CRR Study 2
Final Scenario Assumptions

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July 19, 2004

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1. Introduction

On February 5, 2004 the California Independent System Operator (CAISO) submitted for stakeholder review an initial set of modeling assumptions[1] for its second Congestion Revenue Rights (CRR) study (CRR Study 2) that focused on the allocation of CRRs to eligible entities. This second study is needed because the CAISO proposed several modifications to the market design beginning with a Conceptual Market Design Proposal filing[2] since the time of the first CRR study, CRR Study 1[3].

This document provides a description of the final set of CRR Study 2 scenarios that were developed and compiled as a result of several months of discussion (via face-to-face meetings and conference calls), interim reports and comments between CAISO staff and stakeholders during the spring and summer of 2004[4]. The initial set of modeling assumptions provided only one study scenario which was based on, but not fully consistent with, the newly modified market design. After the Conceptual Market Design Proposal was filed, the CAISO continued to further refine the CRR allocation methodology. However, through the discussions with stakeholders it became clear that several scenarios (instead of just one) were needed for stakeholders to further explore different allocation rules and get a better understanding on the relationships between these proposed CRR allocation rules (as defined through a particular scenario), the amount of CRR MW that could be allocated as well as an estimate of the resulting hedging positions offered by these CRRs. It is agreed to by all that the understanding gained through the different CRR Study 2 scenarios, as well as any additional CRR studies that may be performed by the CAISO, should guide both the CAISO and stakeholders in crafting the final set of rules and tariff language for the allocation of CRRs to eligible entities.

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 eligible parties can be fully allocated, given the different sets of allocation rule scenarios. 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 (the results from each scenario) can hedge congestion costs in the Day-Ahead Market. 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 schedules on a MW basis in each hour.

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

[1] http://www.caiso.com/docs/2004/03/17/2004031714560526438.pdf
[2] The new set of design modifications were initially set out in the CAISO's July 22, 2003 Amended Comprehensive Market Design Proposal filing (Amended filing). At http://www.caiso.com/docs/2002/05/29/2002052908585310 76.html. Also see the CAISO's answers and reply comments to stakeholder comments on the July 22, 2003 Conceptual Design filing, http://www.caiso.com/docs/2003/09/17/2003091713094366 89.pdf
[3] The CAISO's first CRR study, CRR Study 1, began in the spring of 2003 and was completed in October 2003. The CAISO published the results of this study in the report "Congestion Revenue Rights Preliminary Study Report" (http://www.caiso.com/docs/2003/10/02/2003100216045813 75.pdf) along with the results of two additional sensitivity runs in the report "Congestion Revenue Rights Sensitivity Study Report" (http://www.caiso.com/docs/2003/12/15/2003121514062310 939.pdf).
[4] See CRR Studies page at http://www.caiso.com/docs/2004/01/29/20040129103438275 11.html

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 market redesign proposal.

1.2. CRR Study 2 Scenarios

After much discussion, debate and consideration by the CAISO and CRR Stakeholders, it was agreed that CRR Study 2 would consist of six scenarios. Based on an initial time frame that had CRR Study 2 completing sometime in the early months of 2005, the study was limited to six scenarios, with the possibility of additional sensitivities being performed if warranted by results of the six scenarios or other external factors. It was estimated, based on experience from CRR Study 1, that including more scenarios would extend the completion date of CRR Study 2 into the late spring of 2005.

In the initial CRR Study 2 assumptions document, a preliminary list of all parameters (e.g., hedge type – Obligation or Option) that played a significant role in the CRR allocation process were compiled and for each of these parameters the CAISO noted what value the parameter would take (e.g., the hedge type for LSE CRR would be of Obligation type) or how that parameter would be modeled. During the stakeholder review process of this initial CRR Study 2 assumptions document, it was decided as noted above, that more than one scenario would be appropriate so that particular parameters could take on more than one value. In expanding the set of scenarios, additional parameters were also identified. The stakeholders and the CAISO worked to create a list of all potential practical values for each parameter. It was from these potential values for each parameter that the stakeholders and the CAISO worked together to create the scenarios.

The six scenarios are listed in Table A.1 of Appendix A. There were 32 parameters identified and all parameters, except three, are the same across all six scenarios. These three parameters are the hedge types for the CRRs allocated for hedging the Existing Transmission Contract schedules and the Load Serving Entity schedules, and the restrictions on the use of Trading Hubs. The following section provides a more in-depth explanation on the values selected for various study parameters. A list of the sensitivity descriptions is provided in Appendix B.

2. Discussion of Selected CRR Study Parameters

The six scenarios developed for CRR Study 2 are listed in Table A.1 of Appendix A. This table includes all identified parameters associated with the study. Each scenario is defined by the value given to each of the parameters. This section provides an in-depth discussion on selected study parameters including their associated values.

2.1. Study Period

The time frame chosen for CRR Study 2 is the year 2006. The year 2006 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.

2.2. CRR Terms

Generally the *term* of the CRR represents its time period or duration. For example, a CRR having a term of one year (i.e., annual term) means that it is a financial instrument with a given Source,

Sink, MW amount, time-of-use identifier, and hedge type identifier, which are all constant for a duration of 1 year. However, the use of this definition has been modified in constructing the scenarios for CRR Study 2. The term of the CRR does not necessarily mean the time duration of the CRR, but rather the time period in which a CRR is available for allocation. In CRR Study 2 across all scenarios, an annual term CRR is comprised of potentially 12 one-month CRRs with the availability of these CRRs being one year. That is, an eligible entity could request these one-month CRRs that would apply to a time period of 12 months out.

For the study, one-month in duration CRRs can be requested for each of the 12 months of the study period and these CRRs will be allocated using a downward scaling of the network capacity (75% in the study) as defined through the full network model and the operating constraints being used. These will be defined as the long-term or annual term CRRs in the study. Note that for each month of the long-term CRR, an upper bound based on historical load data will be calculated.

Short-term or monthly CRRs can also be requested for each month of the study period. For the short-term allocation, the network capacity will not be scaled downward. Note that for each month of the short-term CRR an upper bound based on forecasted load data will be calculated.

Each CRR term will have two associated time-of-use periods, on-peak and off-peak. These periods are consistent with those defined by the WECC. The on-peak period is defined by the hours from 6 AM to 10 PM, Monday through Saturday, provided these days are not Holidays (New Years Day, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas). The off-peak period hours are all hours that are not on-peak, i.e., from 10 PM to 6 AM on weekdays and all hours of Sunday and all hours of the six holidays previously listed.

For CRR Study 2, the CAISO will ask for CRR requests (annual-term and monthly-term) for all 12 months of 2006.

2.3. Network Model

The CAISO Grid Planning department has recently finalized its "2004 California ISO Controlled Grid Study – Final Study Plan, version 2.1". This plan was sent to market participants on July 2, 2004. For this Grid Planning study the CAISO will develop with the assistance of the Participating Transmission Owners, a series power flow base case that will represent the transmission network summer-time conditions for the years of 2006, 2009 and 2014. The study plan includes a listing of new transmission projects/upgrades that includes project name, location, project description, construction status and in-service date. The network used for CRR Study 2 will be based on the 2006 base case model. As noted in the study plan, there are only two months in the year 2006 in which new transmission projects will be completed (May and June). It will be assumed in CRR Study 2 that these upgrades are in service at the start of 2006. In other words, the same network model will be used for every month of 2006 as a starting point for the allocations (however, constraint limits and LDFs will generally change. See the corresponding sections below).

The 2006 base case model will be converted to a passive DC[5] model for use in the allocation process and 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

[5] 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.

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[6] with the intent to implement a closed loop network at a later time.

2.3.1. Network Outages

As noted above, in the annual-term allocation, the transmission capacity will be scaled downward by 75% and for CRR Study 2 all lines from the 2006 base case will be assumed to be in-service. In actual production, the same rule will apply for the annual-term allocation, except if major long-term outages are scheduled. Under these conditions, the CAISO may take these outages into consideration when developing the model for the annual term CRR allocation.

Similarly, in the monthly-term production allocation the CAISO will take into consideration any scheduled outages for the next monthly allocation. Since the study period starts at least one year from now, the CAISO does not have any scheduled outage information for this period. For purposes of this CRR study, the CAISO will review planned outages that were submitted by the PTOs to the CAISO during the year of 2003 and use this information as a basis to determine reasonable assumptions for 2006 network outages for monthly-term allocation.

The reason for scaling of network capacity for the annual-term allocation is to take into consideration network capacity that may not be available due to the planned outages and the fact that these planned outages will not be known at the time of the annual term allocation. Thus, some capacity is reserved for the monthly-term allocation at which time the planned outages are better known. The scaling factor of 75% will be analyzed in this study; an example will help explain. Suppose that for a given month, certain planned outages are taken into consideration and network capacity (as compared to un-scaled annual-term network model for the same month) is removed from the system by removing transmission lines corresponding to these planned outages. Removing transmission lines has two effects: (i) it may cause constraint limits (that were used in the annual-term allocation) to be changed, and (ii) it changes the connectivity of the system and hence it changes the shift factors (or power transfer distribution factors). The first step in the allocation of the monthly-term CRRs is to apply the annual-term CRRs (from both the allocation and auction (if simulated) onto the network model as fixed CRRs (i.e., they are not reduced to ensure feasibility – they are not control variables in the optimization). When these annual-term CRRs are applied to the system, feasibility is checked; if they are infeasible, this means that the capacity that was removed (via the planned outages) had an impact on the annual-term CRRs. This implies that too much capacity was made available in the annual-term allocation and the scaling factor of 75% was too large.

The CAISO developed a draft procedure[7] for determining which of the planned outages to remove from the monthly-term allocation. This procedure is still a draft and the CAISO may modify it before the selection of historical outages.

2.4. Operating Constraints and Contingencies

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

[6] 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.

[7] See the white paper: http://www.caiso.com/docs/2002/10/01/2002100111403627109.pdf

contingency analysis in the simultaneous feasibility test (SFT). Presently, the CAISO has other operating constraints that are not purely branch or single interface limits (i.e., limiting the MW flow on the interface) which are used in the full network model. Such operating constraints are, for example, nomograms.

The ISO is planning to distribute a white paper that explains the methodology for calculating the various constraints used in CRR Study 2.

2.5. Standard Load Aggregation Points

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

2.5.1. Load Distribution Factors

The load distribution factors (LDFs) or allocation factors for the standard load aggregation points (i.e., aggregated pricing nodes) are used to allocate the CRR Sinks to the underlying network nodes. For the study, the CAISO will create seasonal sets of LDFs for both the on-peak and off-peak periods. The CAISO is exploring the use of WECC base cases for gathering LDF information for the non-summer seasons. As part of the 2004 CAISO Controlled Grid Study, an off-peak summer 2006 case is being developed. On-peak LDFs for summer will be derived from the on-peak summer 2006 case and the off-peak LDFs will be derived from the off-peak summer 2006 case. The CAISO will keep the stakeholders informed on this data gathering effort.

2.6. CRR Structures

For CRR Study 2, the CAISO is anticipating that all CRRs will be Point-to-Point. The CAISO has proposed another CRR structure that is a multiple-point-to-multiple-point CRR called a Network Service Right[8] (NSR). Due to software limitations, the NSR functionality was not available for CRR Study 1. The CAISO is currently developing a NSR Detailed Statement of Work 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. The ISO will keep the stakeholders informed on any progress in this area.

2.7. Entities Submitting CRR Nominations

CRR nominations will be requested from the following entities:

- The Scheduling Coordinator (SC) that submits the ETC schedules. The CAISO encourages ETC right holders to discuss requests with the SCs that will be submitting CRR allocation requests for this Study along with the PTO that is party to the contract;
- Converted Rights holders (i.e., the new PTOs);
- LSEs whose load is not served under ETC rights. These include municipal utilities and Direct Access providers;
- Metered Sub-systems;
- Merchant Transmission; and

[8] See the white paper: http://www.caiso.com/docs/2004/03/18/2004031815494611474.pdf

- Other entities that may be entitled to CRR allocations.[9]

With regard to CRR allocations, it is important to keep in mind that a crucial objective is to enable CAISO control-area loads to effectively hedge the congestion risks associated with the market redesign. As agreed to in the CRR stakeholder meetings, there will be three study scenarios where all nominations are made without using trading hubs. The CAISO recognizes that there are some challenges in meeting this requirement 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 other three study scenarios will make either trading hubs or actual source locations available for nominations.

More detailed discussion surrounding the nomination of CRRs by these entities is provided next.

2.7.1. Requesting CRRs for ETC Holders

The CAISO recognizes that the question of how best to enable ETC loads to hedge their congestion cost risks under the market redesign proposal is still open for discussion with stakeholders and is currently being addressed in the on-going discussions between the CAISO, PTOs and the ETC holders. For CRR Study 2, the assumption is that the SC that currently schedules for the ETC holder will be the entity that is requesting CRRs on behalf of the ETC holder for each of the study scenarios. The methodology for calculating the upper bound of the CRR request is provided in Appendix C.

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 plans to have further discussions with and provide further details to entities that are requesting CRRs for ETC holders. These discussion and details will include a list of locations in the FNM that will be used as the Sources and Sinks for the ETC resources.

2.7.2. Converted Rights Holders

The new PTOs (Anaheim, Azusa, Banning, Riverside and Vernon) are Converted Rights holders and currently hold Firm Transmission Rights (FTRs) that were 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. However, in CRR Study 1, some of the transmission that the new PTOs have rights on and that lie outside of the control area was not fully modeled in the FNM.

In CRR Study 2, the transmission that the new PTOs have rights on and that lies outside of the control area will be modeled in the FNM. The CAISO will continue to work with the five new PTOs to determine the correct modeling of Point-to-Point CRRs on this transmission. In all six scenarios, the new PTOs will be provided CRR Options. The upper bound for the amount of CRRs that will be allocated is given in Appendix C. If it is determined that Converted Rights holder is eligible for more CRRs than what is covered under their Converted Rights, CRRs can

[9] The CAISO, in discussions with CRR Stakeholders, has decided to conduct a sensitivity study that will consider allocating CRRs to SMUD and other entities identified to serve load outside the ISO control area and have made a significant contribution to the embedded costs of the ISO control area.

be requested for the residual amount through the LSE allocation process. The ISO plans to work with the new PTOs to accurately model their rights.

2.7.3. LSEs

The CAISO will maintain a process that is very similar to the one followed in CRR Study 1 for LSEs that request CRRs for the study. There are three main load aggregation points, PGE, SCE and SDGE. The upper bound for requesting CRRs is provided in Appendix C.

As mentioned previously, LSEs with bilateral contracts will make their "best attempt" at providing a specific source location for scenarios 1, 2 and 3. For scenarios 4, 5 and 6, LSEs may use Trading Hubs if the sources are not explicitly known.

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.

MSSs may choose CRR allocations based upon gross or net settlement. If the choice is gross settlement, the upper bound calculation for long-term and short-term CRRs is determined the same way as for LSEs (see Appendix C). For MSSs that choose net settlement, the historical and forecasted data used as a basis in the upper bound calculation will be modified as follows.

- The long-term CRR upper bound is based on subtracting the 2006 hourly forecasted generator (the generator within the MSS bubble) dispatch from the 2003 hourly historical load on an hourly basis and then using this information as input into the upper bound calculation.
- The short-term (monthly) CRR upper bound is based on subtracting the 2006 hourly forecasted generator (the generator within the MSS bubble) dispatch from the 2006 hourly forecasted load on an hourly basis and then using this information as input into the upper bound calculation.

Under the net settlement option, the corresponding Standard Load Aggregation Point price will be applied if the MSS is a net load. Thus, the MSS should use the corresponding Standard Load Aggregation Point as the Sink in any request. The CAISO will modify the LDFs associated with MSS load points so that they more accurately represent the amount of load that will be modeled at these locations.

2.7.5. Merchant Transmission

The CAISO is currently developing a proposal 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. After distribution of this white paper, the CAISO hopes to include merchant transmission owners as part of this study.

2.7.6. Pump Load

For purposes of CRR Study 2, all entities with pump load will use an average water year when developing historical and forecasted load data that the CAISO will use in calculating an upper bound for both long-term and short-term CRR requests.

2.7.7. Basic Validation Rules (For Study Purposes Only)

For purposes of CRR Study 2, the CAISO requests that all Study participants make CRR requests that adhere to the following basic validation rules.

- The total CRR MW request should not exceed the calculated Upper Bound.
- CRR requests should have generation nodes or inter-tie points as sources, except for scenarios 4, 5 and 6 of the Study where trading hubs may be used if desired.
- A CRR request from a particular source should not exceed the MW generating capacity or import capacity at that source node. As the ISO works with bilateral contract holders the ISO will assist, where possible, in alerting requesters to instances where "best guess" resources have resulted in total aggregate CRR requests as specific sources that exceed the capacity at that source.
- For a generating unit owned by an LSE, only that LSE can request CRRs from that generator location unless owning LSE agrees to allow another LSE to use that generator.
- Requests by LSEs for CRRs from an inter-tie scheduling point will be limited to each LSE's historic use of that inter-tie to serve its load. If the LSE owns a resource outside of the control area with a capacity greater than the LSEs historic use, the maximum quantity may be used as the requested amount.
- Requests will be for Point-to-Point CRRs. LSEs will assign priorities according to the SCE simple 4-priority approach.
- Sinks shall be the three standard Load Aggregation Points (PG&E, SDG&E and SCE), except for ETCs which shall be the particular load nodes.
- In general, a consistent pattern should exist between the CRR source-sink request and the actual or historic supply sources that the requestor uses to serve load.

2.8. Transmission Ownership Rights (TOR)

There exist transmission within the CAISO control area that is non ISO-grid, i.e., not under the direct control of the CAISO. An example of this is the California-Oregon Transmission Project (COTP). The assumption for CRR Study 2 is that TOR is not subject to forward market congestion. As such, this capacity will be removed from the FNM. This capacity will be removed by the CAISO applying Point-to-Point CRR Options. The exact locations and the exact amount of MWs will be determined through discussions with these transmission owners. The CAISO will keep the stakeholders informed on exactly how this capacity is removed.

2.9. Optimization and Simultaneous Feasibility Test Process

The CAISO will perform one optimization/SFT process 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 and similarly one optimization/SFT process for allocating monthly-term CRRs (one each for on-peak and off-peak). The optimization process will be priority based to provide certain CRR nominations a priority over other CRR nominations.

The priorities will be assigned based on CRR type and the priorities assumed for CRR Study 2 are given in Table 1 below.

Table 1. Proposed CRR priorities

CRR Type	Priority (1 is the highest)
ETC	1
Converted Rights	2
LSE (includes MSS) (Using the SCE 4-priority approach within the LSE CRR type)	3

For all LSE type CRRs, the SCE simple 4-priority approach[10] will be implemented. In this approach, the upper bound of an LSE will be divided by 4 to derive a sub-priority upper bound. Along with each CRR request, the LSE tags that request with a sub-priority from 1 to 4, with 1 being the highest sub-priority (LSE type CRRs with a higher sub-priority over other LSE type CRRs will have priority to the transmission capacity). The LSE must make sure that the sum of the MWs associated with each sub-priority does not exceed the sub-priority upper bound.

The optimization/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 optimization/SFT process will be as follows:

- Remove capacity from the system associated with Transmission Ownership Rights;
- Reduce the remaining capacity of the system by scaling all operational constraints by 75%;
- 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. In this step, since we will be running separate monthly long-term CRR allocations there will be 12 monthly optimization/SFT processes;
- Run the optimization/SFT for each month and determine the cleared annual term CRRs by month;
- Provide the individual results of each monthly long-term allocation to each respective entity so that each entity can make adjustments to their short-term requests based on the awarded CRRs in the annual-term process.
- Run the optimization/SFT for each of the 12 months of short-term CRR allocations (note that the capacity of the network model is not scaled downward). This will be done as follows.
    - Remove transmission capacity based on historical planned outages.
    - Apply all of the annual fixed (awarded) CRRs to the network from the appropriate month (this step also assumes that TOR capacity is still removed).

[10] See the presentation provided by SCE at http://www.caiso.com/docs/2004/04/05/2004040508411911452.pdf

- 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.
- Run the optimization/SFT and determine the cleared monthly term CRRs.

2.9.1. Modeling Annual-term Auction Results

Scenarios 4, 5 and 6 provide the eligible entities the opportunity to use Trading Hubs if they wish. If eligible entities used Trading Hubs for their CRR Sources in the annual-term CRR allocation process, it is likely that these entities are being supplied power by generator owners or power marketers trading that power at the Trading Hub. It is expected that these suppliers will bid in the annual-term auction for CRRs from an actual Source to the Trading Hub. These CRRs will be fixed CRRs in the monthly-term allocation and thus can certainly have an impact on the amount of CRR MW that can be allocated. The CAISO will attempt, for purposes of the Study, to model the results of an annual-term auction prior to the short-term allocation process. Note that the same can be said of CRRs that were bid for wheel-through and wheel-out schedules that may not be eligible for a CRR allocation. The CAISO may also model these CRRs.

2.9.2. 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.

2.9.3. 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.

2.9.4. 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 MW 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. In addition, the ISO will perform a sensitivity run using scenario #1 in which all the CRR requests will be kept at the higher load aggregation levels.

[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 Hedging Positions

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 "financially" 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 effectiveness of their allocated CRRs in hedging congestion. In order to achieve this objective the CAISO must perform the following tasks:

- Simulate Day-ahead market outcomes (i.e., calculate LMPs) for the study period.
- Work with the market participants to determine applicable congestion cost for each LSE.
- Apply LMPs to the allocated CRRs to determine CRR revenue.
- Finally, compare the CRR revenue to congestion costs (on an hourly, monthly and yearly basis) to determine the effectiveness of the allocated CRRs in hedging against congestion.

These tasks are discussed in more detail below.

3.1.1. Calculation of 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 2006 planning model; and
- The enforced constraints are modified to account for any new transmission projects that are reflected in the 2006 planning model.

This process will calculate a set of estimated LMPs for the year 2006.

3.1.2. Calculation of Congestion Costs

Resource ownership/responsibility and transaction data are needed to determine congestion costs on an LSE basis. In the process of calculating LMPs, resources (generation, load, import and export) will be scheduled to certain MW levels. The energy payment to the resource or energy charge to the resource will be based on the LMP and the final energy schedule. Congestion cost is the difference between the energy charges and payments to an LSE (based solely on the congestion component of the LMP), which may also include inter-SC trades that take place at Trading Hubs. Congestion costs can be determined directly through ownership of generation and load resources. However, transaction data is needed to determine allocation of costs associated with imports/exports as well as inter-SC trades. The CAISO will work with the market participants on how best to determine this needed information.

3.1.3. Calculation of CRR Revenue

Based on the allocated CRRs and the congestion components of the LMPs, CRR revenue can be calculated on an hourly basis. During the discussion with stakeholders in determining the scenarios, there was discussion about the re-aggregation of the Surrogate Aggregation Points as well as discussion on which allocation factors should be used as the weighting factors in determining the prices used in the CRR revenue calculation. It was decided that all combinations be studied. Thus for the study, four different CRR revenues will be calculated. The difference in these revenues will be based on the level of CRR aggregations (Load Aggregation Points or Surrogate Load Aggregation Point) and the allocation factors (from the CRR Allocation or from the LMP calculation) used as the weighting factors in determining the aggregation prices. The four different price calculations are as follows. First denote the following terms:

λ_{ij} is the congestion component for node *i* for hour *j*;

LAP_k is the set of nodes for the k^{th} Load Aggegation Point (one of the standard Load Aggregation Points of PG&E, SCE and SDG&E);

$SLAP_k$ is the set of nodes for the k^{th} Surrogate Load Aggregation Point;

$AF\_CRR\_SLAP_{i,j}$ is the allocation factor used in the CRR allocation for allocating Sink MW to node *i* in its corresponding SLAP for hour *j*;

$AF\_CRR\_LAP_{i,j}$ is the allocation factor used in the CRR allocation for allocating Sink MW to node *i* in its corresponding LAP for hour *j*;

[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.

$AF\_LMP\_SLAP_{i,j}$ is the allocation factor derived from final scheduled load at node *i* in its corresponding SLAP for hour *j*;

$AF\_LMP\_LAP_{i,j}$ is the allocation factor derived from final scheduled load at node *i* in its corresponding LAP for hour *j*;

Price Set 1

This price is for a Surrogate Load Aggregation Point and uses CRR Allocation factors. The price for the k^{th} SLAP for hour j is:

$$\lambda_{SLAPk,j} = \sum_{i \in SLAPk} \lambda_{i,j} \cdot AF\_CRR\_SLAP_{i,j}$$

Price Set 2

This price is for a Surrogate Load Aggregation Point and uses LMP Allocation factors derived from final scheduled load. The price for the k^{th} SLAP for hour j is:

$$\lambda_{SLAPk,j} = \sum_{i \in SLAPk} \lambda_{i,j} \cdot AF\_LMP\_SLAP_{i,j}$$

Price Set 3

This price is for a Standard Load Aggregation Point and uses CRR Allocation factors. The price for the k^{th} LAP for hour j is:

$$\lambda_{LAPk,j} = \sum_{i \in LAPk} \lambda_{i,j} \cdot AF\_CRR\_LAP_{i,j}$$

Price Set 4

This price is for a Load Aggregation Point (Strandard) and uses LMP Allocation factors derived from final scheduled load. The price for the k^{th} LAP for hour j is:

$$\lambda_{LAPk,j} = \sum_{i \in LAPk} \lambda_{i,j} \cdot AF\_LMP\_LAP_{i,j}$$

Based on these prices, four different sets of CRR revenues will be calculated and used in the comparison to the congestion costs to help determine the effectiveness of these revenues in hedging congestion.

For the current Congestion Zones of NP15, SP15 and ZP26, Trading Hubs will be defined. The allocation factors used for the Trading Hubs in the CRR Allocation process will be used exclusively in the calculation of the Trading Hub prices.

3.1.4. Determining Yearly Financial Hedge Positions

For each market participants, there will be calculated congestion charges that will be by hour, summed over each month and summed over the year (all per the applicable time-of-use period). Similarly, CRR revenue will be on the same aggregate basis (hourly, monthly, annual) except that 4 different sets of revenue will be available. Per market participant, the CAISO will compare the congestion costs and the CRR revenue (for each set) on an hourly basis, monthly basis and annual basis per time-of-use period. At this point the CAISO will re-evaluate with the stakeholders any further analysis

4. Appendix A CRR Study 2 Scenarios

Table A.1 provides a description of the six CRR Study scenarios that were developed from discussions between the stakeholders and the CAISO staff. The six scenarios developed for CRR Study 2 are listed in Table A.1 of Appendix A. This table includes all identified parameters associated with the study. Each scenario is defined by the value given to each of the parameters. Note that several of the parameters each have the same value over the six scenarios and in this case all table cells over the row are merged.

Table A.1 CRR Study 2 Scenarios

#	CRR Study 2 Parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
1	Objectives of CRR Study 2	Determine new CRR MW coverage based on nominations and financial hedge positions					
2	Study Period	2006					
3	Terms of CRRs to Study	12 one-month terms @ 75% of network capacity and 12 individual true-ups of 1 month terms @ 100% of network capacity (12/12)					
4	Time-of-Use period	On-peak and Off-peak					
5	Full Network Model (FNM)	DC model with open loop consistent with Study period based on a Grid Planning model					
6	Transmission Outages in the Full Network Model for monthly term CRR allocations	Model historical planned outages that satisfies a proposed criteria, which will be based on CRR Stakeholder input (CAISO).					
7	Operating Constraints	Same set as CRR Study 1 and potentially use additional constraints					
8	LSE and Converted Rights Sink Location (Standard Load Aggregation Points)	PG&E, SCE and SDGE					
9	ETC Sink Location	Actual sink loction will be used in the study, where applicable					
10	Load Distribution Factors (LDFs)	Stakeholders need to know the availability of LDFs and their variation throughout the year. Seasonal sets for the months					
11	CRR Structure	Point to Point					
12	CRR Nomination Validation	Validation rules will be based on the CRR Request Guidelines and Validation Rules for CRR Study 2 doc					

13	CRR Nominations for ETCs	Submitted by SC for ETC with involvement of ETC rights holder (with certain exceptions I.e. Grizzly contract)					
14	Hedge Type for ETCs	Obligation	Option	Option	Obligation	Option	Option
15	Hedge Type for Converted Rights	Option					
16	Hedge Type for LSEs	Obligation	Option	Obligation	Obligation	Option	Obligation
17	Metered Sub-systems (MSS)	Net or Gross, depending upon nomination, Day-ahead energy settlement and CRR allocation.					
18	Merchant Transmission	Based on final White Paper					
19	Transmission Ownership Rights (TOR) / Non-ISO Transmission	Assumption will be that TORs are not subject to FM congestion and will be removed using P-T-P options.					
20	Sequence of Optimization and Simultaneous Feasibility Test (SFT)	One optimization/SFT run for each CRR term					
21	CRR Allocation Objective Function	Maximize MW (maximize proxy CRR value based on priorities (proxy bids))					
22	Priorities and Proxy Bids with original objective function (max proxy value)	CRR types will be given the following priorities, ETCs-1st, converted ETCs-2nd and LSEs-3rd, with the LSEs using the SCE 4-Priority approach.					
23	Break down of Large Aggregation Points for Allocation Purposes	Break down large aggregations into smaller aggregations (Surrogate Aggregations).					
24	LMP Calculations	Use same set of assumptions as LMP Study 3 with certain modifications to be determined and reviewed by stakeholders.					
25	Developing Transaction Data / Forecast individual LSE annual congestion costs	Work with market participants and/or use historical data as reflected in item #24 above.					
26	Determining Yearly Financial Hedge Positions	Compare estimated congestion costs with CRR revenue to determine financial hedge positions. Potentially scale down CRRs with CRR revenue surplus and re-run optimization/SFT					
27	Upper Bound Calculation	The Upper Bound will be based on the .5% level on the load duration curve. MSS entities using "net settlement" will forecast internal gen on an hourly basis and adjust historical and forecast load duration curves accordingly.					

28	Prices used in CRR Settlements	Both CRR and final DA allocation factors to be used.	
29	CRR MW levels used in Settlements	Use both combined and surrogate MW levels.	
30	Trading Hub definition	Trading Hubs will be NP15, ZP26 and SP15 and will be based on load takeout points (allocation factors are not known at this time). Trading Hub allocation factors will be fixed.	
31	Replace Trading Hub Sources with generator/import Sources	CRR requestors to use best efforts to come up with actual sources	CRR requestors can use either actual sources or Trading Hubs
32	Modeling the results of an auction (e.g., generation/import to Trading Hub)	If trading hubs are used then we will model the auction.	

5. Appendix B CRR Allocation Sensitivity Analysis

In addition to running six scenarios for CRR Study 2, the CAISO will also conduct a sensitivity analysis. The specific sensitivity analysis contemplated by the ISO is described below.

1. A sensitivity will be run (based on one of the scenarios) in which out-of-control area load can request CRRs (e.g., SMUD). The upper bound for this request will be based on historical usage of the inter-tie over which their energy leaves the ISO's grid.
2. If needed, based on results of scenarios 1 to 6, a sensitivity may be run that would utilize San Diego's proposed priority scheme in which there would be no distinction in priority levels between ETC, Converted Rights and LSE CRR types.
3. If needed, a sensitivity may be run that would model WAPA as a separate control area. This sensitivity would be based on a specified scenario.
4. If needed, based on results of scenarios 1 to 6 and the modeling of outages in the short-term allocation runs, a sensitivity may be run that would change the scaling factor that is applied to determine the amount of long-term capacity. The new percentage would need to be determined as well as the scenario on which this sensitivity will be based.
5. A sensitivity will be run that will not break down the standard load aggregation sinks into surrogate aggregation points, but rather keep the nominated sinks at the larger level during the actual optimization/SFT process. This will be based on scenario #1.
6. If needed, a sensitivity may be run that would model the ETC sinks at their respective standard load aggregation point. This sensitivity would be based on a specified scenario.

6. Appendix C Upper Bounds Calculations

When submitting CRR requests for a certain CRR term and time-of-use period, eligible entities are capped on their total MW request. This cap is called the "Upper Bound". This section provides the necessary calculations for determining the upper bound.

The transmission capacity that serves an LSE's load can be categorized into the following:

- Transmission Owner Rights (TOR);
- ETC;
- Converted Rights; and
- CAISO transmission that is neither TOR or ETC or Converted Rights.

As noted in Section 2.8, TOR capacity will be removed from the network (i.e., no CRRs will be allocated to market participants for this transmission capacity). The next three categories are eligible for requesting CRRs and note that these three are CRR types. Since CRR types will be treated differently in the study, it is important to determine the amount of MW of load-serving transmission capacity within each CRR type (since CRRs are for hedging against transmission

congestion). This determination of transmission capacity will lead to the separate upper bounds for each CRR types.

The CAISO will work with the market participants to determine the amount of their load that is served under TOR. Likewise the CAISO will work with market participants and PTOs to determine the ETC rights that serve load and will work with the Converted Rights holders to determine the amount of CRRs that they should be given based on their original transmission rights that were transferred to the CAISO.

In the process of calculating the upper bound, the following parameters are needed, where each parameter has the following implicit attributes:

- Associated with a particular LSE;
- For a particular CRR term (monthly for the annual term);
- For a particular month;
- For a particular time-of-use period (on-peak or off-peak); and
- Located within a particular Standard Load Aggregation Point.

L_P is the peak load. For the annual-term allocation this is based on historical load data and for the monthly-term allocation this is based on forecasted load data (unless in either case specified otherwise). For MSS that choose net settlement, L_P would be based on the net load duration curve, which is calculated by subtracting forecasted generation from forecasted or historical load as discussed in the MSS section above;

C_{TOR} is the Transmission Ownership Rights related transmission capacity;

L_{TOR} is the amount of the LSE's load that is directly served over the TOR (as determined through agreements with CAISO and LSE), $L_{TOR} \leq \min (L_P, C_{TOR})$, (assuming no counter flow);

C_{ETC} is the amount of Existing Rights that the LSE has for serving its load;

C_{CR} is the amount of Converted Rights that the LSE has for serving its load (as determined through agreements with CAISO and LSE);

The following terms, L_{ETC}, L_{CR} and L_{LSE} will be used in the direct calculation of the upper bound for each CRR type; their definitions are:

$L_{ETC} = \min(L_P – L_{TOR}, C_{ETC})$

$L_{CR} = \min(L_P – L_{TOR} - L_{ETC}, C_{CR})$

$L_{LSE} = L_P – L_{TOR} - L_{ETC} - L_{CR}$

6.1. Annual-Term Upper Bounds

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

1) For load within each Standard Load Aggregation Point (PG&E, SCE or SDG&E), gather hourly historical load over the one-year Historical Reference Period (HRP). For the study the HRP is the year 2003.

a) For pump load the HRP would be an average water year. For pump load associated with pump/generation, the requestor should forecast the pumping load consumption for the year 2006 and use this as part of the 2003 load data (first remove this pump load from the 2003 load before adding the forecasted pumping load for 2006).

b) For MSS opting for the net settlement, the hourly load must first be adjusted by subtracting the 2006 hourly forecasted generator (generator within the MSS bubble) dispatch from the 2003 hourly historical load on an hourly basis

2) Label each of the hours with the appropriate time-of-use identifier of on-peak or off-peak.

3) Develop a load duration curve for each month from these data per on-peak and off-peak period (i.e., sort the data so that it is descending in value). The peak value should correspond to L_P.

4) For a given month calculate the on-peak load metric from the on-peak load duration curve and calculate the off-peak load metric from the off-peak load duration curve. The load metric will be denoted by LM. The load metric is the 0.5%[14] exceedence level of the load duration curve, i.e., a MW level that is expected to be equaled or exceeded only 0.5% of the time over a month (an example is provided in Section 6.1.1).

5) The annual-term upper bound (in MW) per CRR type for a given month and time-of-use period (note that if (L_P- L_{TOR}) is zero then these upper bound calculations are not necessary since all load is served by TOR):

Upper Bound for ETC = $75\% * (LM - L_{TOR}) * L_{ETC}/(L_P - L_{TOR})$

Upper Bound for Converted Rights $= 75\% * (LM - L_{TOR}) * L_{CR}/(L_P - L_{TOR})$

Upper Bound for LSE = $75\% * (LM - L_{TOR}) * L_{LSE}/(L_P - L_{TOR})$

The above equations state that no more than 75% * (LM – L_{TOR}) will be allocated in aggregate to the three CRR types in the annual allocation process. The load metric is discounted by the amount of load that is served by TOR since CRRs will not be allocated to TOR. Note that $L_P - L_{TOR} = L_{LSE} + L_{ETC} + L_{CR}$, and the three factors used above, $L_{ETC}/(L_P - L_{TOR})$, $L_{CR}/(L_P - L_{TOR})$ and $L_{LSE}/(L_P - L_{TOR})$ sum to 1.0, thus these factors determine the allocation of the aggregate upper bound 75% * (LM – L_{TOR}) to each of the CRR types.

The upper bound has been scaled by 75% since 75% of the capacity in the network will be used in the optimization/SFT for the annual term CRR allocation.

6.1.1. Example of Determining the 0.5% Exceedence Level

The following is an example of a monthly load duration curve for on-peak hours. For this load duration curve the maximum load is 1981 MW and the minimum load is 893 MW.

[14] In the past the ISO has referred to this same point as the 99.5% exceedance level but to more consistent with how this is used in statistical analysis we will now refer to this as the 0.5% exceedance level.

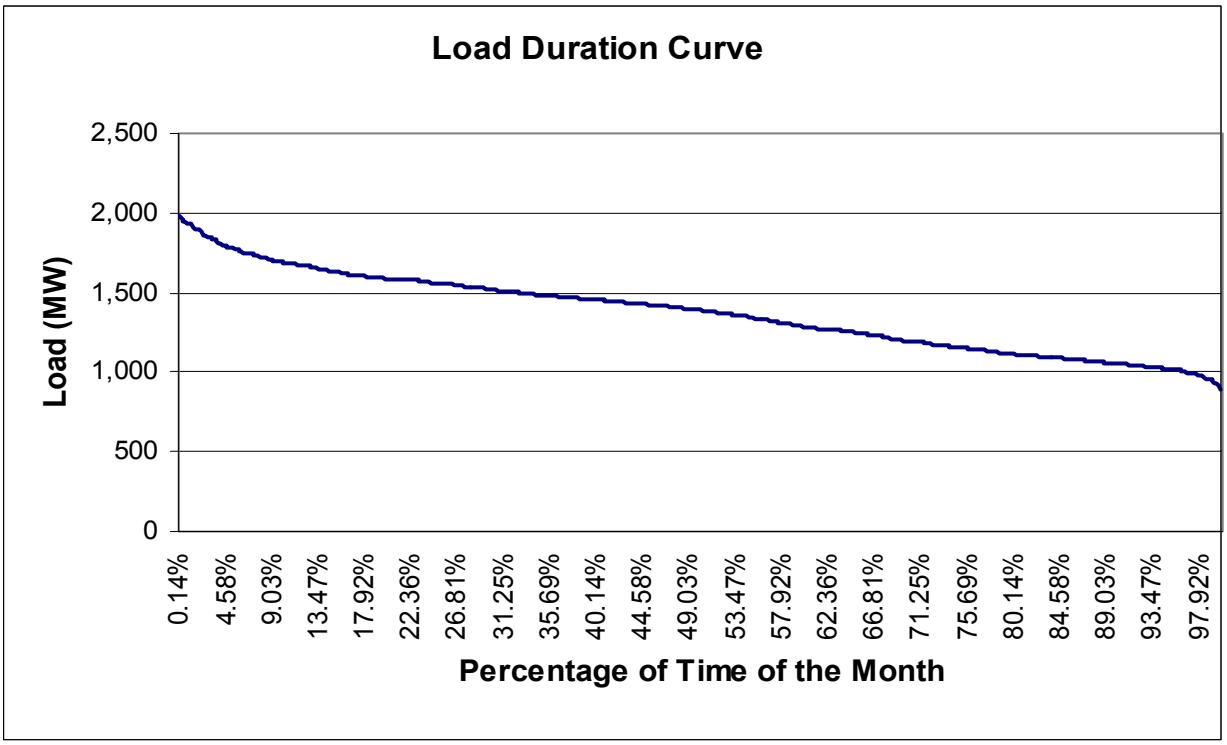

Figure C.1 Load duration curve

The load metric for this load duration curve is shown in Figure C.2. Figure C.2 is a close-up look at the upper right part of the load duration curve in Figure C.1. Note that the 0.5% exceedence point corresponds to the MW level associated with 0.5% point in the graph. The load level at the 0.5% point in Figure C.2 is 1955 MW (which happens to be 98.7% of the peak load, i.e., 98.7% = 1955/1981) and is the load metric for this month.

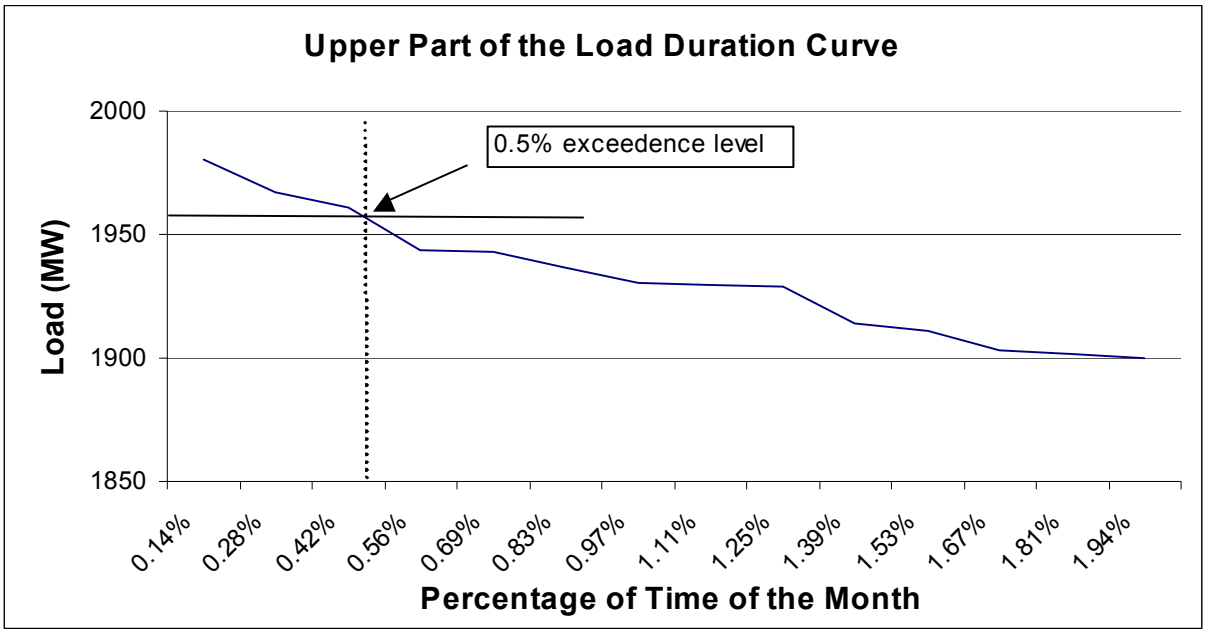

Figure C.2 Load duration curve with 0.5% exceedence level point shown

[Roger – need to change the graph above to read 0.5% exceedence level]

6.2. Monthly-Term Upper Bounds

The upper bound calculation for the monthly-term CRRs follows very much the same methodology for the annual-term calculation. The values of L_P, L_{TOR}, L_{ETC}, L_{CR} and L_{LSE} are all calculated on the same basis except that L_P is determined from forecasted load data.

The Monthly-term upper bound (in MW) per CRR type for a given month and time-of-use period:

Upper Bound for ETC = $(LM - L_{TOR}) * L_{ETC}/(L_P - L_{TOR})$ – Annual Term Allocation for ETC

Upper Bound for Converted Rights = $(LM - L_{TOR}) * L_{CR}/(L_P - L_{TOR})$ – Annual Term Allocation for Converted Rights

Upper Bound for LSE = $(LM - L_{TOR}) * L_{LSE}/(L_P - L_{TOR})$ – Annual Term Allocation for LSE

6.3. Example

The following provides an example for the calculation of the annual-term and monthly-term upper bounds.

Suppose for an LSE, the following parameters are identified for a particular Standard Load Aggregation Point, month and TOU period for the annual allocation:

$L_P = 100$ MW;

C_{TOR} = 10 MW

L_{TOR} = 10 MW

C_{ETC} = 30 MW

C_{CR} = 20 MW

L_{ETC} = min(100 – 10, 30); = 30 MW. After the removal of TOR capacity to serve 10 MW of the LSE's load, the LSE has 90 MW of peak load left to serve. The LSE has 30 MW of ETC capacity to be used to serve it load. The LSE can use all of this 30 MW of ETC capacity to service it load and this 30 MW will be used in determining the upper bound for the entity that will be requesting CRRs for the ETC capacity. Note that if C_{ETC} is 150 MW, then L_{ETC} would be limited to the remaining capacity of 90 MW, i.e., there is no reason to calculate an upper bound based on 150 MW when the load (less the amount that can be served by TOR) is 90 MW.

L_{CR} = min(100 – 10 - 30, 20) = 20 MW. The upper bound for the amount of CRRs to be used for the Converted Rights holder will be based on the 20 MW.

L_{LSE} = 100 – 10 - 30 – 20 = 40 MW. The upper bound for the amount of CRRs to be used for the LSE holder will be based on the 40 MW.

Assume that the load metric is 95 MW based on historical data and that the available CRRs for the three CRR types is discounted by the TOR of 10 MW. The upper bound calculation for each CRR type is:

Upper Bound for ETC = 75% * (95 – 10) * 30/(100 – 10) = 21.25 MW

Upper Bound for Converted Rights =75% * (95 – 10) * 20/(100 – 10) = 14.17 MW

Upper Bound for LSE = 75% * (95 – 10) * 40/(100 – 10) = 28.33 MW

Note that 23.75 + 15.83 + 31.67 = 75% (95).

Suppose the entity requesting CRRs for the ETC was allocated 18 MW. The allocation for Converted Rights related CRRs was 10 MW and the allocation for LSE related CRRs was 25 MW.

Assume that for the monthly-term allocation for the same Standard Load Aggregation Point, month and TOU period the L_P is 105 MW, with C_{TOR}, L_{TOR}, C_{ETC} and C_{CR} the same.

L_{ETC} = min(105 – 10, 30); = 30 MW.

L_{CR} = min(105 – 10 - 30, 20) = 20 MW.

L_{LSE} = 105 – 10 - 30 – 20 = 45 MW.

Assume that the load metric is 99.75 MW based on forecasted data. Discounting the load metric by the TOR of 10 MW, the amount in aggregate that can be allocated to the CRR types in aggregate is 99.75 – 10 = 89.75 MW. The proportion of this upper that each type should receive is based on L_{LSE}, L_{ETC} and L_{CR}. For example, for the LSE CRR type, the proportion would be 45/(30 + 20 + 45), which is equal to 45/(105 – 10). Since it is assumed that each CRR type was allocated some CRR MW in the annual allocation for the same corresponding time period, these allocations are discounted from the proportion to arrive at the upper bound for the monthly-term allocation. The upper bound calculation for each CRR type is:

Upper Bound for ETC = (99.75 – 10) * 30/(105 – 10) - 18 = 10.34 MW

Upper Bound for Converted Rights =(99.75 – 10) * 20/(105 –10) - 10 = 8.89 MW

Upper Bound for LSE = (99.75 – 10) * 45/(105 – 10) - 25 = 17.51 MW

Note that the allocation of CRRs in the annual term for this time period was 53 MW (18 + 10 + 25) and the total upper bound is 89.75 with the difference being the total in the monthly upper bound, 89.75 – 53 = 36.75 = 10.34 + 8.89 + 17.51.