIN_BG	0	222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLNL_BG	-164	164	-67	-61	-57	-55	-55	-28	-36	-49	-78	-80	-86	-91	-90	-87	-91	-90	-92	-91	-96	-93	-91	-90	-81	-66
MARBLE_BG	-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCCLMKTPC_MSL	-783	783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCCULLGH_MSL	-2598	2598	259	283	298	276	266	272	210	273	313	325	299	289	291	363	347	325	380	375	335	362	328	356	323	236
MEAD_MSL	-1460	1460	-455	-450	-473	-469	-540	-812	-484	-706	-589	-901	-1,067	-907	-539	-534	-613	-632	-628	-586	-587	-573	-586	-585	-748	-676
MEADELDORD_BG	-1140	1140	-215	-219	-231	-224	-248	-350	-221	-329	-293	-416	-475	-409	-270	-282	-301	-309	-316	-300	-305	-305	-303	-313	-352	-293
MEADMKTPC_MSL	-1855	1855	-14	-9	-4	-9	-10	51	15	30	28	47	35	37	25	46	-30	-30	-56	-17	48	11	31	37	16	-6
MEADTMEAD_MSL	-1668	1668	0	0	0	0	-3	-6	-6	-14	-19	-19	-36	-24	-19	-30	-34	-34	-26	-25	-57	-46	-19	-19	0	0
MERCHANT_BG	-645	645	-4	-8	-7	-4	4	23	3	8	-4	18	33	24	-4	-17	-6	-3	-10	-12	-17	-27	-21	-26	2	14
MKTPCADLN_MSL	-1935	1935	-191	-196	-204	-199	-214	-218	-177	-246	-242	-311	-356	-312	-238	-236	-319	-322	-361	-311	-235	-269	-240	-246	-266	-229
MONAIPPDC_MSL	-189	188	-100	-100	-100	-100	-100	-100	-103	-103	-103	-83	-83	-83	-52	-52	-127	-52	-52	-52	-52	-52	-83	-83	-95	-105
NEWMELONP_BG	-384	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGILABK4_BG	-366	366	98	152	153	150	148	148	143	133	132	89	68	69	74	82	172	173	178	176	174	175	75	76	82	99
NOB_BG	-1591	1520	-525	0	0	0	-2	-112	-1,291	-1,346	-1,519	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,557	-1,436	-1,393	-1,025	-922
OAKDALE_BG	-246	246	-52	-50	-48	-47	-48	-50	-51	-51	-51	-51	-50	-51	-49	-66	-65	-64	-64	-65	-51	-55	-52	-52	-55	-52
PACI_MSL	-3200	2450	-2,464	-1,704	-1,422	-1,663	-1,967	-1,876	-1,856	-1,663	-1,782	-1,782	-2,106	-2,011	-1,741	-1,739	-2,223	-2,130	-1,691	-2,199	-2,140	-2,474	-2,349	-2,119	-2,626	-2,845
PALOVRDE_MSL	-3328	3328	-1,273	-1,274	-1,277	-1,270	-1,244	-1,386	-1,259	-1,267	-1,617	-1,731	-1,640	-1,672	-1,811	-2,060	-1,890	-1,919	-1,919	-2,020	-2,034	-2,044	-1,914	-1,918	-1,468	-1,244
PARKER_BG	-220	60	-27	-31	-32	-28	-24	-19	-26	-40	-61	-71	-62	-67	-78	-92	-83	-83	-89	-90	-85	-85	-82	-85	-45	-22
PATH15_BG	-5400	9999	-1,588	-1,940	-1,933	-1,581	-1,386	-1,664	-2,110	-2,024	-2,097	-2,417	-1,968	-1,972	-1,777	-2,519	-1,660	-1,509	-1,803	-1,913	-1,466	-2,064	-1,910	-2,422	-1,355	-591
PATH26_BG	-9999	4000	1,241	965	956	1,292	1,664	1,327	1,878	1,043	1,306	1,166	1,609	2,166	2,319	1,551	2,094	2,103	1,247	1,341	1,710	1,662	1,914	1,009	1,365	1,922
RDM230_BG	-320	320	145	126	118	124	131	131	113	117	132	134	137	129	125	129	139	142	134	142	140	144	142	140	144	156
RNCHLAKE_BG	-1271	1271	104	134	130	122	114	115	-42	-44	97	106	95	96	157	199	223	299	326	336	279	217	105	198	167	237
SILVERPK_BG	-17	17	-11	-12	-11	-12	-11	-12	-11	-12	-11	-12	-11	-12	-17	-17	-17	-17	-17	-17	-11	-12	-11	-12	-11	-12
STANDIFORD_BG	-306	306	-46	-41	-39	-41	-43	-43	-53	-60	-68	-71	-77	-76	-79	-42	-46	-52	-55	-55	-88	-80	-77	-75	-36	-29
SUMMIT_BG	-120	100	-82	-79	-77	-78	-79	-77	-67	-63	-45	-43	-44	-50	-50	-35	-33	-34	-32	-50	-30	-34	-30	-45	-69	-75
SUTTEROBANION_BG	-1366	1366	0	0	30	30	30	30	525	453	250	250	250	525	525	525	525	525	525	525	525	525	525	250	250	0
SYLMAR-AC_BG	-1600	1600	-156	65	425	428	421	20	-492	-525	-701	-635	-711	-711	-694	-682	-686	-681	-677	-680	-694	-641	-578	-621	-387	-325
TRACY230_BG	-1366	1366	-532	-493	-468	-450	-457	-448	-494	-529	-527	-557	-549	-554	-521	-678	-687	-684	-680	-695	-567	-605	-572	-574	-585	-499
TRACY500_BG	-4265	4388	-421	-246	-211	-312	-402	-394	-391	-194	-129	-72	-212	-231	-134	-58	-156	-113	47	-50	-93	-239	-259	-93	-378	-558
VICTVL_BG	-2400	900	-1,005	-1,018	-987	-951	-952	-1,067	-911	-1,131	-1,172	-1,260	-1,262	-1,189	-1,060	-1,170	-1,211	-1,131	-1,217	-1,195	-1,157	-1,182	-1,154	-1,199	-1,137	-1,016
WESTLYLBNS_BG	-600	600	18	72	76	27	-1	13	25	117	163	203	144	138	165	316	262	263	310	297	174	170	149	171	84	-17
WESTLYTSLA_BG	-599	599	-66	-84	-82	-59	-48	-59	-73	-127	-147	-171	-145	-138	-146	-241	-217	-218	-239	-236	-156	-159	-145	-152	-110	-52
WSTWGMEAD_MSL	-126	126	-73	-73	-73	-73	-73	-23	-35	-35	-35	-35	-35	-35	-35	-15	-85	-85	-126	-85	15	-35	-35	-35	-73	-73

5.1.2 FI Results

The FI summary results for spring low hydro, high load, and all 64 supplier combinations for withdrawn capacity are presented in Table 17. Candidate paths listed in the first column represent an aggregation of lines for that constraint set. More specifically, for certain constraints there is more than one physical facility (line, transformer) or simultaneous flow constraint that is associated. In these cases, the minimum FI value for all physical facilities and simultaneous flow constraints associated with the aggregate constraint is used as the FI value for that aggregate constraint for that hour. Where final path designations are made, the designation will apply to all physical facilities and simultaneous flow constraints associated with the aggregate constraint for which the designation is made.

The simulation is run for 24 hours, and in the case of spring low hydro, high load, 1,536 hours are simulated (24 hours * 64 supplier combinations). The second column is the minimum calculated FI value for that candidate path across all hours simulated. The third column shows the number of hours where the calculated FI was less than zero. The fourth column shows the percent of simulated hours where the calculated FI was less than zero.

The minimum FI value reported in the second column is interpreted as follows: the magnitude of the value indicates the proportion of the path limit that was exceeded by the simulated flow in order to solve the simulation with some combination of suppliers' capacity removed.

Please note that the results for all candidate paths that represent an aggregation of lines are presented in this section while only the failed candidate paths that represent a single transmission segment (line/transformer) are listed here to save space.

Table 17. FI Results for Spring - Low Hydro and High Load Scenarios

Candidate Path	Minimum FI	Hours with FI < 0	Percent of Hours with FI < 0
HUMBOLDT_BG HUMBOLDT_XFBG MARTIN_C_POTRPP_NG MOSSLNDMETCALF_NG_SUM_OFFPK MOSSLNDMETCALF_NG_SUM_ONPK MOSSLNDMETCALF_NG_WIN PITSBRG_SANMAT_NG_SUM PITSBRG_SANMAT_NG_WIN RAVENSWD_NG_SUM RAVENSWD_NG_WIN RAVENSWDSANMAT_NG_SUM RAVENSWDSANMAT_NG_WIN TESLA46_XFNG TESLA64_XFNG MONTAVISTA_JEFSN_BG **PITSBRG_XFMR_BG** TESLA_DELTASWYRD_BG TESLA_PITSBURG_BG VACADX_TESLA_XFNG MIGUEL_IMP_BG MIGUEL_MAXIMP_LXNF_NG SDGE_CFEIMP_BG SDGEIMP_BG SSONGS_BG VICTVLUGO_HANG_NG IVALLYBANK_XFBG VINCNT_XFBG	**-0.07**	**59**	**3.84%**

The only frequently violated candidate paths are PITSBRG_XFMRBG (Pittsburgh transformers)

The FI summary results for all load and hydro scenarios and supplier withdrawn combinations in spring are presented in Table 18. The last column shows the seasonal competitive test results with a test threshold of zero hours with negative FI. A column value of “Fail” indicates that based on the FI values resulting from the simulation the candidate path failed the competitiveness test for that season. A blank value indicates the path did not have a negative FI in any of the simulated hours and consequently passed the seasonal competitiveness test.

Table 18. FI Results for Spring - All Load and Hydro Scenarios

Candidate Path	Minimum FI	Hours with FI < 0	Percent of Hours with FI < 0
HUMBOLDT_BG			
HUMBOLDT_XFBG			
MARTIN_C_POTRPP_NG			
MOSSLNDMETCALF_NG_SUM_OFFPK			
MOSSLNDMETCALF_NG_SUM_ONPK			
MOSSLNDMETCALF_NG_WIN			
PITSBRG_SANMAT_NG_SUM			
PITSBRG_SANMAT_NG_WIN			
RAVENSWD_NG_SUM			
RAVENSWD_NG_WIN			
RAVENSWDSANMAT_NG_SUM			
RAVENSWDSANMAT_NG_WIN			
TESLA46_XFNG			
TESLA64_XFNG			
MONTAVISTA_JEFSN_BG			
PITSBRG_XFMR_BG	**-0.07**	**178**	**1.29%**
TESLA_DELTASWYRD_BG			
TESLA_PITSBURG_BG			
VACADX_TESLA_XFNG			
MIGUEL_IMP_BG			
MIGUEL_MAXIMP_LXNF_NG			
SDGE_CFEIMP_BG			
SDGEIMP_BG			
SSONGS_BG			
VICTVLUGO_HANG_NG			
IVALLYBANK_XFBG			
VINCNT_XFBG			

The results for all load and hydro scenarios and all 64 supplier combinations are similar to the high load, low hydro results presented in Table 17 except that the relative percent of hours with negative FI values for certain candidate paths is somewhat lower. This is expected, since Table 17 shows results for the most conservative set of system conditions where we expect supply to be relatively tight compared to the other load and hydro scenarios in the spring. Also one more candidate paths in the NP26 area, Humboldt Bank, failed when evaluated across all load and hydro scenarios, as compared to the low hydro and high load scenario alone.

For spring simulations, no load is curtailed in any scenario.

5.2 Summer Season Results

5.2.1 Base Case Results

The base case results for summer are presented in Table 19 below for medium load, medium hydro, and no supplier capacity withdrawn. General simulation characteristics are presented including load, total generation internal to the CAISO, net import values, and internal path flows (Path 15 and Path 26) for each of the 24 hours.

Table 19. Base Case: Model Output for Summer, Medium Hydro, Medium Load, and No Supply Withdrawn

Hour	Load (MWh)		Generation (MWh)		Net Import (MWh)		Internal Path Flow (N->S)	
	NP26	SP26	NP26	SP26	NP26	SP26	Path 15	Path 26
1	12,264	15,588	12,641	10,009	1,225	3,886	-1,951	1,773
2	12,082	14,634	12,192	9,757	1,150	3,576	-2,104	1,381
3	12,278	13,940	12,919	9,262	710	3,569	-1,942	1,443
4	12,063	13,603	12,244	8,980	934	3,760	-1,765	1,194
5	11,737	13,544	11,816	9,136	840	3,697	-2,438	1,043
6	11,860	13,548	11,995	8,920	642	3,766	-2,475	942
7	12,252	14,120	11,838	9,631	1,470	3,735	-2,289	1,001
8	12,398	15,649	13,151	9,699	1,758	3,512	-1,208	2,529
9	12,726	17,565	14,115	10,402	1,739	4,105	-574	3,111
10	13,639	19,570	15,161	11,670	1,584	4,833	-526	3,121
11	14,340	21,179	16,130	12,819	1,666	5,008	-288	3,371
12	14,901	22,268	16,624	13,943	1,663	5,142	-451	3,223
13	15,432	23,283	17,231	15,118	1,751	4,969	-452	3,229
14	16,067	24,197	17,651	16,316	1,685	4,971	-855	2,854
15	16,591	25,015	18,250	17,117	1,962	4,624	-644	3,193
16	17,053	25,451	17,828	18,294	1,957	4,819	-1,602	2,262
17	17,259	25,379	18,114	18,250	1,963	4,775	-1,665	2,178
18	17,230	24,913	17,848	18,234	2,010	4,719	-1,959	1,894
19	16,821	23,851	16,705	17,685	1,883	4,993	-2,698	1,116
20	16,175	22,813	17,647	15,173	2,229	4,569	-656	3,042
21	16,145	22,753	17,176	15,057	2,446	4,574	-499	3,204
22	15,315	21,383	16,419	13,717	2,164	4,876	-801	2,921
23	13,875	19,324	15,462	10,639	2,168	4,871	1,620	3,920
24	12,560	17,392	13,795	10,430	1,819	3,861	-441	3,187

Internal path flows indicate north-to-south flows throughout the hours on Path 26, and flow on Path 15 is in north-to-south direction in most hours. The SP26 area is a net importer throughout the day. The total imports into the CAISO control area are around 2,500 MW and 5,000 MW from the Northwest and Southwest respectively during the peak hours.

Limits and hourly flows for existing Branch Groups for the summer, medium load, and medium hydro base case are shown in Table 20.

Table 20. Base Case: Branch Group Flows for Summer, Medium Hydro, Medium Load, and No Supply Withdrawn

Name	Min Flow	Max Flow	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24
ADLANTOSP_MSL	-2548	2014	-793	-740	-738	-829	-735	-788	-557	-572	-764	-693	-791	-813	-729	-752	-751	-759	-757	-789	-875	-745	-554	-685	-852	-683
ADLANTOVICTVL-SP_MSL	-4022	2522	-912	-858	-856	-950	-855	-910	-681	-702	-895	-816	-999	-1,022	-938	-1,054	-1,077	-1,075	-1,193	-1,116	-1,202	-1,072	-764	-821	-967	-805
BLYTHE_BG	-218	168	-51	-48	-46	-46	-47	-48	-46	-47	-72	-87	-87	-90	-97	-100	-102	-106	-107	-105	-102	-95	-89	-90	-60	-58
CASCADE_BG	-80	45	-80	-80	-80	-80	-80	-80	0	0	0	0	0	0	0	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80
CFE_BG	-800	408	0	0	0	-55	-85	-120	-162	-52	-106	-100	-71	-101	-70	-21	31	54	-61	-60	-61	-80	-84	-88	-76	-89
COTP_MSL	-1567	1199	-564	-520	-427	-445	-462	-467	-646	-747	-716	-712	-696	-656	-588	-570	-603	-654	-602	-614	-650	-708	-795	-678	-738	-672
COTPISO_MSL	-33	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTW230_BG	-1594	1594	-38	-29	-35	-47	-40	-41	-100	-89	-103	-126	-140	-143	-133	-76	-81	-95	-89	-91	-90	-62	-88	-92	-36	-66
ELDORADO_MSL	-1555	1555	-557	-547	-550	-576	-577	-550	-123	-154	-138	-172	-143	-154	-142	-206	-135	-201	-176	-182	-186	-149	-140	-192	-567	-569
FCORNER3_MSL	-840	840	373	373	365	384	383	360	-36	72	37	23	27	41	30	95	52	86	61	65	41	53	15	38	413	381
FCORNER5_MSL	-1555	1555	-557	-547	-550	-576	-577	-550	-123	-154	-138	-172	-143	-154	-142	-206	-135	-201	-176	-182	-186	-149	-140	-192	-567	-569
GONDIPPDC_BG	-3	5	5	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
IID-SCE_BG	-600	100	-481	-502	-522	-542	-542	-542	-575	-543	-523	-468	-488	-458	-393	-371	-327	-323	-303	-313	-353	-383	-448	-443	-442	-492
IID-SDGE_BG	-225	225	35	35	35	35	35	35	60	60	60	60	110	132	132	132	132	132	132	132	132	132	132	110	85	85
IPPDCADLN_BG	-647	471	-513	-463	-463	-558	-463	-513	-328	-346	-467	-420	-497	-494	-435	-462	-449	-452	-460	-499	-574	-473	-286	-387	-516	-516
IPP-IPPGEN_MSL	-470	0	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470	-470
LAUGHLIN_BG	0	222	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
LLNL_BG	-164	164	-44	-45	-44	-49	-54	-54	-59	-56	-59	-70	-46	-42	-44	-51	-50	-72	-75	-74	-75	-59	-60	-59	-28	-54
MARBLE_BG	-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCCLMKTPC_MSL	-783	783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCCULLGH_MSL	-2598	2598	267	253	263	277	280	269	81	20	42	91	64	72	63	80	34	86	77	78	108	44	67	111	253	243
MEAD_MSL	-1460	1460	-208	-182	-153	-127	-129	-152	123	121	-7	168	-106	-213	-125	-47	-103	-99	-95	-50	-91	-26	23	30	-271	422
MEADELDORD_BG	-1140	1140	-99	-89	-82	-75	-75	-82	67	86	31	86	-12	-56	-20	7	-7	-11	-9	6	-21	13	26	21	-118	146
MEADMKTPC_MSL	-1855	1855	-22	-24	-23	-23	-22	-23	-15	-11	-9	-9	23	30	30	14	2	18	22	21	28	14	19	1	-78	-76
MEADTMEAD_MSL	-1668	1668	0	0	0	0	0	0	25	15	6	6	6	6	12	-1	-9	-1	6	6	6	6	6	6	-57	-19
MERCHANT_BG	-645	645	-186	-185	-188	-192	-192	-189	-273	-262	-257	-280	-255	-250	-256	-267	-257	-257	-258	-262	-267	-271	-277	-283	-186	-236
MKTPCADLN_MSL	-1935	1935	-280	-277	-275	-271	-272	-275	-229	-226	-297	-273	-294	-319	-294	-290	-302	-307	-297	-290	-301	-272	-268	-298	-336	-167
MONAIPPDC_MSL	-189	188	-48	2	2	-93	2	-48	142	124	3	50	-27	-24	35	8	21	18	10	-29	-104	-3	184	83	-51	-51
NEWMELONP_BG	-384	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGILABK4_BG	-366	366	128	117	112	110	111	109	100	112	122	142	149	172	188	195	193	199	201	201	201	193	182	171	177	154
NOB_BG	-1591	1520	45	60	70	76	80	68	-1,113	-1,225	-1,189	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,591	-1,580	-572	-267
OAKDALE_BG	-246	246	-37	-34	-29	-27	-34	-35	-35	-32	-33	-37	-38	-40	-40	-43	-42	-58	-56	-59	-63	-44	-46	-43	-27	-34
PACI_MSL	-3200	2450	-1,141	-1,061	-675	-869	-803	-640	-1,424	-1,680	-1,648	-1,515	-1,577	-1,554	-1,579	-1,456	-1,685	-1,703	-1,693	-1,739	-1,652	-1,927	-2,147	-1,889	-1,906	-1,639
PALOVRDE_MSL	-3328	3328	-1,633	-1,405	-1,411	-1,414	-1,418	-1,407	-1,167	-912	-1,249	-1,762	-1,683	-1,678	-1,740	-1,740	-1,556	-1,675	-1,583	-1,512	-1,632	-1,395	-1,601	-1,697	-1,893	-1,835
PARKER_BG	-220	60	-46	-44	-45	-48	-49	-48	-38	-27	-33	-58	-43	-49	-52	-55	-48	-56	-56	-57	-59	-50	-53	-60	-42	-62
PATH15_BG	-5400	9999	-1,951	-2,104	-1,942	-1,765	-2,438	-2,475	-2,289	-1,208	-574	-526	-288	-451	-452	-855	-644	-1,602	-1,665	-1,959	-2,698	-656	-499	-801	1,620	-441
PATH26_BG	-9999	4000	1,773	1,381	1,443	1,194	1,043	942	1,001	2,529	3,111	3,121	3,371	3,223	3,229	2,854	3,193	2,262	2,178	1,894	1,116	3,042	3,204	2,921	3,920	3,187
RDM230_BG	-320	320	54	51	32	24	33	33	65	81	90	97	100	109	118	120	126	132	129	132	130	138	137	106	97	61
RNCHLAKE_BG	-1271	1271	10	4	-76	-95	19	34	92	108	-1	16	51	64	77	120	109	261	246	308	317	264	93	67	-104	-57
SILVERPK_BG	-17	17	-17	-13	-11	-12	-11	-12	-11	-15	-16	-17	-11	-12	-11	-12	-11	-12	-11	-12	-11	-12	-11	-17	-16	-17
STANDIFORD_BG	-306	306	-56	-69	-64	-68	-62	-61	-79	-69	-58	-54	-59	-58	-62	-67	-71	-49	-54	-51	-44	-79	-73	-76	-59	-46
SUMMIT_BG	-120	100	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	-42	50	50	50	50	50	50	0	0
SUTTEROBANION_BG	-1366	1366	250	250	525	525	250	250	250	250	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525
SYLMAR-AC_BG	-1600	1600	81	87	304	298	313	78	-235	-399	-364	-521	-534	-535	-553	-550	-545	-547	-535	-530	-522	-493	-486	-504	-184	-29
TRACY230_BG	-1366	1366	-363	-344	-261	-267	-359	-358	-386	-325	-340	-389	-386	-408	-406	-430	-409	-604	-576	-618	-651	-443	-477	-453	-232	-327
TRACY500_BG	-4265	4388	23	57	-40	-34	175	194	130	-91	-208	-140	-123	-91	-88	-24	-103	78	108	160	167	-75	-205	-68	-547	-293
VICTVL_BG	-2400	900	-1,132	-1,064	-1,047	-1,135	-1,072	-1,113	-751	-684	-862	-883	-1,035	-1,079	-1,002	-1,106	-1,064	-1,147	-1,229	-1,167	-1,289	-1,066	-849	-921	-1,146	-945
WESTLYLBNS_BG	-600	600	174	156	81	81	204	203	199	100	63	83	82	104	93	129	94	277	279	327	366	124	100	142	-152	32
WESTLYTSLA_BG	-599	599	-146	-130	-80	-81	-151	-148	-160	-105	-91	-99	-100	-114	-108	-129	-112	-220	-221	-250	-272	-131	-125	-146	26	-72
WSTWGMEAD_MSL	-126	126	-90	-90	-90	-90	-90	-90	-75	-50	-50	-50	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	-50	-90	-90

5.2.2 FI Results

The FI summary results for summer low hydro high load and all 26 withdrawn supplier combinations are presented in Table 21.

Table 21. FI Results for Summer - Low Hydro and High Load Scenarios

Candidate Path	Minimum FI	Hours with FI < 0	Percent of Hours with FI < 0
HUMBOLDT_BG HUMBOLDT_XFBG MARTIN_C_POTRPP_NG MOSSLNDMETCALF_NG_SUM_OFFPK MOSSLNDMETCALF_NG_SUM_ONPK MOSSLNDMETCALF_NG_WIN PITSBRG_SANMAT_NG_SUM PITSBRG_SANMAT_NG_WIN RAVENSWD_NG_SUM RAVENSWD_NG_WIN RAVENSWDSANMAT_NG_SUM RAVENSWDSANMAT_NG_WIN TESLA46_XFNG TESLA64_XFNG MONTAVISTA_JEFSN_BG **PITSBRG_XFMR_BG** TESLA_DELTASWYRD_BG TESLA_PITSBURG_BG VACADX_TESLA_XFNG MIGUEL_IMP_BG MIGUEL_MAXIMP_LXNF_NG SDGE_CFEIMP_BG SDGEIMP_BG SSONGS_BG VICTVLUGO_HANG_NG IVALLYBANK_XFBG VINCNT_XFBG	**-0.11**	**133**	**8.66%**

Note here that in the summer low hydro high load results, one candidate path failed the test. PITSBRG_XFMRBG is still the most frequently violated candidate paths for the summer high load low hydro scenario as in spring counterparts.

The FI summary results for all load and hydro scenarios and supplier withdrawn combinations in summer are presented in Table 22.

Table 22. FI Results for Summer - All Hydro and Load Scenarios

Candidate Path	Minimum FI	Hours with FI < 0	Percent of Hours with FI < 0
HUMBOLDT_BG			
HUMBOLDT_XFBG			
MARTIN_C_POTRPP_NG			
MOSSLNDMETCALF_NG_SUM_OFFPK			
MOSSLNDMETCALF_NG_SUM_ONPK			
MOSSLNDMETCALF_NG_WIN			
PITSBRG_SANMAT_NG_SUM			
PITSBRG_SANMAT_NG_WIN			
RAVENSWD_NG_SUM			
RAVENSWD_NG_WIN			
RAVENSWDSANMAT_NG_SUM			
RAVENSWDSANMAT_NG_WIN			
TESLA46_XFNG			
TESLA64_XFNG			
MONTAVISTA_JEFSN_BG			
PITSBRG_XFMR_BG	**-0.11**	**406**	**2.94%**
TESLA_DELTASWYRD_BG			
TESLA_PITSBURG_BG			
VACADX_TESLA_XFNG			
MIGUEL_IMP_BG			
MIGUEL_MAXIMP_LXNF_NG			
SDGE_CFEIMP_BG			
SDGEIMP_BG			
SSONGS_BG			
VICTVLUGO_HANG_NG			
IVALLYBANK_XFBG			
VINCNT_XFBG			

The all hydro and load scenario results for the summer season are similar to low hydro high load summer scenario results, with the same candidate path failed the test.

For the summer scenarios, there is no load curtailed for supplier withdrawal cases.

5.3 Fall Season Results

5.3.1 Base Case Results

The base case results for fall are presented in Table 23 below for medium load, medium hydro, and no supplier capacity withdrawn. General simulation characteristics are presented including load, total generation internal to the CAISO, net import values, and internal path flows (Path 15 and Path 26) for each of the 24 hours of the fall medium load medium hydro base case.

Table 23. Base Case: Model Output for Fall, Medium Hydro, Medium Load, and No Supply Withdrawn

Hour	Load (MWh)		Generation (MWh)		Net Import (MWh)		Internal Path Flow (N->S)	
	NP26	SP26	NP26	SP26	NP26	SP26	Path 15	Path 26
1	10,868	10,523	10,698	7,548	-100	4,248	-3,668	-737
2	10,640	10,311	10,807	7,631	-891	4,216	-4,031	-1,099
3	10,620	10,176	10,510	7,355	-648	4,358	-4,056	-1,125
4	10,708	10,274	11,048	7,903	-891	3,704	-3,879	-922
5	10,902	10,844	11,278	8,290	-891	3,863	-4,036	-897
6	11,881	12,207	12,423	8,706	-998	4,798	-4,130	-886
7	13,636	13,783	14,652	9,712	-922	4,443	-3,719	-100
8	13,606	14,451	15,121	9,666	-435	4,333	-3,226	829
9	14,200	15,005	15,405	9,774	-131	4,302	-3,143	1,004
10	13,710	15,367	14,976	9,751	-1	4,414	-2,909	1,253
11	13,299	15,534	14,586	9,356	399	4,835	-2,633	1,518
12	13,172	15,459	14,399	9,271	261	5,074	-2,794	1,364
13	13,328	15,419	14,688	9,310	-1	5,081	-2,884	1,277
14	13,162	15,318	14,481	9,204	38	5,187	-2,985	1,177
15	12,990	15,111	14,342	9,163	-166	5,138	-3,109	1,060
16	12,960	14,970	14,245	9,045	-25	4,985	-2,997	1,164
17	14,068	16,378	15,758	9,951	340	4,615	-2,084	2,036
18	15,502	17,768	16,563	10,130	1,552	5,058	-1,578	2,529
19	15,472	17,578	16,555	9,992	1,446	5,080	-1,707	2,405
20	15,218	17,190	16,094	9,954	1,251	5,128	-2,107	2,020
21	14,564	16,512	15,778	9,489	695	5,198	-2,327	1,812
22	13,568	15,209	14,698	9,130	125	5,097	-3,014	1,158
23	12,212	13,503	12,353	8,706	-117	5,084	-3,276	-112
24	11,410	12,174	11,528	7,787	-194	4,765	-3,106	-202

The power flows on the internal paths are from north-to-south (from ZP26 into SP15) for Path 26 in peak hours. The power flows are from south-to-north (ZP26 to NP15) for Path 15. The total imports into the CAISO control area are over 5,000 MW from the Southwest during the peak hours while imports from the Northwest are reduced considerably due to less hydro power production during the fall season.

Limits and hourly flows for existing Branch Groups for the fall, medium load, and medium hydro base case are shown in Table 24.

Table 24. Base Case: Branch Group Flows for Fall, Medium Hydro, Medium Load, and No Supply Withdrawn

Name	Min Flow (MW)	Max Flow (MW)	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24
ADLANTOSP_MSL	-2548	2014	-904	-906	-914	-866	-873	-990	-876	-933	-883	-883	-887	-936	-932	-934	-934	-904	-894	-977	-1,007	-1,008	-1,008	-907	-919	-897
ADLANTOVICTVL-SP_MSL	-4022	2522	-883	-885	-893	-845	-852	-969	-865	-872	-1,122	-1,147	-1,126	-1,175	-1,171	-1,173	-1,173	-1,168	-1,158	-1,441	-1,508	-1,509	-1,434	-1,146	-1,158	-1,136
BLYTHE_BG	-218	168	-41	-41	-38	-39	-40	-45	-48	-48	-49	-52	-56	-56	-57	-57	-57	-56	-54	-55	-55	-55	-56	-58	-56	-55
CASCADE_BG	-80	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CFE_BG	-800	408	-195	-220	-220	-220	-220	-205	-175	-155	-105	-85	-75	-75	-75	-75	-75	-75	-55	-55	-85	-55	-55	-145	-105	-105
COTP_MSL	-1567	1199	-479	-366	-405	-372	-371	-344	-428	-470	-549	-576	-637	-637	-610	-644	-612	-653	-650	-786	-733	-712	-633	-555	-802	-709
COTPISO_MSL	-33	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTW230_BG	-1594	1594	95	95	88	96	92	49	4	-2	-32	-29	3	21	6	46	46	38	-31	-71	-72	-67	-38	22	42	60
ELDORADO_MSL	-1555	1555	-611	-615	-673	-509	-583	-650	-622	-565	-585	-643	-656	-702	-705	-756	-755	-704	-570	-551	-568	-586	-608	-699	-790	-825
FCORNER3_MSL	-840	840	299	295	367	201	277	360	363	345	375	442	404	433	430	479	480	431	340	359	367	374	372	411	470	485
FCORNER5_MSL	-1555	1555	-611	-615	-673	-509	-583	-650	-622	-565	-585	-643	-656	-702	-705	-756	-755	-704	-570	-551	-568	-586	-608	-699	-790	-825
GONDIPPDC_BG	-3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
IID-SCE_BG	-600	100	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488	-488
IID-SDGE_BG	-225	225	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136
IPPDCADLN_BG	-647	471	-572	-572	-597	-552	-556	-647	-569	-634	-597	-597	-601	-647	-647	-647	-647	-619	-618	-618	-647	-647	-647	-616	-614	-580
IPP-IPPGEN_MSL	-470	0	-470	-470	-470	-470	-470	-467	-470	-470	-470	-470	-470	-470	-463	-466	-463	-470	-470	-470	-466	-470	-463	-470	-470	-470
LAUGHLIN_BG	0	222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLNL_BG	-164	164	-32	-33	-34	-33	-35	-41	-64	-64	-66	-64	-63	-65	-66	-65	-65	-64	-68	-80	-79	-77	-71	-62	-48	-39
MARBLE_BG	-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCCLMKTPC_MSL	-783	783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCCULLGH_MSL	-2598	2598	410	417	420	365	390	406	359	304	299	310	361	392	396	416	414	394	308	291	304	320	350	408	470	502
MEAD_MSL	-1460	1460	-203	-202	-121	-122	-123	-273	-137	-138	-99	-98	-74	-71	-46	-46	-41	-42	-45	-465	-467	-465	-469	-73	-89	-111
MEADELDORD_BG	-1140	1140	-109	-110	-77	-75	-78	-134	-69	-57	-38	-34	-35	-41	-32	-34	-32	-30	-17	-170	-174	-176	-183	-46	-66	-82
MEADMKTPC_MSL	-1855	1855	70	72	67	61	64	71	56	47	40	40	48	52	52	54	54	51	33	37	40	44	56	55	66	74
MEADTMEAD_MSL	-1668	1668	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	-15	-14	-12	-6	0	0	0
MERCHANT_BG	-645	645	-320	-321	-326	-321	-323	-315	-319	-311	-315	-314	-325	-331	-334	-335	-334	-333	-323	-291	-293	-295	-298	-335	-341	-343
MKTPCADLN_MSL	-1935	1935	-332	-334	-317	-314	-317	-343	-307	-299	-286	-286	-286	-289	-285	-287	-287	-285	-276	-359	-360	-361	-361	-291	-305	-317
MONAIPPDC_MSL	-189	188	-107	-107	-132	-87	-91	-185	-104	-169	-132	-132	-136	-182	-189	-186	-189	-154	-153	-153	-186	-182	-189	-151	-149	-115
NEWMELONP_BG	-384	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGILABK4_BG	-366	366	121	122	120	119	119	120	117	113	113	114	119	121	122	122	122	122	115	109	111	112	115	124	129	131
NOB_BG	-1591	1520	848	910	867	997	933	249	296	222	216	209	209	209	209	209	209	209	204	141	216	221	279	279	434	802
OAKDALE_BG	-246	246	-31	-30	-32	-30	-32	-35	-26	-25	-28	-27	-28	-28	-26	-24	-25	-25	-29	-37	-37	-37	-36	-31	-37	-30
PACI_MSL	-3200	2450	-45	621	414	626	625	713	603	208	-69	-180	-519	-406	-194	-231	-57	-184	-488	-1,486	-1,382	-1,221	-751	-265	-171	-70
PALOVRDE_MSL	-3328	3328	-2,330	-2,331	-2,381	-2,188	-2,148	-2,054	-2,029	-1,889	-1,941	-1,963	-2,401	-2,521	-2,551	-2,567	-2,523	-2,487	-2,349	-2,328	-2,351	-2,397	-2,493	-2,581	-2,601	-2,605
PARKER_BG	-220	60	-64	-66	-65	-61	-63	-61	-59	-51	-52	-53	-64	-68	-69	-71	-71	-69	-57	-43	-44	-47	-52	-71	-78	-81
PATH15_BG	-5400	9999	-3,668	-4,031	-4,056	-3,879	-4,036	-4,130	-3,719	-3,226	-3,143	-2,909	-2,633	-2,794	-2,884	-2,985	-3,109	-2,997	-2,084	-1,578	-1,707	-2,107	-2,327	-3,014	-3,276	-3,106
PATH26_BG	-9999	4000	-737	-1,099	-1,125	-922	-897	-886	-100	829	1,004	1,253	1,518	1,364	1,277	1,177	1,060	1,164	2,036	2,529	2,405	2,020	1,812	1,158	-112	-202
RDM230_BG	-320	320	103	87	91	88	89	83	78	87	92	94	106	107	95	104	99	104	97	125	121	117	104	101	110	102
RNCHLAKE_BG	-1271	1271	553	524	529	537	546	492	253	250	172	148	307	336	238	384	362	360	155	139	139	149	165	274	557	484
SILVERPK_BG	-17	17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17
STANDIFORD_BG	-306	306	-26	-22	-17	-16	-16	-12	-57	-55	-51	-48	-42	-40	-50	-56	-52	-51	-35	-35	-34	-30	-24	-43	-20	-26
SUMMIT_BG	-120	100	0	0	0	0	-2	-5	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30
SUTTEROBANION_BG	-1366	1366	30	30	30	30	30	250	525	525	525	525	347	250	459	250	250	250	525	525	525	525	525	250	250	250
SYLMAR-AC_BG	-1600	1600	614	554	516	572	538	244	187	208	202	196	273	337	335	333	334	333	354	246	271	274	290	295	353	477
TRACY230_BG	-1366	1366	-344	-334	-347	-331	-345	-388	-365	-359	-398	-389	-368	-378	-367	-343	-351	-359	-406	-481	-482	-478	-441	-393	-419	-356
TRACY500_BG	-4265	4388	388	563	495	529	550	569	506	382	298	220	189	246	236	306	342	301	140	-61	-23	-1	72	286	322	267
VICTVL_BG	-2400	900	-1,299	-1,318	-1,320	-1,203	-1,239	-1,404	-1,267	-1,190	-1,382	-1,412	-1,454	-1,534	-1,532	-1,561	-1,557	-1,525	-1,406	-1,653	-1,720	-1,748	-1,725	-1,533	-1,624	-1,614
WESTLYLBNS_BG	-600	600	180	237	216	218	233	259	204	153	142	109	115	140	114	132	146	133	113	69	87	110	128	167	194	127
WESTLYTSLA_BG	-599	599	-116	-139	-130	-127	-136	-156	-126	-101	-102	-87	-93	-106	-89	-95	-101	-95	-98	-93	-102	-113	-115	-120	-141	-94
WSTWGMEAD_MSL	-126	126	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34	-34

5.3.2 FI Results

All candidate paths passed the FI test for all fall scenarios.

5.4 Winter Season Results

5.4.1 Base Case Results

The base case results for winter are presented in Table 25 below for medium load, medium hydro, and no supplier capacity withdrawn. General simulation characteristics are presented including load, total generation internal to the CAISO, net import values, and internal path flows (Path 15 and Path 26) for each of the 24 hours of the winter medium load medium hydro base case.

Table 25. Base Case: Model Output for Winter, Medium Hydro, Medium Load, and No Supply Withdrawn

Hour	Load (MWh)		Generation (MWh)		Net Import (MWh)		Internal Path Flow (N->S)	
	NP26	SP26	NP26	SP26	NP26	SP26	Path 15	Path 26
1	10,321	12,115	9,384	7,446	88	5,113	-3,475	-661
2	10,304	11,716	9,291	7,840	-98	4,577	-3,746	-919
3	10,194	11,571	9,280	8,083	-500	4,816	-4,106	-1,279
4	10,265	11,636	9,611	8,185	-651	4,667	-3,983	-1,167
5	10,354	11,938	9,617	8,034	-553	4,968	-4,019	-1,014
6	10,974	12,856	10,420	8,307	-327	5,158	-3,601	-560
7	12,373	13,970	11,716	9,131	312	5,311	-3,642	-94
8	12,820	14,848	12,050	9,177	523	5,868	-3,353	183
9	12,782	15,343	11,995	9,231	1,000	5,816	-2,829	676
10	12,815	15,617	12,092	9,236	961	6,078	-2,857	681
11	12,873	15,785	12,011	9,385	1,093	6,121	-2,833	657
12	12,706	15,794	11,790	9,456	1,029	6,178	-2,750	539
13	12,567	15,725	11,951	9,285	990	6,017	-2,693	801
14	12,485	15,717	11,763	9,219	1,127	6,050	-2,461	828
15	12,353	15,550	11,402	9,303	1,015	6,094	-2,559	496
16	12,308	15,312	11,186	9,392	800	6,127	-2,904	133
17	13,064	16,104	12,295	9,436	1,009	6,294	-3,236	714
18	14,290	17,650	13,885	10,739	840	6,325	-3,087	926
19	14,108	17,323	13,902	9,972	1,555	6,025	-2,280	1,706
20	13,746	16,987	13,412	9,777	1,934	5,653	-2,044	1,938
21	13,145	16,319	12,882	9,698	1,260	5,614	-2,653	1,339
22	12,261	15,085	11,250	9,516	867	5,685	-2,989	195
23	11,159	13,795	9,897	8,658	1,065	5,095	-2,471	92
24	10,514	12,673	9,297	7,907	637	5,142	-2,857	-327

Similar to the fall base case, Path 15 flows are in South-to-North direction and Path 26 flows are in North-to-South direction in peak hours and in South-to-North direction in off-peak hours.

Limits and hourly flows for existing Branch Groups for the winter, medium load, medium hydro base case are shown in Table 26.

Table 26. Base Case: Branch Group Flows for Winter, Medium Hydro, Medium Load, and No Supply Withdrawn

Winter																										
Name	Min Flow (MW)	Max Flow (MW)	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24
ADLANTOSP_MSL	-2548	2014	-809	-744	-672	-661	-678	-780	-754	-787	-859	-793	-837	-798	-794	-778	-821	-830	-812	-813	-779	-781	-829	-834	-732	-709
ADLANTOVICTVL-SP_MSL	-4022	2522	-1,099	-1,034	-912	-901	-918	-1,020	-869	-900	-972	-908	-952	-913	-909	-891	-934	-945	-927	-926	-892	-894	-942	-947	-972	-949
BLYTHE_BG	-218	168	-47	-48	-53	-52	-55	-56	-59	-61	-60	-63	-64	-65	-64	-64	-63	-62	-62	-62	-60	-60	-59	-61	-58	-52
CASCADE_BG	-80	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CFE_BG	-800	408	-290	-325	-345	-355	-345	-345	-384	-374	-319	-284	-264	-254	-264	-259	-259	-264	-269	-249	-209	-189	-189	-234	-200	-225
COTP_MSL	-1567	1199	-140	-112	-51	-26	-138	-193	-370	-498	-594	-549	-558	-540	-559	-590	-573	-561	-589	-558	-652	-709	-593	-448	-383	-295
COTPISO_MSL	-33	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTW230_BG	-1594	1594	-2	8	16	-8	2	-35	-61	-77	-77	-71	-71	-55	-38	-34	-30	-36	-60	-104	-65	-77	-79	-78	-53	-2
ELDORADO_MSL	-1555	1555	-752	-656	-709	-676	-756	-654	-572	-515	-472	-570	-574	-581	-556	-528	-559	-558	-525	-532	-486	-495	-497	-521	-720	-708
FCORNER3_MSL	-840	840	492	363	360	343	413	355	288	220	213	284	286	283	273	242	278	272	255	278	279	275	266	239	409	411
FCORNER5_MSL	-1555	1555	-752	-656	-709	-676	-756	-654	-572	-515	-472	-570	-574	-581	-556	-528	-559	-558	-525	-532	-486	-495	-497	-521	-720	-708
GONDIPPDC_BG	-3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IID-SCE_BG	-600	100	-488	-488	-488	-461	-461	-405	-405	-389	-390	-390	-390	-386	-386	-388	-388	-388	-388	-388	-388	-388	-388	-388	-388	-388
IID-SDGE_BG	-225	225	134	134	134	134	134	134	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	134	134
IPPDCADLN_BG	-647	471	-427	-427	-345	-345	-345	-380	-290	-290	-290	-290	-340	-290	-290	-290	-290	-290	-290	-290	-290	-290	-290	-290	-380	-345
IPP-IPPGEN_MSL	-470	0	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238
LAUGHLIN_BG	0	222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLNL_BG	-164	164	-40	-50	-50	-50	-41	-45	-42	-45	-48	-50	-51	-51	-49	-47	-47	-47	-53	-57	-57	-57	-51	-48	-39	-31
MARBLE_BG	-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCCLMKTPC_MSL	-783	783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCCULLGH_MSL	-2598	2598	403	380	450	426	465	413	371	371	341	381	382	396	372	361	368	374	344	333	278	292	303	355	427	414
MEAD_MSL	-1460	1460	-451	-101	-100	-58	-133	-529	-375	-533	-878	-519	-486	-531	-525	-445	-468	-504	-452	-476	-528	-527	-518	-473	-234	-300
MEADELDORD_BG	-1140	1140	-218	-89	-103	-82	-115	-253	-164	-224	-349	-218	-206	-225	-219	-188	-198	-213	-188	-193	-200	-202	-203	-199	-143	-164
MEADMKTPC_MSL	-1855	1855	-1	-19	-6	-12	-3	7	-24	-21	-18	-30	-32	-27	-31	-36	-33	-30	-38	-40	-47	-44	-41	-19	-15	-14
MEADTMEAD_MSL	-1668	1668	0	0	0	0	0	0	-25	-30	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-25	-10	-10
MERCHANT_BG	-645	645	-189	-216	-226	-225	-225	-187	-303	-293	-262	-295	-298	-296	-293	-298	-297	-295	-297	-294	-280	-282	-285	-297	-214	-205
MKTPCADLN_MSL	-1935	1935	-382	-317	-327	-316	-333	-400	-464	-497	-569	-503	-497	-508	-504	-488	-531	-540	-522	-523	-489	-491	-539	-544	-352	-364
MONAIPPDC_MSL	-189	188	-189	-189	-107	-107	-107	-142	-52	-52	-52	-52	-102	-52	-52	-52	-52	-52	-52	-52	-52	-52	-52	-52	-142	-107
NEWMELONP_BG	-384	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGILABK4_BG	-366	366	170	175	182	181	184	179	175	174	137	118	118	119	118	118	117	117	115	109	106	107	110	118	128	125
NOB_BG	-1591	1520	102	102	165	104	104	-46	-317	-540	-404	-671	-671	-671	-671	-821	-821	-821	-1,096	-1,096	-1,174	-714	-683	-625	-82	-71
OAKDALE_BG	-246	246	-45	-42	-42	-42	-46	-49	-57	-60	-58	-58	-59	-58	-57	-56	-55	-55	-59	-61	-58	-60	-60	-55	-49	-44
PACI_MSL	-3200	2450	-112	46	384	509	386	183	-387	-610	-1,026	-975	-1,084	-1,026	-1,004	-1,125	-1,030	-858	-1,038	-897	-1,479	-1,798	-1,225	-864	-981	-601
PALOVRDE_MSL	-3328	3328	-2,172	-2,123	-2,408	-2,306	-2,405	-2,242	-2,218	-2,516	-2,339	-2,532	-2,570	-2,636	-2,511	-2,527	-2,493	-2,490	-2,483	-2,493	-2,174	-2,271	-2,272	-2,387	-2,422	-2,445
PARKER_BG	-220	60	-58	-69	-80	-78	-81	-64	-64	-62	-48	-63	-64	-65	-62	-63	-62	-62	-60	-56	-46	-49	-51	-61	-74	-68
PATH15_BG	-5400	9999	-3,475	-3,746	-4,106	-3,983	-4,019	-3,601	-3,642	-3,353	-2,829	-2,857	-2,833	-2,750	-2,693	-2,461	-2,559	-2,904	-3,236	-3,087	-2,280	-2,044	-2,653	-2,989	-2,471	-2,857
PATH26_BG	-9999	4000	-661	-919	-1,279	-1,167	-1,014	-560	-94	183	676	681	657	539	801	828	496	133	714	926	1,706	1,938	1,339	195	92	-327
RDM230_BG	-320	320	65	61	53	44	54	62	83	90	99	97	99	95	94	96	94	92	97	89	111	121	108	87	87	83
RNCHLAKE_BG	-1271	1271	23	6	0	-81	5	-75	8	49	39	23	3	8	16	27	20	26	7	-116	42	65	67	-10	-46	36
SILVERPK_BG	-17	17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17
STANDIFORD_BG	-306	306	-24	-38	-38	-35	-25	-10	-21	-13	-15	-13	-13	-12	-15	-15	-16	-20	-20	-16	-17	-14	-12	-19	-13	-27
SUMMIT_BG	-120	100	-96	-96	-26	-26	-26	-26	-50	-120	-120	-120	-91	-102	-108	-107	-118	-120	-120	-120	-113	-115	-120	-120	-96	-96
SUTTEROBANION_BG	-1366	1366	30	30	30	250	47	250	250	250	250	250	250	250	250	250	250	250	250	525	273	250	250	250	218	0
SYLMAR-AC_BG	-1600	1600	-106	-98	122	104	91	27	116	19	70	-41	-43	-43	-42	-103	-103	-102	-214	-195	-233	-46	-32	-16	9	25
TRACY230_BG	-1366	1366	-440	-430	-429	-430	-447	-485	-558	-577	-571	-576	-587	-574	-559	-545	-544	-547	-602	-593	-547	-570	-574	-535	-465	-410
TRACY500_BG	-4265	4388	319	388	495	451	457	320	276	186	48	57	31	26	28	-26	13	82	95	43	-103	-176	11	127	-23	129
VICTVL_BG	-2400	900	-1,500	-1,383	-1,374	-1,330	-1,398	-1,458	-1,268	-1,320	-1,357	-1,332	-1,365	-1,359	-1,321	-1,292	-1,326	-1,350	-1,301	-1,300	-1,207	-1,202	-1,239	-1,311	-1,395	-1,375
WESTLYLBNS_BG	-600	600	290	291	332	313	346	332	356	341	287	291	287	278	275	250	262	279	316	310	235	217	290	303	198	211
WESTLYTSLA_BG	-599	599	-191	-186	-206	-196	-219	-223	-247	-239	-214	-215	-214	-208	-207	-194	-202	-209	-235	-236	-191	-185	-219	-222	-161	-155
WSTWGMEAD_MSL	-126	126	-103	-103	-103	-103	-103	-103	-107	-107	-107	-107	-107	-107	-107	-107	-107	-107	-107	-107	-107	-107	-107	-107	-103	-103

5.4.2 FI Results

All candidate paths passed the FI test for all winter scenarios.

5.5 FI Results Summary

Summing up the results for all four seasons, the final candidate path competitiveness test results are shown. Note that if a candidate path fails the competitive test in one season, that path will be designated as uncompetitive for the entire year.

Table 27. FI Results Summary

Candidate Path	Minimum FI	Hours with FI < 0	Pass or Fail
HUMBOLDT_BG			Pass
HUMBOLDT_XFBG			Pass
MARTIN_C_POTRPP_NG			Pass
MOSSLNDMETCALF_NG_SUM_OFFPK			Pass
MOSSLNDMETCALF_NG_SUM_ONPK			Pass
MOSSLNDMETCALF_NG_WIN			Pass
PITSBRG_SANMAT_NG_SUM			Pass
PITSBRG_SANMAT_NG_WIN			Pass
RAVENSWD_NG_SUM			Pass
RAVENSWD_NG_WIN			Pass
RAVENSWDSANMAT_NG_SUM			Pass
RAVENSWDSANMAT_NG_WIN			Pass
TESLA46_XFNG			Pass
TESLA64_XFNG			Pass
MONTAVISTA_JEFSN_BG			Pass
PITSBRG_XFMR_BG	**-0.11**	**406**	**Fail**
TESLA_DELTASWYRD_BG			Pass
TESLA_PITSBURG_BG			Pass
VACADX_TESLA_XFNG			Pass
MIGUEL_IMP_BG			Pass
MIGUEL_MAXIMP_LXNF_NG			Pass
SDGE_CFEIMP_BG			Pass
SDGEIMP_BG			Pass
SSONGS_BG			Pass
VICTVLUGO_HANG_NG			Pass
IVALLYBANK_XFBG			Pass
VINCNT_XFBG			Pass

Overall, all aggregated candidate paths except PITSBRG_XFMR_BG passed the four seasonal FI tests and would be designated as competitive paths. 18 passed candidate paths are in NP26 area and 10 passed candidate paths are in SP26 area. All of the candidate paths that are individual transmission lines passed the four seasonal FI tests.

The seasonal test results are summarized in Table 28. Candidate paths only failed in spring or summer scenarios when demands are high.

Table 28. FI Results Summary by Season

Candidate Path	Spring	Summer	Fall	Winter	All
HUMBOLDT_BG					Pass
HUMBOLDT_XFBG					Pass
MARTIN_C_POTRPP_NG					Pass
MOSSLNDMETCALF_NG_SUM_OFFPK					Pass
MOSSLNDMETCALF_NG_SUM_ONPK					Pass
MOSSLNDMETCALF_NG_WIN					Pass
PITSBRG_SANMAT_NG_SUM					Pass
PITSBRG_SANMAT_NG_WIN					Pass
RAVENSWD_NG_SUM					Pass
RAVENSWD_NG_WIN					Pass
RAVENSWDSANMAT_NG_SUM					Pass
RAVENSWDSANMAT_NG_WIN					Pass
TESLA46_XFNG					Pass
TESLA64_XFNG					Pass
MONTAVISTA_JEFSN_BG					Pass
PITSBRG_XFMR_BG	**Fail**	**Fail**			**Fail**
TESLA_DELTASWYRD_BG					Pass
TESLA_PITSBURG_BG					Pass
VACADX_TESLA_XFNG					Pass
MIGUEL_IMP_BG					Pass
MIGUEL_MAXIMP_LXNF_NG					Pass
SDGE_CFEIMP_BG					Pass
SDGEIMP_BG					Pass
SSONGS_BG					Pass
VICTVLUGO_HANG_NG					Pass
IVALLYBANK_XFBG					Pass
VINCNT_XFBG					Pass

The aggregated candidate paths that passed the FI tests and would become competitive paths in MPM-RRD runs in IFM and RTM under MRTU[22] are shown in Table 29. The single candidate paths that passed the tests are shown in Table 30.

[22] Please refer to Market Operation Business Practice Manual for additional market operation information. The documents can be found at http://www.caiso.com/17ba/17baa8bc1ce20.html.

Table 29. Competitive Path List – Aggregated Constraints

Competitive Aggregated Constraints	Transmission Segment
HUMBOLDT_BG	31000_HUMBSB 1_115.00_31452_TRINTY 1_115.00_1_CKT
HUMBOLDT_BG	31015_BRDGVL 1_115.00_31010_LOWGAP 1_115.00_1_CKT
HUMBOLDT_BG	31093_GRSCRK 2_60.00_31092_MPLCRK 1_60.00_1_CKT
HUMBOLDT_BG	31116_GARBVL 1_60.00_31118_KEKAWK 1_60.00_1_CKT
MARTIN_C_POTRPP_NG	28_LARKIN 2_115.00_33208_MARTIN 1_115.00_1_CKT
MARTIN_C_POTRPP_NG	30695_MARTIN 4_230.00_99158_MARTIN 9_230.00_1_CKT
MARTIN_C_POTRPP_NG	30695_MARTIN 4_230.00_99160_MARTIN 5_230.00_1_CKT
MARTIN_C_POTRPP_NG	33204_POTRPP 1_115.00_33252_POTRPP 5_20.00_1_CKT
MARTIN_C_POTRPP_NG	33204_POTRPP 1_115.00_33253_POTRPP 2_13.80_1_CKT
MARTIN_C_POTRPP_NG	33204_POTRPP 1_115.00_33254_POTRPP 3_13.80_1_CKT
MARTIN_C_POTRPP_NG	33204_POTRPP 1_115.00_33255_POTRPP 4_13.80_1_CKT
MARTIN_C_POTRPP_NG	33205_HUNTER 1_115.00_33208_MARTIN 1_115.00_1_CKT
MARTIN_C_POTRPP_NG	33205_HUNTER 1_115.00_33208_MARTIN 1_115.00_2_CKT
MARTIN_C_POTRPP_NG	33206_BAYSHR 1_115.00_33208_MARTIN 1_115.00_1_CKT
MARTIN_C_POTRPP_NG	33207_BAYSHR 2_115.00_33208_MARTIN 1_115.00_1_CKT
MIGUEL_IMP_BG	22464_MIGUEL 1_230.00_20149_TJUANA 1_230.00_1_CKT
MIGUEL_IMP_BG	99_IVALLY 3_500.00_22468_MIGUEL 3_500.00_1_CKT
MIGUEL_MAXIMP_LXNF_NG	22356_IVALLY 1_230.00_22994_TERMEX 1_230.00_1_CKT
MIGUEL_MAXIMP_LXNF_NG	22356_IVALLY 1_230.00_22994_TERMEX 1_230.00_2_CKT
MIGUEL_MAXIMP_LXNF_NG	22356_IVALLY 1_230.00_22998_LAROA2 1_230.00_1_CKT
MIGUEL_MAXIMP_LXNF_NG	22356_IVALLY 1_230.00_22998_LAROA2 1_230.00_2_CKT
MIGUEL_MAXIMP_LXNF_NG	22464_MIGUEL 1_230.00_22468_MIGUEL 3_500.00_1_CKT
MIGUEL_MAXIMP_LXNF_NG	22468_MIGUEL 3_500.00_22472_MIGUEL 4_1.00_1_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	30042_METCLF 5_500.00_30045_MOSSLD13_500.00_1_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	30735_METCLF 4_230.00_30750_MOSSLD11_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	30735_METCLF 4_230.00_30750_MOSSLD11_230.00_2_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	36221_MOSSLD 3_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	36222_MOSSLD 4_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	36223_MOSSLD 6_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	36224_MOSSLD 5_18.00_30787_MOSSLD12_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	36225_MOSSLD 2_18.00_30787_MOSSLD12_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_OFFPK	36226_MOSSLD 7_18.00_30787_MOSSLD12_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	30042_METCLF 5_500.00_30045_MOSSLD13_500.00_1_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	30735_METCLF 4_230.00_30750_MOSSLD11_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	30735_METCLF 4_230.00_30750_MOSSLD11_230.00_2_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	36221_MOSSLD 3_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	36222_MOSSLD 4_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	36223_MOSSLD 6_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	36224_MOSSLD 5_18.00_30787_MOSSLD12_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	36225_MOSSLD 2_18.00_30787_MOSSLD12_230.00_1_CKT
MOSSLNDMETCALF_NG_SUM_ONPK	36226_MOSSLD 7_18.00_30787_MOSSLD12_230.00_1_CKT
MOSSLNDMETCALF_NG_WIN	30042_METCLF 5_500.00_30045_MOSSLD13_500.00_1_CKT
MOSSLNDMETCALF_NG_WIN	30735_METCLF 4_230.00_30750_MOSSLD11_230.00_1_CKT
MOSSLNDMETCALF_NG_WIN	30735_METCLF 4_230.00_30750_MOSSLD11_230.00_2_CKT
MOSSLNDMETCALF_NG_WIN	36221_MOSSLD 3_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_WIN	36222_MOSSLD 4_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_WIN	36223_MOSSLD 6_18.00_30780_MOSSLD10_230.00_1_CKT
MOSSLNDMETCALF_NG_WIN	36224_MOSSLD 5_18.00_30787_MOSSLD12_230.00_1_CKT
MOSSLNDMETCALF_NG_WIN	36225_MOSSLD 2_18.00_30787_MOSSLD12_230.00_1_CKT
MOSSLNDMETCALF_NG_WIN	36226_MOSSLD 7_18.00_30787_MOSSLD12_230.00_1_CKT

Competitive Aggregated Constraints	Transmission Segment
PITSBRG_SANMAT_NG_SUM	30527_PITTSP 5_230.00_99100_PITTSP 7_230.00_1_CKT
PITSBRG_SANMAT_NG_SUM	30527_PITTSP 5_230.00_99102_PITTSP 6_230.00_1_CKT
PITSBRG_SANMAT_NG_WIN	30527_PITTSP 5_230.00_99100_PITTSP 7_230.00_1_CKT
PITSBRG_SANMAT_NG_WIN	30527_PITTSP 5_230.00_99102_PITTSP 6_230.00_1_CKT
RAVENSWD_NG_SUM	30630_NEWARK 3_230.00_30703_RAVENS 2_230.00_1_CKT
RAVENSWD_NG_SUM	30703_RAVENS 2_230.00_30624_TESLA 7_230.00_1_CKT
RAVENSWD_NG_SUM	35349_AMES 2_115.00_35122_NEWARK 2_115.00_1_CKT
RAVENSWD_NG_WIN	30630_NEWARK 3_230.00_30703_RAVENS 2_230.00_1_CKT
RAVENSWD_NG_WIN	30703_RAVENS 2_230.00_30624_TESLA 7_230.00_1_CKT
RAVENSWD_NG_WIN	35349_AMES 2_115.00_35122_NEWARK 2_115.00_1_CKT
RAVENSWDSANMAT_NG_SUM	30703_RAVENS 2_230.00_30700_SANMAT 8_230.00_1_CKT
RAVENSWDSANMAT_NG_SUM	30703_RAVENS 2_230.00_30700_SANMAT 8_230.00_2_CKT
RAVENSWDSANMAT_NG_SUM	33315_RAVENS 1_115.00_33310_SANMAT 1_115.00_1_CKT
RAVENSWDSANMAT_NG_WIN	30703_RAVENS 2_230.00_30700_SANMAT 8_230.00_1_CKT
RAVENSWDSANMAT_NG_WIN	30703_RAVENS 2_230.00_30700_SANMAT 8_230.00_2_CKT
RAVENSWDSANMAT_NG_WIN	33315_RAVENS 1_115.00_33310_SANMAT 1_115.00_1_CKT
SDGE_CFEIMP_BG	22356_IVALLY 1_230.00_20118_ROA 1_230.00_1_CKT
SDGE_CFEIMP_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_1_CKT
SDGE_CFEIMP_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_2_CKT
SDGE_CFEIMP_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_3_CKT
SDGE_CFEIMP_BG	24131_SONGS 1_230.00_22844_TALEGA 2_230.00_1_CKT
SDGE_CFEIMP_BG	24131_SONGS 1_230.00_22844_TALEGA 2_230.00_2_CKT
SDGE_CFEIMP_BG	99_IVALLY 3_500.00_22468_MIGUEL 3_500.00_1_CKT
SDGEIMP_BG	22464_MIGUEL 1_230.00_20149_TJUANA 1_230.00_1_CKT
SDGEIMP_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_1_CKT
SDGEIMP_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_2_CKT
SDGEIMP_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_3_CKT
SDGEIMP_BG	24131_SONGS 1_230.00_22844_TALEGA 2_230.00_1_CKT
SDGEIMP_BG	24131_SONGS 1_230.00_22844_TALEGA 2_230.00_2_CKT
SDGEIMP_BG	99_IVALLY 3_500.00_22468_MIGUEL 3_500.00_1_CKT
SSONGS_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_1_CKT
SSONGS_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_2_CKT
SSONGS_BG	24131_SONGS 1_230.00_22716_SANLUS 2_230.00_3_CKT
SSONGS_BG	24131_SONGS 1_230.00_22844_TALEGA 2_230.00_1_CKT
SSONGS_BG	24131_SONGS 1_230.00_22844_TALEGA 2_230.00_2_CKT
TESLA46_XFNG	30625_TESLA 6_230.00_30040_TESLA 8_500.00_1_CKT
TESLA46_XFNG	30640_TESLA 5_230.00_30040_TESLA 8_500.00_1_CKT
TESLA64_XFNG	30625_TESLA 6_230.00_30040_TESLA 8_500.00_1_CKT
TESLA64_XFNG	30640_TESLA 5_230.00_30040_TESLA 8_500.00_1_CKT
VACADX_TESLA_XFNG	30067_VACADX 1_1.00_30460_VACADX 7_230.00_1_CKT
VACADX_TESLA_XFNG	30640_TESLA 5_230.00_30040_TESLA 8_500.00_1_CKT
VICTVLUGO_HANG_NG	101_NGILA 2_500.00_15090_HASAMP 1_500.00_1_CKT
VICTVLUGO_HANG_NG	24086_LUGO 5_500.00_26105_VICTVL 1_500.00_1_CKT
HUMBOLDT_XFBG	31000_HUMBSB 1_115.00_31001_HUMBSB 3_1.00_1_CKT
HUMBOLDT_XFBG	31080_HUMBSB 4_60.00_31000_HUMBSB 1_115.00_1_CKT
IVALLYBANK_XFBG	22356_IVALLY 1_230.00_22360_IVALLY 2_500.00_1_CKT
IVALLYBANK_XFBG	22356_IVALLY 1_230.00_22360_IVALLY 2_500.00_2_CKT
MONTAVISTA_JEFSN_BG	30705_MNTVIS 2_230.00_30710_SLAC 2_230.00_1_CKT
MONTAVISTA_JEFSN_BG	30705_MNTVIS 2_230.00_30712_SLAC 3_230.00_1_CKT
TESLA_DELTASWYRD_BG	30580_ALTMID 1_230.00_38610_BANKPP 6_230.00_1_CKT
TESLA_PITSBURG_BG	30595_FLOWD2 2_230.00_30640_TESLA 5_230.00_1_CKT
TESLA_PITSBURG_BG	30600_JVENTR 1_230.00_30640_TESLA 5_230.00_1_CKT
VINCNT_XFBG	24155_VINCNT 7_230.00_24156_VINCNT 8_500.00_1_CKT
VINCNT_XFBG	24188_VINCNT 1_1.00_24156_VINCNT 8_500.00_1_CKT
VINCNT_XFBG	24248_VINCNT 3_1.00_24156_VINCNT 8_500.00_1_CKT

Table 30. Competitive Path List – Single Transmission Segments

Competitive Path	Competitive Path
10_EMBARC 2_230.00_99160_MARTIN 5_230.00_1_CKT	30717_JEFRSN 4_230.00_99170_MARTIN 7_230.00_1_CKT
22052_BQUTOS 2_138.00_22228_ENCINA 4_138.00_1_CKT	31080_HUMBSB 4_60.00_31092_MPLCRK 1_60.00_1_CKT
22052_BQUTOS 2_138.00_22648_PQUTOS 3_138.00_1_CKT	31110_BRDGVL 4_60.00_31112_FRTLND 1_60.00_1_CKT
22227_ENCINA 6_230.00_22261_PALOMR 4_230.00_1_CKT	33200_LARKIN 1_115.00_33204_POTRPP 1_115.00_1_CKT
22227_ENCINA 6_230.00_22716_SANLUS 2_230.00_1_CKT	33203_MISSIX 1_115.00_33204_POTRPP 1_115.00_1_CKT
22232_ENCINA 5_230.00_22716_SANLUS 2_230.00_1_CKT	33205_HUNTER 1_115.00_33203_MISSIX 1_115.00_1_CKT
22260_ESCNDO 5_230.00_22261_PALOMR 4_230.00_1_CKT	33205_HUNTER 1_115.00_33203_MISSIX 1_115.00_2_CKT
22260_ESCNDO 5_230.00_22261_PALOMR 4_230.00_2_CKT	33205_HUNTER 1_115.00_33204_POTRPP 1_115.00_1_CKT
22260_ESCNDO 5_230.00_22844_TALEGA 2_230.00_1_CKT	33206_BAYSHR 1_115.00_33204_POTRPP 1_115.00_1_CKT
22261_PALOMR 4_230.00_22832_SXCYN 2_230.00_1_CKT	33207_BAYSHR 2_115.00_33204_POTRPP 1_115.00_1_CKT
22464_MIGUEL 1_230.00_22504_MSSION 1_230.00_1_CKT	33208_MARTIN 1_115.00_30695_MARTIN 4_230.00_1_CKT
22464_MIGUEL 1_230.00_22504_MSSION 1_230.00_2_CKT	33208_MARTIN 1_115.00_30695_MARTIN 4_230.00_2_CKT
22464_MIGUEL 1_230.00_22596_OLDTWN 1_230.00_1_CKT	33208_MARTIN 1_115.00_33305_SHAWRD 1_115.00_1_CKT
22464_MIGUEL 1_230.00_22832_SXCYN 2_230.00_1_CKT	33208_MARTIN 1_115.00_33307_MILBRA 1_115.00_1_CKT
22464_MIGUEL 1_230.00_22832_SXCYN 2_230.00_2_CKT	33208_MARTIN 1_115.00_33310_SANMAT 1_115.00_1_CKT
22504_MSSION 1_230.00_22596_OLDTWN 1_230.00_1_CKT	33208_MARTIN 1_115.00_33322_UNTDQF 2_115.00_1_CKT
22504_MSSION 1_230.00_22596_OLDTWN 1_230.00_2_CKT	33303_EGRAND 1_115.00_33208_MARTIN 1_115.00_1_CKT
22504_MSSION 1_230.00_22716_SANLUS 2_230.00_1_CKT	33303_EGRAND 1_115.00_33308_SFIAMA 1_115.00_1_CKT
22504_MSSION 1_230.00_22716_SANLUS 2_230.00_2_CKT	33306_SFARPT 1_115.00_33322_UNTDQF 2_115.00_1_CKT
22596_OLDTWN 1_230.00_22652_PQUTOS 1_230.00_1_CKT	33307_MILBRA 1_115.00_33310_SANMAT 1_115.00_1_CKT
28_LARKIN 2_115.00_33203_MISSIX 1_115.00_1_CKT	33310_SANMAT 1_115.00_33305_SHAWRD 1_115.00_1_CKT
28_LARKIN 2_115.00_33204_POTRPP 1_115.00_1_CKT	33310_SANMAT 1_115.00_33306_SFARPT 1_115.00_1_CKT
30560_EASTSH 2_230.00_30700_SANMAT 8_230.00_1_CKT	33310_SANMAT 1_115.00_33308_SFIAMA 1_115.00_1_CKT
30685_EMBARC 1_230.00_99158_MARTIN 9_230.00_1_CKT	33312_BELMNT 1_115.00_33310_SANMAT 1_115.00_1_CKT
30700_SANMAT 8_230.00_30567_TESSUB 2_230.00_1_CKT	33356_BURLNG 1_115.00_33208_MARTIN 1_115.00_1_CKT
30701_SANMAT 5_1.00_30700_SANMAT 8_230.00_1_CKT	33356_BURLNG 1_115.00_33310_SANMAT 1_115.00_1_CKT
30702_SANMAT 6_1.00_30700_SANMAT 8_230.00_1_CKT	46_SANMAT10_230.00_47_SANMAT11_230.00_1_CKT
30704_SANMAT 7_1.00_30700_SANMAT 8_230.00_1_CKT	95_VINCNT 2_1.00_24156_VINCNT 8_500.00_1_CKT
30715_JEFRSN 1_230.00_30710_SLAC 2_230.00_1_CKT	99102_PITTSP 6_230.00_30567_TESSUB 2_230.00_1_CKT
30715_JEFRSN 1_230.00_30712_SLAC 3_230.00_1_CKT	

Table 31 and Table 32 below show the distribution of all the negative FIs on candidate paths upon 9 different hydro and load scenarios. Not surprisingly, most of the line flow violations occur under high load scenarios.

Table 31. Negative FI Distribution by Load and Hydro Scenarios in Spring

# of hours w/ negative FI in Spring Simulations		Load Scenarios			Total
		High	Medium	Low	
Hydro Scenarios	High	59	0	0	**59**
	Medium	60	0	0	**60**
	Low	59	0	0	**59**
Total		**178**	**0**	**0**	***178***

Table 32. Negative FI Distribution by Load and Hydro Scenarios in Summer

# of hours w/ negative FI in Summer Simulations		Load Scenarios			Total
		High	Medium	Low	
Hydro Scenarios	High	140	0	0	**140**
	Medium	133	0	0	**133**
	Low	133	0	0	**133**
Total		**406**	**0**	**0**	***406***

Table 33 and Table 34 below show the distribution of all the negative FIs on candidate paths upon all the scenarios grouped by the number of pivotal players withdrawn. These tables were requested at the stakeholder meeting held after the first release of preliminary results in June. Not surprisingly, most of the negative FIs occurred when three players were withdrawn from the market.

Table 33. Negative FI Distribution by Number of Suppliers Withdrawn in Spring

Candidate Path	Mininum FI				Percentage of hours with negative FI				# of hours with negative FI			
# of company withdrawn	0	1	2	3	0	1	2	3	0	1	2	3
HUMBOLDT_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
HUMBOLDT_XFBG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MARTIN_C_POTRPP_NG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MOSSLNDMETCALF_NG_SUM_OFFPK					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MOSSLNDMETCALF_NG_SUM_ONPK					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MOSSLNDMETCALF_NG_WIN					0.0%	0.0%	0.0%	0.0%	0	0	0	0
PITSBRG_SANMAT_NG_SUM					0.0%	0.0%	0.0%	0.0%	0	0	0	0
PITSBRG_SANMAT_NG_WIN					0.0%	0.0%	0.0%	0.0%	0	0	0	0
RAVENSWD_NG_SUM					0.0%	0.0%	0.0%	0.0%	0	0	0	0
RAVENSWD_NG_WIN					0.0%	0.0%	0.0%	0.0%	0	0	0	0
RAVENSWDSANMAT_NG_SUM					0.0%	0.0%	0.0%	0.0%	0	0	0	0
RAVENSWDSANMAT_NG_WIN					0.0%	0.0%	0.0%	0.0%	0	0	0	0
TESLA46_XFNG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
TESLA64_XFNG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MONTAVISTA_JEFSN_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
PITSBRG_XFMR_BG		-0.01	-0.07	-0.07	0.0%	0.0%	0.4%	0.9%	0	6	54	118
TESLA_DELTASWYRD_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
TESLA_PITSBURG_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
VACADX_TESLA_XFNG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MIGUEL_IMP_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MIGUEL_MAXIMP_LXNF_NG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
SDGE_CFEIMP_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
SDGEIMP_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
SSONGS_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
VICTVLUGO_HANG_NG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
IVALLYBANK_XFBG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
VINCNT_XFBG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
Total									**0**	**6**	**54**	**118**

Table 34. Negative FI Distribution by Load and Hydro Scenarios in Summer

Candidate Path	Mininum FI				Percentage of hours with negative FI				# of hours with negative FI			
# of company withdrawn	0	1	2	3	0	1	2	3	0	1	2	3
HUMBOLDT_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
HUMBOLDT_XFBG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MARTIN_C_POTRPP_NG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MOSSLNDMETCALF_NG_SUM_OFFPK					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MOSSLNDMETCALF_NG_SUM_ONPK					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MOSSLNDMETCALF_NG_WIN					0.0%	0.0%	0.0%	0.0%	0	0	0	0
PITSBRG_SANMAT_NG_SUM					0.0%	0.0%	0.0%	0.0%	0	0	0	0
PITSBRG_SANMAT_NG_WIN					0.0%	0.0%	0.0%	0.0%	0	0	0	0
RAVENSWD_NG_SUM					0.0%	0.0%	0.0%	0.0%	0	0	0	0
RAVENSWD_NG_WIN					0.0%	0.0%	0.0%	0.0%	0	0	0	0
RAVENSWDSANMAT_NG_SUM					0.0%	0.0%	0.0%	0.0%	0	0	0	0
RAVENSWDSANMAT_NG_WIN					0.0%	0.0%	0.0%	0.0%	0	0	0	0
TESLA46_XFNG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
TESLA64_XFNG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MONTAVISTA_JEFSN_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
PITSBRG_XFMR_BG		-0.06	-0.10	-0.11	0.0%	0.1%	0.9%	1.9%	0	15	127	264
TESLA_DELTASWYRD_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
TESLA_PITSBURG_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
VACADX_TESLA_XFNG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MIGUEL_IMP_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
MIGUEL_MAXIMP_LXNF_NG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
SDGE_CFEIMP_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
SDGEIMP_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
SSONGS_BG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
VICTVLUGO_HANG_NG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
IVALLYBANK_XFBG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
VINCNT_XFBG					0.0%	0.0%	0.0%	0.0%	0	0	0	0
Total									**0**	**15**	**127**	**264**

6 Concluding Comments

The simulation results and competitive test outcomes presented in this paper represent the final path designations that will be incorporated in the market software at the time MRTU is implemented. These designations reflect updates introduced in the last version of the CPA, updated input data and network model, as well as adjustments to supplier portfolios to account for transfer of operational and bidding control of generation resources within the CAISO control area.

Incorporating results from all seasons, 27 aggregated candidate constraints and all single candidate paths passed the competitiveness test. The single candidate paths are comprised of 59 individual transmission segments, and the aggregated candidate constraints that passed collectively are comprised of 135 records of individual lines and 93 distinct individual lines. This brought the total number of individual line segments that passed the competitiveness test to 152. Note that there are a total of roughly 4,800 individual line segments in the FNM and 154 of these were included in the testing as candidate paths.

The results of this release show a much lower incidence of failure for tested paths, where only the PITSBRG_XFMR_BG path failed the FI test under any of the scenarios compared to seven paths that failed in Release 3. There are several differences between the two releases that can attribute to this difference:

- Changes in supplier portfolios withheld, either through new or retired generation, transfer of ownership of generation, or change in transfer of operational and bidding control via tolling agreement,
- Transmission upgrades that relieve previously binding constraints under various withholding scenarios,
- Updates in the FNM used in the simulation, and
- Updated input data used to form the basis for load, hydro, scheduled generation, and bids.

Transmission upgrades directly impacted the Contra Costa 230kV, Moss Landing to Metcalf, and Vaca and Tesla Bank facilities, which all tested uncompetitive in Release 3 but due to increases in transfer capacity did not fail the FI test and were deemed competitive in this release of designations. In addition to transmission upgrades, more accurate and current versions of the FNM also reduced the incidence of binding and violated constraints across the various withholding scenarios. These two transmission-related factors, transmission upgrades and improved FNM, likely account for much of the difference in test results between the third release and this release of competitive test results. Changes in supplier portfolios, whether due to changes in asset ownership or contracting, and the input data (load, hydro, schedules, bids) appear to have had less impact on the difference in test results than did the transmission upgrades and FNM change.

The current competitive path assessment incorporates latest released FNM DB32 with Integrated Balance Authority Area modeling, projected major transmission upgrade for Mosslanding-Metcalf, projected new generators in 2009, updated hydro and load conditions as well as generation bids, updated candidate path list, updated generation ownership considering the tolling agreement for 2009, and a reduced 500MW threshold to screen the major generation owner. The results of the competitive paths reflect all these updates.

There are still factors that may require periodic review and update of the CPA after MRTU go live. Such factors include:

- Update of MRTU Full Network Model: the FNM is updated several times a year, and commercial network model topology may be changed from seasonal switches, modeling of new areas and transmission facilities, adjustments of major transmission limits, etc. New network model will be used or incremental changes will be incorporated if the changes are significant to update the results.
- Market Clearing Model and Optimization: Currently the CPA is done by the simulation tool different from MRTU software. To further align the simulations used for path designations with the actual market model and software, developing the CPA within a simulation tool that more closely reflects the market software will be reviewed.
- Impact of Relatively Small Generation Owners. The 3-pivitol suppliers tests are computationally intensive, and there exists a large number of potential combinations of suppliers that could withdrawal. It is impractical to exhaust all the combinations for all suppliers, and that's the reason a threshold of 500 MW is established to identify larger suppliers that can more easily influence market prices. However, there may be cases where, in a relatively small congested area, a small generation owner whose generation capacity is less than the selection threshold may be pivotal to relieve the constraint. While this analysis does not consider such cases, DMM has developed tools to analyze the effectiveness of LMPM in local areas and will monitor market outcomes for the purpose of detecting potentially uncompetitive circumstances in local areas. In cases where uncompetitive outcomes are observed and the competitive path designations for that area do not appear to be consistent with the market outcomes, DMM will evaluate both the path designations as well as the application of LMPM in that area.