CRR Study 2

Proposed Processes, Input Data and Modeling Assumptions

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1. Introduction

The California Independent System Operator (CAISO) is preparing to embark on Congestion Revenue Rights (CRR) Study 2. This document provides the proposed processes, input data and modeling assumptions upon which this Study will be based.

The CAISO has recently completed CRR Study 1 (refered to as "Congestion Revenue Rights Preliminary Study Report"[1]) along with two sensitivity runs (refer to "Congestion Revenue Rights Sensitivity Study Report"[2]). The proposed processes, data input and modeling assumptions for CRR Study 1 were based on the initial market design elements of the CAISO's Market Redesign 2002 project (MD02). These design elements were described in the CAISO's May 1, 2002 Comprehensive Market Design Proposal (Amendment 44)[3] and June 17, 2002 tariff filing with the Federal Energy Regulatory Commission[3, 4].

The objective of CRR Study 1 was two-fold. The primary objective of this study was to estimate the extent to which the initial CRR requests submitted by Load Serving Entities (LSEs) can be fully allocated, given the major market design elements proposed in the CAISO's May and June 2002 MD02 filings. A secondary objective was to test and demonstrate the performance of the CRR study software and other essential study elements such as the network model and the source-to-sink representation of ETC rights and to gain experience in developing and implementing a CRR allocation process.

The CAISO has proposed several modifications to the market design since the May and June 2002 filings including those associated with CRRs as noted in the CAISO's July 22, 2003 Amended Comprehensive Market Design Proposal filing (Amended filing)[3]. The proposed processes, data input and modeling assumptions contained in this document are based on this Amended filing with a few exceptions, as discussed below.

1.1. CRR Study 2 Objectives

There are two main objectives for CRR Study 2. The first objective is to estimate the extent to which the CRR requests submitted by LSEs can be fully allocated, given the recent changes to the market design elements as proposed in the Amended filing (with exceptions as noted below). The second objective is to address questions of CRR effectiveness in hedging congestion costs. Specifically, this second objective will attempt to determine the extent to which allocated CRRs can hedge congestion costs in the Day-Ahead Market for LSEs serving CAISO control area load. Thus Study 2 will demonstrate the viability of an approach to CRR allocation that is based on the concept of adequate hedging of congestion costs over the course of the year, rather than trying to cover LSE schedules on a MW basis in each hour.

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[1] At http://www.caiso.com/docs/2003/10/02/200310021604581375.pdf
[2] At http://www.caiso.com/docs/2003/12/15/2003121514062310939.pdf
[3] At http://www.caiso.com/docs/2002/05/29/200205290858531076.html
[4] The latter filing, which contained Tariff language implementing the forward-market elements of Amendment 44 (including LMP and CRRs) was never acted on by FERC and was formally withdrawn by the ISO in its July 22, 2003 filing.

Addressing the question of CRR effectiveness in hedging congestion costs requires the execution and comparison of the results of two streams of quantitative analysis that need to be conducted and then brought together. The first analysis involves the simultaneous feasibility of CRRs in terms of MW quantities and source and sink locations. The second analysis compares the congestion costs and CRR revenues produced under the Locational Marginal Pricing (LMP) congestion management approach that is at the heart of the MD02 proposal. The main objectives of CRR Study 2 are summarized as follows.

- Estimate the quantities of CRRs that can be released assuming the market design features proposed in the Amended filing (with exceptions as noted below).
- Estimate the quantities of CRRs that each LSE serving CAISO control area load will need to maximize the hedge against congestion costs over the course of a year, and demonstrate that these sets of CRRs are simultaneously feasible.

1.2. Additional Sensitivity Runs as Part of CRR Study 2

The CAISO is anticipating additional "sensitivity runs" after CRR Study 2 is complete. The purpose for these market runs will be dictated by need.

1.3. Major Modeling Changes from CRR Study 1

The proposed processes, data input, and modeling assumptions for CRR Study 2 are provided in this document. An overview of the major CRR allocation process changes from CRR Study 1 is given in Table 1.3.

Table 1.3. Major CRR Allocation Process Changes

Network Model	A 2005 network model will be used. But this model will have an open loop rather than an external equivalent, as used in Study 1.
Existing Transmission Contracts (ETCs)	Participating Transmission Owners (PTO) that are party to Existing Transmission Contracts (ETC) will request CRR obligations for those ETCs.
Converted Rights	The Converted Rights holder is allocated CRR options in accordance with their rights that were turned over to the CAISO.
Metered Sub-systems (MSS)	MSS that are requesting CRR obligations as an LSE are allocated CRRs based on their net MSS bubble load (internal bubble generation minus internal bubble load).
CRR Allocation and Simultaneous Feasibility Test (SFT)	Instead of performing sequential Simultaneous Feasibility Tests (SFTs) to allocate CRRs to different types of MPs as in CRR Study 1, there is one (1) SFT for allocating CRRs to the PTOs for their ETCs, to Converted Rights holders and to LSEs. Priorities are used in the allocation process to give priorities to specific CRR types i.e., ETC type, Converted Right type and LSE type. There will still be separate SFTs for annual and monthly CRRs, and for peak and off-peak CRRs.

2. CRR Allocation Proposed Processes, Data Input and Modeling Assumptions

This section provides the CRR Study 2 detailed assumptions for the proposed processes, data input and modeling.

2.1. Study Period

The time frame chosen for CRR Study 2 is the year 2005 (the same as CRR Study 1). The year 2005 was chosen because it represents the first year in the future where the configuration of the grid best matches the conditions under which the LMP congestion management approach and CRR design proposed under MD02 are expected to be operational. Specifically, in 2005, significant transmission upgrades are expected to be completed and certain ETCs are expected to expire.

2.2. CRR Study Data Time Periods

In CRR Study 2 there will be an annual term and a monthly term for both the on-peak and off-peak periods as was the case in CRR Study 1. Also, CRR nominations will be required for the annual term as well as for all 12 months of 2005.

2.3. Network Model

The network used for CRR Study 2 will be based on a DC version of the summer 2005 CAISO planning model[5]. This model will be converted to a passive DC[6] model for use in the allocation process. The network used for CRR Study 1 was based on a heavy summer 2002 base case with the addition of bulk system transmission upgrades that would be operational by 2005.

This model will also have an open loop (i.e., there will be no external control area transmission system representation in the model that externally connects the northern part of the control area with the southern part of the control area). This assumption is consistent with the Amended filing that states that the CAISO will use an open loop model in the Integrated Forward Markets (IFM) over a transitional period[7] with the intent to implement a closed loop network at a later time.

The reason to use the planning model is that it incorporates lower-voltage transmission upgrades as well as the bulk transmission upgrades. The reason that this model was not used in CRR Study 1 is that the CAISO wanted to leverage

[5] For a description of this Planning Model contact your CAISO client representative (this information is not posted on the CAISO web site for security reasons). The information that describes this case is included in Appendix A – 2003 Controlled Grid Study Report (Draft 10-31-2003) and Appendix E Controlled Grid Study Report (Draft 12-03-2003). This information also includes a description of the system upgrades.

[6] DC is a Direct Current network model. In this model, all resistances are set to zero and all voltages are assumed to be 1.0 per unit. A passive DC model contains no active type of resources (i.e., no load or generation). The sources and sinks of the CRR nominations will take the place of generation and load.

[7] The duration of the transition period is not fixed at this time. It depends on if and when other Western RTOs finalize and implement their market systems, along with the resolution of related inter-RTO seams issues, including potential changes to the existing WECC scheduling rules.

applicable network data from LMP Study 2[8] to minimize any duplication of work. The LMP Study 2 network model was based on a heavy summer 2002 base case.

2.3.1. Network Outages

As noted in the Amended filing, the network model used in the annual term CRR allocation will have all lines in service. However, if major long-term outages are scheduled the CAISO may take this outage into consideration when developing the model for the annual term CRR allocation.

Once the actual CRR allocation and auction process is implemented, the network model used in the monthly allocations under MD02 will take into consideration the scheduled outages for that month. However, for CRR Study 2, the CAISO has no meaningful way to estimate future short-term scheduled transmission outages and therefore does not assume any network outages in the monthly CRR allocations.

2.4. Operating Constraints

For CRR Study 1, the set of constraints enforced in the Simultaneous Feasibility Test (SFT) were the current branch group constraints, an additional set of six internal interfaces and the branch thermal limits. In CRR Study 2, the CAISO will investigate the use of additional constraints and contingency analysis in the SFT. Presently, the CAISO has other operating constraints that are not purely branch or interface limits (i.e., limiting the MW flow on the interface) used in the full network model. Such operating constraints are, for example, nomograms. Since the model used in the allocation is a DC model, the investigation will cover two topics.

Topic 1: For nomogram (non-interface) constraints, can these constraints somehow be transformed into an interface constraint to be used in the DC model?

Topic 2: Since the DC model does not include reactive load model or losses, and the operating constraints are based on AC network model (Alternating Current model that includes losses and reactive load modeling) there is a difference in the two models (AC vs. DC) between the relationship of the active power (MW) and the magnitude of the electrical current (amperes) between the two models (AC and DC). This could lead to inconsistencies in the enforcement of the operating constraints. For example, a DC-derived power flow in a line may appear to be feasible with respect to an AC-derived limit, but the same flow may be infeasible in an AC based model causing a thermal overload (the thermal rating is an electrical current magnitude rating). Likewise, an active power limit in the AC model takes losses into consideration where as a DC model will not, thus creating an inconsistency. The general solution to both of these problems (reactive load modeling and losses) is to scale the interface limits by some factor before using them in the DC model. The scaling can occur on a system-wide basis (say 3% throughout the system), or on an exception basis to more accurately represent local system and network conditions.

[8] This Study can be found at http://www.caiso.com/docs/2004/01/29/2004012910361428106.html

2.5. Standard Load Aggregation Points

As noted in the Amended filing, there will be three (3) standard load aggregations for CRR Study 2, one each for the service territories of PG&E, SCE and SDG&E. Additional load aggregations will be established for MSS.

Additionally, any CRR nominations for non-conforming load resource such as pump load that has met the CAISO's communication and metering standards will have the CRR sink at the specific location of the load. The CAISO will identify these load resources before the start of CRR Study 2 and provide this list to those wishing to request CRR allocations.

2.5.1. Load Distribution Factors

The load distribution factors (i.e., allocation factors) for the standard load aggregation points (i.e., aggregated pricing nodes), which are used to allocate the CRR sinks to the underlying network nodes, will be based on the loads within the summer 2005 base case.

Because the relative distribution of the load within each part (southern and northern) of the control area is the same in both variants of the 2005 summer planning case, the LDFs will be identical.

2.6. CRR Types

For CRR Study 2, the CAISO is anticipating that all CRRs will be Point-to-Point. In the June 2002 FERC filing, the CAISO proposed another type of multiple-injection-point CRR called a Network Service Right (NSR). A detailed description of the NSR CRR is provided in a separate document titled, "Network Service Right Definition for the CRR Allocation Process". Due to software limitations, the NSR functionality was not available for CRR Study 1. The CAISO is currently developing the Detailed Statement of Work (DSOW) in conjunction with the CRR system vendor, but at this time, the CAISO doubts that a system with the NSR functionality will be available for CRR Study 2.

2.7. CRR Nominations For CRR Study 2

CRR nominations will be requested for CRR Study 2 from the following entities (i.e., CRR types):

1. The PTOs (PG&E, SCE and SDG&E) that are party to ETCs, specifically for CRRs to hedge the loads served under ETC rights;
2. Converted Rights holders (i.e., the new PTOs);
3. LSEs, which include municipal utilities, and Direct Access providers whose loads are not served under ETC rights;
4. Metered Sub-Systems;
5. Merchant Transmission; and
6. Other entities that may be entitled to CRR allocations.[9]

[9] The CAISO will explore the possibility of allocating CRRs to entities that serve load outside the ISO control area and have made a significant contribution to the embedded costs of the ISO control area.

With regard to CRR allocations, it is important to understand that a crucial objective is to enable CAISO control-area loads to effectively hedge the congestion risks associated with the MD02 market redesign. Although many details of the CRR allocation rules remain to be worked out in conjunction with a stakeholder process, the CAISO would argue that this objective is best served by requiring that the source (injection) pattern of CRRs allocated to each LSE reflect the actual sources of supply (internal generation and import points) used by the LSE to serve its load. The CAISO recognizes that there are some challenges in meeting this requirement. For example, where LSEs rely on supply contracts that are simply delivered by the supplier to one of today's congestion zones, and will work with parties to develop a meaningful way to deal with these challenges.

The proposed methodologies for allocating CRRs to each of these entities are provided next.

2.7.1. PTOs That Are Party to ETCs

The CAISO recognizes that the question of how best to enable ETC loads to hedge their congestion cost risks under the MD02 proposal is open for discussion with stakeholders in a forthcoming process on the CAISO's ETC proposal. For CRR Study 2, however, the CAISO must make working assumption and therefore proposes that the PTO party to an ETC be allocated CRR obligations for that ETC. This is different from the approach taken in CRR Study 1, where the ETCs were modeled as options (as a means of removing the capacity from the network that was reserved for the ETCs). Since Study 2 is planning on modeling ETC rights as obligations, the Upper Bound of the CRR request will be based on the minimum of the following two quantities: (i) the peak load MW quantity for the load that is served under the ETC and (ii) the contractual MW rights quantity for serving that load. If the CRR term is annual, the peak load MW will be determined from historical load data, if the CRR term is monthly the peak load MW will be determined from forecasted load data.

Consistent with the CAISO's Amended filing, the ETC sinks will be modeled at the actual ETC load location rather than be included as part of a standard load aggregation point.

The CAISO is proposing that each applicable PTO submit CRR requests for their ETCs. The CAISO plans to provide further details in this effort, and this process of requesting CRRs will be very similar to the process for LSEs requesting CRRs.

2.7.2. Converted Rights

The new PTOs (Anaheim, Azusa, Banning, Riverside and Vernon) currently hold Firm Transmission Rights (FTRs) given to them in exchange for their respective transmission rights that were turned over to the CAISO. These FTRs are based on the current three-zone and branch group congestion management model and thus need to be converted to Point-to-Point (PTP) CRRs. For CRR Study 1, the CAISO worked with the new PTOs to convert their branch based FTRs into PTP CRRs and this conversion was based on their original ETCs.

In CRR Study 2, the CAISO proposes that the five new PTOs request CRR options for their Converted Rights. The Upper Bound for the amount of CRRs that will be modeled as options will be based on the minimum of the following two quantities: (i) the peak load MW quantity for the load that is served under the Converted Right and (ii) the contractual MW rights quantity for serving that load. If the CRR term is annual, the peak load MW will be determined from historical load data, if the CRR term is monthly the peak load MW will be determined from forecasted load data. If the peak load quantity happens to be greater than the Converted Rights MW amount, CRR can be requested for the residual load amount through the LSE allocation process.

2.7.3. LSEs

For the LSE request of CRRs for CRR Study 2, the CAISO basically keeps the same process as previously followed in CRR Study 1. Those LSEs that have already submitted PTP CRR obligation requests for CRR Study 1 may submit a new set of requests if they want to do so.

The differences in the process from CRR Study 1 to CRR Study 2 in requesting CRR obligations are the following:

- In CRR Study 1, there were four main load aggregation points, PGE3, PGE4, SCE1 and SDG1. As noted above, for Study 2 there will be three main load aggregation points (combining PGE3 and PGE4 into a single PGE load aggregation point).
- There will also be a slight difference in how the Upper Bound for the amount (MW) of CRRs that can be requested (see Appendix B).

LSEs with bilateral contracts have energy contracts in which the sources of the energy delivery is not specific enough to accurately determine a source location for requesting a CRR. In absence of this knowledge about a specific location, many LSEs submitted a trading hub as their source when requesting a CRR for CRR Study 1. The CAISO is proposing, as part of CRR Study 2, to explicitly model actual source locations for this contract energy instead of using the trading hub. Determination of these source locations will be based on input from Market Participants and from historical CAISO scheduling data.

2.7.4. Metered Sub-Systems

There have been on-going discussions for determining how to model Metered Sub-Systems (MSSs) within both the Integrated Forward Market and in the CRR allocation process. The CAISO prepared a document that outlines various alternatives for performing forward congestion management and pricing for the MSS. This document is in Appendix A.

The CAISO preferred pricing alternative is Pricing Option B and the CAISO will use this alternative as the basis for developing the modeling assumptions for the MSS in CRR Study 2. Under this pricing option the MSS is priced on the net MSS load or net MSS generation, which ever the case may be. If the MSS is generally a net generation (i.e., more internal bubble generation than internal bubble load), they would not be allocated CRRs. If the MSS is generally a net load, the MSS should request a CRR from an external source to a MSS aggregation point. This differs somewhat from how the CAISO proposes to treat MSS load in settlement. If the net MSS load is not served under ETC rights, it is settled at one of the three load aggregation points; otherwise it is settled at the MSS aggregation point.

The reason CRR Study 2 will require that the Metered Sub-Systems (MSS) schedule net load (if this is the case) at the MSS Load Aggregation Point is to more accurately model the scheduled net load within the MSS bubble and thus get a more realistic representation of the MSS's use of the CAISO-grid when the MSS is a net load. The MSS load will be removed from the calculation of LDFs for standard load aggregation points.

2.7.5. Merchant Transmission

The CAISO is currently developing a process for allocating CRRs to Merchant Transmission (CAISO-grid transmission that does not recover investment through an access-charge-based revenue requirement) reflecting the amount of added capacity the addition contributes. The process for this allocation will be posted as a white paper for discussion with stakeholders and includes any constraints on the location of the sources or sinks and states at what step in the allocation process that this allocation occurs.

The proposed methodology will be consistent with the Amended filing (paragraph #97):

"In the case of a market-based transmission upgrade, the parties responsible for creating the new transmission capacity will be entitled to receive CRRs reflecting the added capacity once the upgrade is in service, as long as they are in fact bearing the cost of the upgrade and not recovering their investment through an access-charge-based revenue requirement. Market participants who receive a regulated rate of return on investment for building or upgrading transmission will not receive CRRs for the added capacity."

After this white paper, on allocating CRRs to merchant transmission, is published the CAISO hopes to include merchant transmission owners as part of this study.

2.8. Non-ISO Transmission Issues

In the CAISO control area there is non ISO-grid transmission that is part of an enforced operational interface. Even though a CAISO PTO does not own this transmission, some of the PTOs still have rights over this transmission. An example of this is the California-Oregon Transmission Project (COTP).[10] The COTP is part the California Oregon Interface (COI), which is an interface to be enforced in the CRR allocation. The COTP starts at the Captain Jack substation and ends near the Tesla 500 kV substation and will have most of its capacity reserved in the Integrated Forward Markets (IFM) in both the south-to-north direction as well as the north-to-south direction to account for this non ISO-grid transmission. In the CRR allocation process, the CAISO removes this non ISO-grid from COTP in either of two ways:

1. Applies a CRR option with the source option at Captain Jack and the sink a Tesla to remove the capacity in the north-to-south direction. Similarly, applies a CRR option with the source option at Tesla and the sink a Captain Jack to remove the capacity in the south-to-north direction.
2. Reduces the limits on the COI interface in both the south-to-north and north-to-south direction.

For CRR Study 2 the CAISO proposes to adopt Option 2 as the most straightforward and transparent way to treat such rights. The appropriate MW reductions are determined through discussions with the MPs.

There are other non-ISO transmission related issues that also need to be discussed with market participants, e.g., contract 2947A.

[10] The October 28, 2003 FERC order on MD02 directed the CAISO to justify why transmission ownership rights such as COTP should be treated differently from other ETCs. Although the CAISO has not yet responded to the FERC order, the CAISO will assume for CRR Study 2 that its proposed treatment of ownership rights in the July 2003 filing will be implement.

2.9. Simultaneous Feasibility Test Process

In CRR Study 1, there were two sequential Simultaneous Feasibility Tests (SFTs) for the allocation of annual term CRRs to ETC rights holders and LSEs, respectively and two sequential SFTs for the allocation of monthly term CRRs. These sequential SFTs were consistent with the June 2002 FERC filing.

For allocation of the annual CRRs for Study 1, the first SFT was used to remove transmission capacity associated with the ETCs from the network. This was consistent with the Day-Ahead integrated forward market design for reserving transmission for ETCs as noted in the June 2002 FERC filing. This was accomplished by modeling these ETCs as Point-to-point (PTP) options. The second SFT was used to allocate 75% of the remaining transmission capacity to both Converted Rights (modeled at annual PTP Options) and LSEs (modeled as annual PTP obligations). The reason that the Converted Rights CRR Options and LSE CRR Obligations were allocated together using the same SFT rather than two separate SFTs was due to software limitations.

For the monthly CRR term allocation the first SFT was used to allocate the remaining transmission capacity to Converted Rights (modeled at monthly PTP Options) and the second SFT was used to allocate the remaining transmission capacity to LSEs (modeled as monthly PTP obligations).

In the Amended filing, the CAISO proposed that there would be no Day-Ahead transmission reservation for ETCs. Therefore, for Study 2, the PTOs will be allocated CRR obligations for hedging transmission congestion.

Since the PTOs are allocated CRR obligations for their ETCs and there is no reservation of unscheduled ETC capacity in the forward market, there is no reason to perform a separate allocation just involving the ETC CRRs. In fact, the CRR allocation should resemble as much as possible the way in which self-schedules and bids are treated in the IFM including the manner in which the IFM provides priority for certain types of energy schedules (as is the case with ETC schedules which get a higher priority).

The CAISO proposes for CRR Study 2 that there is one SFT for allocating annual term CRRs (one each for on-peak and off-peak) that includes the nominations for ETC CRRs, the Converted Rights CRRs and the LSE CRRs. Since the proposal is to allocate these CRRs as obligations, any allocated CRRs will be able to provide counter flow for other CRR nominations. This was limited in CRR Study 1 since the SFTs were sequential, e.g., LSE CRRs could not provide counter flow for ETCs or Converted Rights since the SFT for the LSE CRRs was run after the SFTs for the ETCs and Converted Rights.

In CRR Study 2, the CAISO proposes the following priorities be assigned to the various CRR types as noted in table 2.10 below.

Table 2.10. Proposed CRR priorities

CRR Type	Priority (1 is the highest)
ETC	1
Converted Rights	2
LSE	3

The combined SFT will use the assigned priorities to allocate transmission capacity to the CRRs with higher priority first before CRRs with lower priority. The only differentiating factor for all CRRs with the same type (i.e., CRRs having the same priority), will be their effectiveness in alleviating any transmission constraints.

The steps taken in the combined SFT process will be as follows:

1. Remove capacity from the system associated with Non-ISO transmission that is part of an operational interface, e.g., COTP;
2. Reduce the remaining capacity of the system by scaling all operational constraints by 75%;
3. Apply to the network, simultaneously and consistently with the priorities provided above, the annual CRR term nominations for the ETCs, the Converted Rights and the LSE;
4. Run the combined SFT and determine the cleared annual term CRRs (fixed CRRs); and
5. Run the SFT for each of the 12 months. This will be done as follows.
    a. Remove the scaling on the operational constraints so they are back to 100%.
    b. Apply all of the annual fixed CRRs to network.
    c. Apply to the network the monthly CRR term nominations for the ETCs, the Converted Rights and the LSE simultaneously and with the priorities provided above.
    d. Run the combined SFT and determine the cleared monthly term CRRs.

2.9.1. Software

The software utilized to perform the allocation of CRRs for CRR Study 2 is expected to be identical software used for CRR Study 1. This software is used to run the PJM production systems.

2.9.2. Objective Function of the CRR Allocation Process

The objective function of the optimization/SFT process is to maximize the amount of allocated CRRs in terms of MW taking into account the priorities associated with the different CRR types. This allocation is subject to the operational constraints that are determined by the CAISO.

2.9.3. Breakdown of Sinks to a Smaller Aggregation Level

In CRR Study 1, the CAISO disaggregated all CRR nominations where the sink was one of the four standard load aggregations. The purpose for disaggregating the four load aggregation areas into smaller load groups was to alleviate constraint violations encountered during the SFT in a more efficient manner and thus allow a larger number of CRR Obligations to "clear" the market[11]. Thus, in preparation for the market runs, the large load aggregation areas were broken down into the smaller load group level aggregations. This same type of disaggregation process will also be conducted in CRR Study 2.

[11] Without breaking down the load aggregation areas into load groups, any downward adjustments made to bid injections at the nodal level by the SFT necessary to achieve simultaneous feasibility could translate into major curtailments of CRRs at the higher load aggregation level since the load distribution factor associated with each injection or withdrawal is fixed.

3. Assumptions for the LMP Calculations and Estimating the Amount of CRRs for Financial Coverage

3.1. Overview

The results of the CRR Study 1 indicated that certain CRR requests were not simultaneously feasible, thus some entities did not receive their full allocation requests. This does not mean necessarily that the resulting CRR awards cannot fully hedge the MPs against congestion charges. Based on the experience of the Northeastern ISOs, a MP can be fully hedged against congestion charges over an entire year, even if the MP does not have a CRR for the full amount of its transaction. This is so because a CRR collects revenue for each hour during the year that the transmission system is congested while the MP transaction is generally not scheduled to flow at full loading during all of the congested hours in the year. Thus, the MP does not pay full congestion costs over the entire year. Instead, it pays congestion costs during those congested hours that its transaction occurred and only for the MW amount of the transaction during those hours.

If the MP is awarded a CRR for the full amount of its transaction, the CRR produces revenue for each hour that the transmission system is congested according to its MW capacity regardless of whether the MP transaction occurred or not during those hours. Therefore, assuming that the CRR is an obligation and the congestion is almost always in the direction of the CRR for the period the MP has chosen to acquire entitlement, then the MP ends up with a revenue surplus equal to CRR revenues minus congestion charges at the end of the year. This also assumes that there are not unexpected transmission outages (i.e., outages not considered during the allocation process) that will reduce the value of CRRs, and that the MPs nominations have been made with the objective of hedging their transactions at peak loading or another high loading level that normally is not maintained throughout the year.

As noted above, the main objective of the CRR Study 1 was to determine the amount of CRRs in MWs that could be released to market participants (MPs), consistent with their requests and with the requirements of a SFT. The argument above leads to the implication that under normal system conditions a less than 100 percent MW CRR coverage would be sufficient to provide full financial hedge against congestion charges over a period of time (e.g., a year). This realization has led the CAISO to explicitly include as one of the key objectives of CRR Study 2 the issue of the CRR financial coverage. Specifically, CRR Study 2 attempts to determine for each LSE serving CAISO control area load the amount of CRRs that are sufficient to fully protect them against congestion charges on an annual basis.

3.2. Proposed Process, Input Data and Modeling Assumptions

In order to achieve the objectives for CRR Study 2, three sets of data are needed:

1. Initial feasible set of CRRs;
2. A set of hourly Locational Marginal Prices (LMP) for each system node over a period of one year; and
3. A set of hourly transactions for each market participant that can be used with the hourly LMPs to determine hourly congestion charges.

3.2.1. Initial feasible set of CRRs

This set is the set of annual and monthly cleared CRRs from objective 1.

3.2.2. Set of Hourly LMPs

Currently the CAISO is conducting LMP Study 3[12], in which LMPs are being calculated. CRR Study 2 plans to use the same methodology, input data and modeling assumptions[13] for calculating the LMPs with two exceptions:

- The network model is based on the same network model used in the CRR allocation process, i.e., a 2005 summer planning model; and
- The enforced constraints are modified to account for any new transmission projects that are reflected in the 2005 planning model.

This process will calculate a set of estimated LMPs for the year 2005.

3.2.3. Transaction Data

Transaction data is needed to determine congestion charges. This data is basically a mapping of resources back to scheduling coordinators so that congestion charges can be accurately calculated. However, this data can also include inter-SC trades that need to be consistent with the Trading Hubs used in the CRR allocation process.

The CAISO will work with the market participants on how best to create this data set. One option would be to use the final schedules from the LMP calculation methodology.

3.2.4. Determining Yearly Financial Hedge Positions

Once the hourly congestion charges are calculated for each market participant, they will be summed over the year. These annual congestion charges will then need to be compared with the annual CRR revenues.

[12] LMP Study 3 report can be found at http://www.caiso.com/docs/2004/01/29/2004012910361428106.html
[13] Refer to LMP Study 3 report.

An initial hourly CRR revenue value for each market participant will be calculated using the CRRs from the allocation process. This hourly revenue will be used to derive the annual CRR revenue for each market participant.

For those market participants that have a net gain (i.e., CRR revenue is greater than Day-Ahead estimate congestion costs), a scaling factor is applied to their CRRs to scale them down so that CRR revenue equals day-ahead estimate congestion costs. Note that while some market participants may have excess net CRR revenues, others may not (i.e., CRR revenue is less than the Day-Ahead estimate congestion costs). Another set of SFTs will then be applied to both the annual and monthly CRRs to determine feasibility. By reducing (scaling) some CRRs, other CRRs (those for market participants that had a positive net congestion cost) may be able to clear more and thus allowing their CRR revenue to increase.

4. Appendix A - Metered Sub-system Pricing Alternatives

4.1. Objective

The objective of Appendix A is to provide to those entities that are Metered Sub-Systems (MSS), options for congestion management and subsequent pricing in the CAISO's Integrated Forward Market (IFM) and Real-time (RT) Imbalance Energy Market.

4.2. Full Network Model

Before addressing the congestion management and pricing issues, the issue of the modeling of the transmission network needs to be addressed. The transmission network is an integral part of both the IFM and the RT market. The RT market should model as closely as possible the conditions in the actual power system. This is accomplished by modeling the network as accurately as possible, metering various location in the network for accurate voltage and power flow measurements and approximating all other quantities with a state estimator calculation.

One main objective of using the full network model in the forward market is to ensure that all forward market schedules are feasible with respect to real-time operations. To this end, all transmission within the control area will be modeled and it is anticipated that various other transmission components will also be modeled (e.g., SMUD). At the present time, the CAISO has decided not to model the transmission system that ties together the interconnection points with certain other control areas (i.e., the model will be an open loop system).

4.3. Enforcement of Operating Constraints Internal to the MSS

To further ensure that all forward market schedules are feasible with respect to real-time operations, most of the real-time operating constraints need to be enforced in the forward markets. However, in the MSS agreement, it states that the MSS operator is responsible for congestion within the MSS operator's transmission system.

The CAISO has recognized that ignoring congestion (if it exists) within a MSS in the forward market energy market (where congestion in the system is cleared) may cause problems in real-time. If congestion does exist within the MSS, then it is possible that when the MSS operator attempts to clear this congestion in real-time by adjusting generation resources or even adjusting the transmission topology within the MSS may have an impact on the CAISO-grid flows and thus may cause congestion on CAISO-grid. It may also be the case that congestion in an MSS can only be alleviated by the combined efforts of CAISO-grid resources and MSS resources.

In light of these potential problems, the CAISO has created several options for managing congestion within the MSS. These options are shown in Table 4.3.

Table 4.3. Options for the enforcement of constraints internal to the MSS in the running of the CAISO IFM (DA & HA) and the real-time security constrained economic dispatch.

	Enforce Internal MSS Constraints (Yes/No)			
Time Frame	**Option 1**	**Option 2**	**Option 3**	**Option 4**
Day-Ahead	No	Yes	No	No
Hour-Ahead	No	Yes	Yes	No
Real-Time	No	Yes	Yes	Yes

It is important to distinguish between recognizing a constraint and enforcing it. A constraint may be recognized without being enforced, in which case the CAISO simply informs parties whether or not it was violated (and by how much) to allow voluntary corrective action by the respective SC in the subsequent scheduling opportunity.

Note*: If the CAISO enforces internal MSS constraints in any of its markets (i.e., a "Yes" in any box), the IFM or the real-time Security Constrained Economic Dispatch (SCED) software re-dispatches resources, in merit order based on the combination of bid price (mitigated where applicable) and effectiveness, to clear congestion within the MSS.*

Thus, although "enforcing constraints" and "resolving congestion" seem like two separate activities, they are linked by the nature of the IFM & SCED software. The MSS can limit the likelihood that its own resources will be adjusted in the IFM in such cases by using the CAISO's provisions for self-scheduling priority.

As long as the MSS is connected to the CAISO grid in a radial fashion there is no problem with Option 1. When there is a looped connection between the CAISO-grid and the MSS, however, there will be instances where schedules and real-time actions within the MSS can affect the CAISO grid (path flows as well as locational prices), and vice versa. At present Silicon Valley Power (SVP) is the only MSS for which this issue arises, as all other MSS are radially connected to the CAISO grid.

Option 1 is probably most consistent with SVP's expectations at this time, because it is consistent with the language of the MSS agreement, which states that the MSS manages its own internal congestion. Although Option 1 is what is currently in the MSS agreement, Option 2 is the CAISO's desired option for SVP because it enables the CAISO to manage congestion on the grid in an integrated fashion, while at the same time allowing SVP to have cheaper non-SVP resource schedule adjustments used, where available, to manage SVP congestion (rather than relying exclusively on its own resources).

4.3.1. Option Details

Under the options provided in Table 1, the proposed interaction between the CAISO and the MSS operator is given below for Options 1, 3 and 4. For Option 2, all interaction between the CAISO and the MSS operator will be through the markets.

Note that Options 1, 3 and 4 are different in that for Option 3 the MSS constraints are enforced in the Hour-Ahead and real-time markets, while for Option 4 the constraints are only enforced in the real-time market.

4.3.1.1. Day-Ahead

Under Options 1, 3, and 4, if, after the Day-Ahead markets are closed, there are overloads on any internal MSS facilities, the CAISO alerts the MSS on this issue. It will be the responsibility of the MSS to take the necessary actions to alleviate such overloads. However, the MSS should advise the CAISO as to what actions it proposes to take prior to the CAISO running the Hour Ahead market for the affected hour(s).

4.3.1.2. Hour-Ahead

In the Hour-Ahead market, the MSS can re-submit schedules to alleviate the congestion, or take other corrective actions within its system. The CAISO reflects these schedule changes and other corrective actions in the Hour Ahead market, but under Options 1 and 4, the CAISO still does not enforce any constraints internal to the MSS. To the extent that the actions of the MSS do **NOT** relieve the congestion identified in the Day Ahead market, or in the event that new overloads appear as part of the Hour Ahead market, the CAISO alerts the MSS of these issues. It will be the MSS responsibility to take actions to relieve such overloads if they are manifested in real time.

4.3.1.3. Real-Time

Under Option 1, during real-time, the MSS operator may need to work with the CAISO to alleviate the congestion and this will probably be accomplished outside of the real-time market.

4.3.1.4. Pricing Options of MSS Generation and Load

This section provides different pricing alternatives for the MSS in the Day-Ahead Market.

Note: *The CRR revenues will only be paid out of the LMP results from the Day-Ahead Market. The Hour-Ahead and real-time markets are for pricing of deviations from final schedules in the preceding market (hour-ahead schedule deviations with respect to final Day-Ahead schedules, and real-time schedule deviations with respect to final Hour-Ahead schedules). With each pricing alternative, a description of the hedging requirements by CRRs is provided. A methodology for the pricing of losses is currently under development by the CAISO.*

4.3.2. General MSS with a Looped Connection to the CAISO-grid

The following one-line diagram (Figure 1) shows a MSS similar to SVP and can be used to show the different pricing options of MSS energy. This diagram is only applicable to an MSS that has loop connections to the CAISO system and can experience parallel[14] flows through its system. However, the settlement approach is applicable to all MSS.

This diagram shows an MSS that has two interconnections with the CAISO-grid and shows the buses at which the MSS connections are metered. The MSS bubble contains the MSS's generation resources, load resources and transmission network. For generality, there are *n* generators and *m* load points within this MSS. The diagram also shows the resulting locational marginal price (LMP and is denoted by the symbol, λ) at each generator and load point node as well as the interconnection nodes to the CAISO-grid. In the IFM, a LMP is calculated for all nodes in the FNM, and since the network of the MSS will be modeled in the FNM, LMPs for these nodes will be calculated.

To be applicable to a MSS that is not looped with the CAISO-grid, remove interconnection #2 and the resulting MSS would be radially connected to the CAISO-grid.

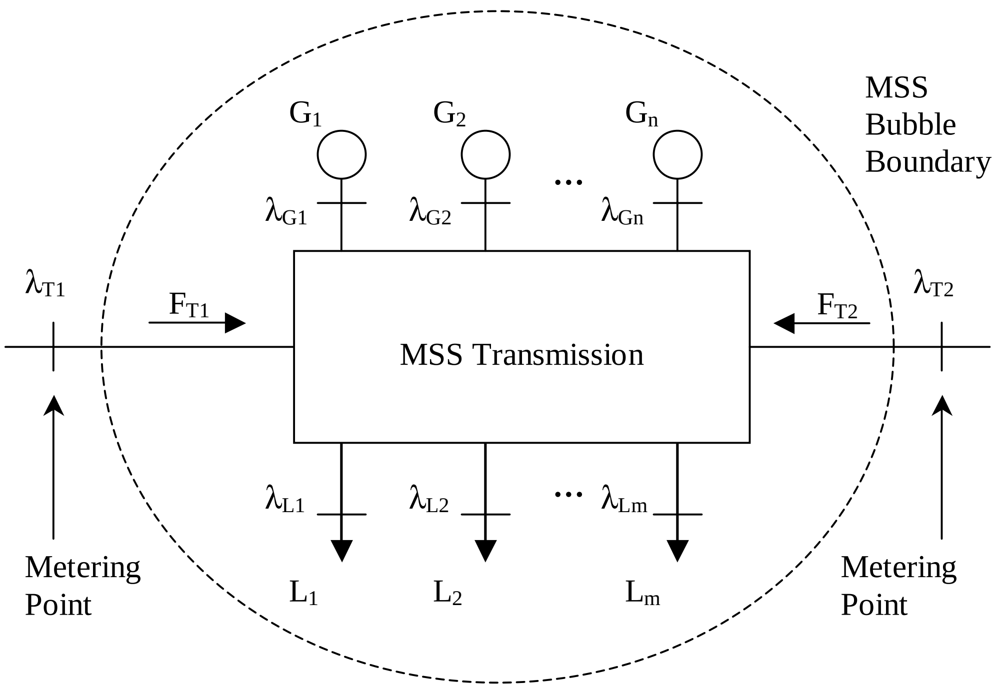

Figure 1 Generalized MSS with a looped connection to the CAISO-grid

[14] The term "Parallel Flow" as used here means flows over MSS transmission that are caused by resource schedules external to MSS transmission and are not under the control of the MSS, but the CAISO has sufficient information to compute these flows.

***Note**: The metered load value is calculated by summing the metering point values at the interconnection points and subtracting from this the summation of the metering point values at the generator connection points. Thus, the metered load value includes the actual load and the transmission losses within the MSS transmission system.*

4.3.3. Pricing Option A

Pricing Option A is the option proposed in the CAISO's Conceptual Design. For this option under the Day-Ahead Market, the MSS would schedule gross generation resources at the generation location and schedule gross load at the appropriate Load Aggregation Point. (For all of the NCPA's MSS locations this would be the PG&E Load Aggregation Point.)

The resulting load at each load point within the MSS bubble would be calculated as the total load scheduled to the relevant UDC (e.g., PG&E) Load Aggregation Point multiplied by the Load Distribution Factor for that corresponding load point.

The IFM would produce LMPs at all nodes in the system and would calculate an aggregated price for the relevant UDC Load Aggregation Point.

The MSS would be paid for its generation at the corresponding LMP for each of its generation and would be charged the relevant UDC Load Aggregation Point price for its load.

The payment for generation would be:

$$\sum_{i=1}^{n} G_i \cdot \lambda_{Gi} .$$

The charge to load (assuming PG&E is the relevant UDC for Load Aggregation) would be:

$$\lambda_{PG\&E} \cdot \sum_{j=1}^{m} L_j$$

Where $\lambda_{PG\&E}$ is the PG&E Load Aggregation Price.

For hedging of the congestion costs, the MSS may be allocated CRRs from each of the generation resources to the relevant UDC Load Aggregation Point. The total quantity of such CRRs would not exceed the MSS load and the CRR source distribution pattern would be fixed for the CRR cycle as pre-specified by the MSS based on historical usage (with adjustments where relevant to reflect forecast supply patterns).

4.3.4. Pricing Option B

Pricing Option B is a pricing scheme that is applied to the net energy within the MSS bubble and is priced differently if the MSS is a net load or net generation.

Under this option the MSS would ***not*** schedule its load at the UDC Load Aggregation Point, but would schedule it load at an MSS Load Aggregation Point, e.g., at the SVP Load Aggregation Point. Note that under this option, each MSS bubble needs to be separately scheduled at its own MSS bubble Load Aggregation Point and the reason for this is given at the end of this section. A set of LDFs will be determined for each MSS bubble. In many cases were the MSS bubble is a radial connection from the CAISO grid and all the MSS load is modeled on one node from the FNM perspective, the LDF would be 1.0.

If the MSS is net long on generation, i.e.,

$$\sum_{i=1}^{n} G_i - \sum_{j=1}^{m} L_j > 0,$$

the amount paid to the MSS in the Day-Ahead Market is:

$$\left(\sum_{i=1}^{n} G_i - \sum_{j=1}^{m} L_j \right) \cdot \bar{\lambda}_G .$$

Where $\bar{\lambda}_G$ is defined as an aggregated MSS generator price as:

$$\bar{\lambda}_G = \frac{\sum_{i=1}^{n} \lambda_{Gi} \cdot G_i}{\sum_{i=1}^{n} G_i} .$$

The net long generation is priced at the average weighted price of the generation LMPs within the MSS.

Note*: The CAISO is still debating if this aggregated generation price is suitable since it may cause the CAISO not to be congestion revenue neutral*.

If the MSS is net short on generation (net long on load), i.e.,

$$\sum_{i=1}^{n} G_i - \sum_{j=1}^{m} L_j < 0,$$

then the Day-Ahead Market load charge is:

$$\left(\sum_{j=1}^{m} L_j - \sum_{i=1}^{n} G_i \right) \cdot \lambda_{PG\&E} .$$

Where $\lambda_{PG\&E}$ is the relevant UDC (PG&E in this case) Load Aggregation Price. Even though the MSS needs to schedule its load at an MSS Load Aggregation Point, this load would be included in the settlement process to calculate the relevant UDC Load Aggregation Price.

Note: *The CAISO believes that charging the net load at the UDC Load Aggregation Price causes congestion revenue neutrality problems.*

The reason for requiring the MSS to schedule load at the MSS Load Aggregation Point is to more accurately model the scheduled load within the MSS bubble and thus get a more realistic representation of the MSS's use of the CAISO-grid when the MSS is a net load.

For congestion hedging the MSS will need CRRs from any external MSS generation to the MSS Load Aggregation Point noting that the MSS Load Aggregation Point will be priced at the relevant UDC Load Aggregation Point. The total quantity of such CRRs, if allocated, would not exceed the MSS net load (MSS bubble load less MSS bubble generation) and the CRR source distribution pattern would be fixed for the CRR cycle as pre-specified by the MSS based on historical usage (with adjustments where relevant to reflect forecast supply patterns).

4.3.5. Pricing Option C

This option provides flexibility for each MSS bubble to Opt-out of getting the Standard Load Aggregation price. The MSS would schedule both generation and load as in Pricing Option B. However, there is no netting of generation and load. The generation, as in Option A will be paid the generator's locational price and the load is charged at the MSS Load Aggregation Price.

For congestion hedging the MSS will need CRRs from external MSS generation to the MSS Load Aggregation Point as well as from internal generation to the MSS Load Aggregation Point. The total quantity of such CRRs, if allocated, would not exceed the MSS load, and the CRR source distribution pattern would be fixed for the CRR cycle as pre-specified by the MSS based on historical usage (with adjustments where relevant to reflect forecast supply patterns). Based on the electrical proximity of the MSS generation and load, the resulting LMP differences at the MSS generation nodes and load nodes may be relatively small.

4.3.6. Pricing Option D

Pricing Option D is similar to Pricing Option C in that locational pricing is used instead of pricing at a UDC Load Aggregation Point. This methodology is as follows:

The payment to the CAISO will be the following:

$$\lambda_{T1} \cdot F_{T1} + \lambda_{T2} \cdot F_{T2}$$

Where the flows are in the reference direction of flow into the MSS as noted in Figure 1. This pricing method is similar to viewing the MSS as a separate control area where the interconnections are similar to export/import points.

For congestion hedging the MSS will need CRRs from external MSS generation to one or both of the interconnection points. The total quantity of such CRRs, if allocated, would not exceed the MSS net load (MSS bubble load less MSS bubble generation) and the CRR distribution pattern (amount and direction at MSS bubble ties) would be fixed for the CRR cycle as pre-specified by the MSS based on historical usage (with adjustments where relevant to reflect forecast supply patterns).

4.3.6.1. Implications for Successive Markets

The settlement methodologies discussed above apply to the Day-Ahead Market. For the Hour-Ahead and real-time markets, the above energy settlement formulas would apply to incremental changes compared to the preceding market's final schedules. However, the CRR revenues that would be based on the Day-ahead market prices. The CRR day-ahead payments and charges are based on the full amount of CRRs held, regardless of how the CRR holder manages it's schedules. Thus, as long as the CRR holder's overall schedule (algebraic sum of day-ahead schedule, hour-ahead schedule change and real-time schedule change) is aligned with their CRRs, there is no quantity risk since the CRR holder gets paid for the full CRR quantity regardless of whether that amount is scheduled in the day-ahead, hour-ahead, or real-time. There is a price risk, however. The CRRs are paid the day-ahead congestion price, whereas the different potions of the schedule are subjected to "congestion" prices of the relevant market (day-ahead, hour-ahead, or real-time) in which they occur.

4.3.6.2. Internal MSS Constraint Enforcement and the Pricing Schemes

The above pricing schemes do not depend on the different congestion management options (1 to 4) for enforcing internal MSS constraints. However, there may be differences in prices if there is congestion on internal MSS transmission and the internal constraints are enforced.

Note: *If the constraints within the MSS are not enforced and the MSS is in a looped connection with the CAISO-grid, there still may be price dispersion at the nodal level due to congestion somewhere else in the system.*

5. Appendix B - Upper Bound CRR Request Calculation

The process for calculating the upper bound for the amount of CRRs a LSE can request for the annual and monthly term CRRs is given in this section.

The upper bound calculation for the annual term CRRs is as follows:

1. Develop the historical load duration curve for each month of the one-year Historical Reference Period (HRP) and calculate the peak load level for each month;
2. Calculate the Load Metric, which equals the smallest peak load level calculated for the 12 months of the HRP;
3. Determine the total quantity of ETCs (or Converted ETCs) held by the Load Serving Entity whose Upper Bound is being determined; and
4. Calculate the Upper Bound for annual CRR allocations which is, Annual Upper Bound = 0.75 × (Load Metric – ETC).

Please note that the Annual Upper Bound has been scaled by 75% since 75% of the capacity in the network will be used in the SFT for the annual term CRR allocation. The remaining capacity will be utilized for monthly CRR allocations.

The upper bound calculation for the monthly term CRRs is as follows:

1. Develop a forecasted load duration curve for the month;
2. Calculate the load metric for the month, which equals the peak load level for the month; and
3. Calculate the Upper Bound for the monthly CRR allocation, which is Monthly Upper Bound = (Monthly Load Metric – Annual Allocation [which is less than or equal to the Annual Upper Bound] – ETC).