California Independent
System Operator Corporation

Congestion Revenue Rights Presentation to the Transmission Maintenance Coordination Committee

Roger Treinen

TMCC Meeting
February 12, 2007

Contents

- Purpose of this presentation
- Need for congestion revenue rights (CRRs)
  - Background on day-ahead energy market and congestion revenue
- CRR entitlement formula
- CRRs and scheduling/bidding
- Methods to provide CRRs to market participants
- Revenue adequacy
  - Simultaneous feasibility test
- Timing of CRR allocations and auctions
- Impact of timing on revenue adequacy
  - Impact of outages
- Proposed help/assistance needed from TMCC

Purpose of Presentation

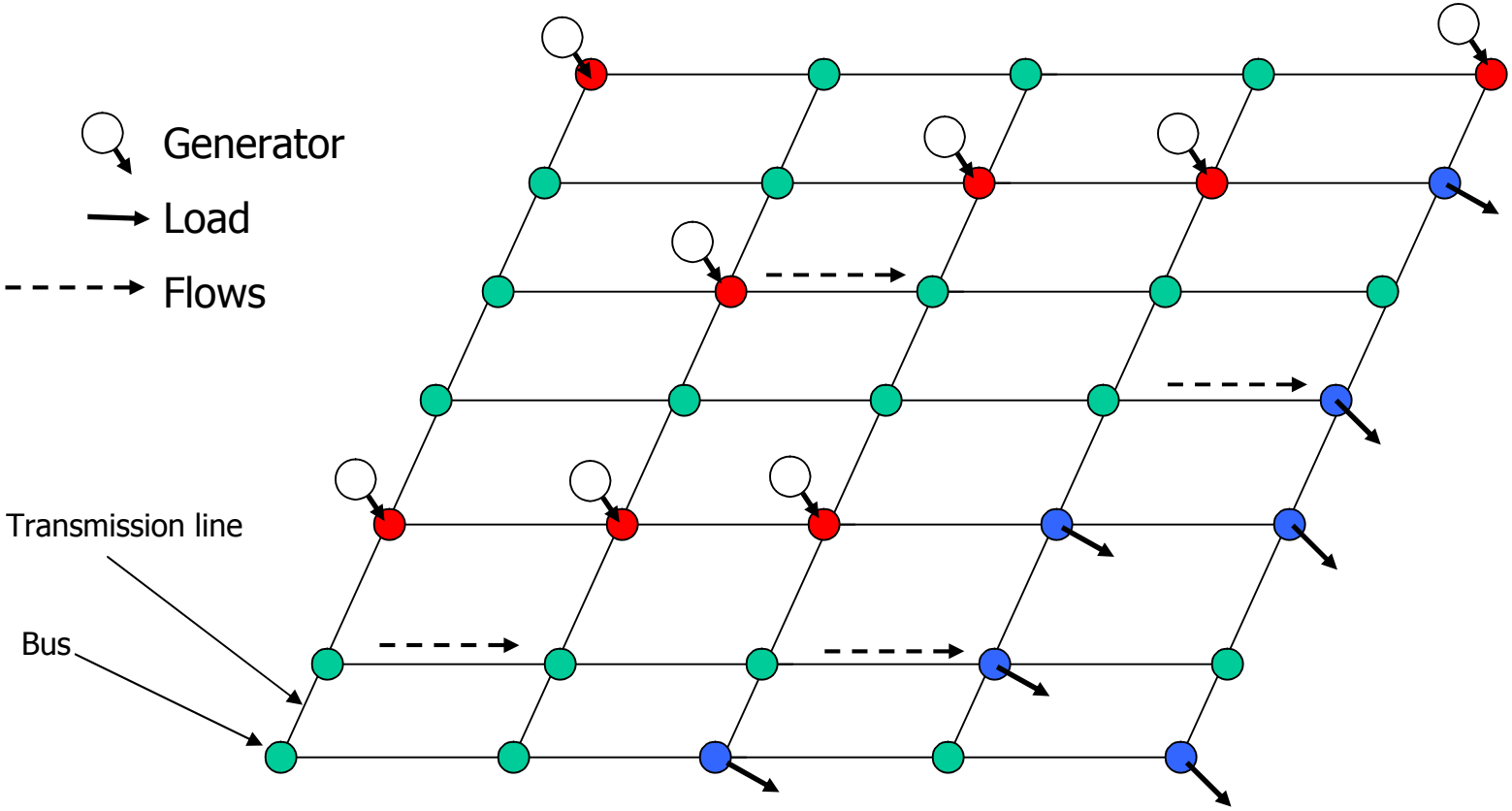
- **Provide the TMCC with an *overview* of Congestion revenue rights**
  - A good understanding of all the aspects of CRRs would take well over one full week
- **Explain how outages have an impact on revenue adequacy**
- **Discuss the role of the TMCC in assisting the CAISO with the handling of the transmission outage modeling within the CRR allocation and auction processes**

Need for Congestion Revenue Rights

- **The need for congestion revenue rights is due to transmission congestion**
- **Background on transmission congestion**
- **The electrical transmission system is used to transfer electrical power from generation to load**
  - Generators are ***not*** located at the load locations
  - The power flows over transmission lines and transformers

Need for Congestion Revenue Rights

- Electrical power system showing generators and loads at different locations
- The transmission lines connect generators and loads
- Power flows over the transmission lines (*sample flows shown*, not all flows shown)



Need for Congestion Revenue Rights

- **Under MRTU, the CAISO will operate an integrated energy and ancillary services market in both the day-ahead time frame (day-ahead market - DAM) and in real-time (real-time market – RTM)**
  - Major component of the markets is the full network model
  - All transmission lines connecting generation and load (including import and export locations) are modeled
  - All transmission constraints will be enforced
- **Integrated forward market (IFM) is part of the DAM process**
- **IFM is a process where supply energy bids and demand energy bids are cleared to establish day-ahead supply and demand schedules**
- **Not all of the cheapest supply may be scheduled to balance out with the scheduled demand ⇒ transmission congestion**
  - Insufficient transmission capacity prevents cheap energy from flowing to load
    - Under this condition certain transmission related constraints are “full”, i.e., no more can flow over the constraint
    - Results in transmission congestion
    - More expensive supply must be scheduled to balance out with scheduled demand

Need for Congestion Revenue Rights

- **The CAISO collects congestion revenue**
- **Within the IFM, locational marginal prices (LMPs) are calculated**
- **LMPs are the locational prices that are the basis for payments to supply and charges to demand**
  - Also provides price signals in the long-term for new generation and transmission siting
- **LMPs are calculated at many buses in the FNM which include**
  - Generator locations
  - Control area Interconnection locations (scheduling points which are for export/import)
  - Default load aggregation points
  - Custom load aggregation points
  - Other locations
- **Due to transmission congestion, LMPs may be different at every location**
- **LMPs have a reference component, congestion component and loss component**
- **For a particular load, the charge to the load is:**
  - Load MW × LMP at load
- **For a particular generator, the payment to the generator is:**
  - Generator MW × LMP at generator
- **If a scheduling coordinator schedules 100 MW of load and 100 MW of generation, the net charge to the SC is**
  - (LMP at load - LMP at generator) × 100 MW

Need for Congestion Revenue Rights

- **Transmission congestion results in the collection of congestion revenue (aka congestion rents or merchandising Surplus) by the CAISO**
- **The congestion revenue is always greater than or equal to zero (never negative)**
- **The CAISO may not keep the congestion revenue because the CAISO is revenue neutral**
- **Must devise a way to allocate the congestion revenue back out to market participants**
- **Congestion revenue rights (CRRs) play the following roles**
  - Provides a means in allocating out the congestion revenue to holders of the CRRs
  - Provides a means for scheduling coordinators to hedge their congestion charges

CRR Entitlement Formula

- **A CRR is similar to a financial forward contract**
- **Point-to-point CRR entitlement formula**
- **(MCC LMP at the CRR sink location - MCC LMP at the CRR source location) × MW quantity**
  - MCC LMP = marginal congestion component of the LMP
  - Funded only through the congestion revenue from the day-ahead market
  - For an entitlement that pertains to a given hour, the MCC LMPs at the CRR sink location and CRR source location are prices generated from the IFM for that same given hour
  - The MW quantity is determined at the time the entitlement is created
    - Through an allocation or auction
  - Point-to-point CRR is equivalent to location-to-location
  - This is interpreted as (CRR source location)-to-(CRR sink location)
  - CRRs may be interpreted as transmission capacity
  - Holder must pay if the entitlement becomes negative

CRR Entitlement Formula

- **Eligible source locations and sink locations**
- **Eligible source locations**
  - Generator locations
  - Trading hub locations
  - Import locations
  - A few other locations to support existing transmission contracts
- **Eligible sink locations**
  - Default load aggregation points
  - Custom load aggregation points (e.g., for metered sub-systems
  - Sub load aggregation points
  - Participating loads and pump/gen locations
  - Export locations
  - Other locations to support existing transmission contracts

CRRs and Scheduling/Bidding

- **Scheduling coordinators do not need to hold CRRs to schedule/bid in the day-ahead market**
  - CRRs are *not* physical scheduling rights
  - If a scheduling coordinator holds a CRR they do not receive an explicit scheduling priority
- **Entities that hold CRRs need not schedule/bid in the CAISO markets**
  - Need not be scheduling coordinators
  - May be speculators

Methods to Provide CRRs to Market Participants

- **Two methods for providing CRRs to market participants**
  - CAISO conducts these methods
- **Allocation**
  - Market participants nominate the CRR they want to have
  - They nominate the source location, the sink location and the MW value
  - Only eligible entities can participate in allocation
    - Pay for embedded cost of transmission grid through the access charge
      - For example, load serving entities in the control area
- **Auction**
  - Market participants bid on the CRR they want to hold
  - Highest bids win the CRRs
- **Market Participants can also trade CRRs**
  - This is another method in which a market participant may acquire a CRR

Revenue Adequacy

- **Revenue adequacy is the situation when congestion revenue is greater then CRR revenue**
  - Congestion revenue: from market participants to CAISO
  - CRR revenue: from CAISO to market participants
- **The CAISO does not want to payout more than it brings in**
  - Does not want to have CRR revenue greater than congestion revenue
- **To avoid this problem, the CAISO limits the amount of MW it allocates and auctions**
  - This is the MW value in the CRR entitlement formula

Revenue Adequacy

- **This limitation on the MW amounts is performed directly through the allocation and auction process by using a simultaneous feasibility test (SFT)**
- **The SFT is similar to a power flow simulation**
- **For the allocation, a market participant nominates a CRR source location, a CRR sink location and a MW amount**
- **In the SFT, this nomination is modeled similar to:**
  - A generator at the source location with the injection level equal to the MW value and
  - A load at the sink location with the withdrawal level equal to the MW value
  - These are modeled on the full network model
- **When all the nominations are applied *simultaneously*, these injections and withdrawals induce flows through the FNM**
- **If any transmission constraint (flow based constraints) is violated, then the SFT fails**
- **If the SFT fails, the MW quantities are reduced until the SFT passes (through an optimization process)**
- **Same applies to auction except reduction is based on bids**

Revenue Adequacy

- ***Revenue adequacy (RA) rule*: if in the IFM, the FNM is the same and the constraints are the same as those used in the CRR allocation and auction process, revenue adequacy is ensured**
  - This is not a sufficient condition, but just a necessary condition for revenue inadequacy
  - Even if the FNM and constraints are different, revenue inadequacy may not occur
- **Current rule states that the CRR entitlements are fully funded**
  - Any short fall (CRR revenue > congestion revenue) will be gathered from metered demand
  - Very important to ensure revenue adequacy
- **Impacts on revenue adequacy**
  - If IFM process uses different FNMs and constraint values as compared to CRR SFT process

Term Lengths of CRRs and Timing of Allocations and Auctions

- **There are 3 term lengths of CRRs**
  - Long Term
    - 10 years by season and on and off peak
  - Seasonal
    - 3 month seasons and on and off peak
  - Monthly
    - One month and on and off peak
- **Annual process**
  - Once a year process
  - Allocates long term CRRs
  - Allocates seasonal CRRs
- **Monthly process**
  - Once a month process

Term Lengths of CRRs and Timing of Allocations and Auctions

- **Annual process**
  - Performed approximately 4 months before the start of the upcoming year
  - Allocates and auctions seasonal CRRs for the upcoming year plus allocates long term CRR for the upcoming ten years
- **Monthly process**
  - Performed approximately 1 month before the start of the upcoming month

Impact of Timing on Revenue Adequacy

- **IFM process**
  - Processed every day for the next trading day
  - The day before time frame
  - Revenue adequacy is based on processes (IFM and CRR) whose time frames are very different
- **Consider the *day before* time frame processing for IFM compared to CRR processes**
  - *month before* time frame for monthly CRR process
    - There is actually a gap of nearly two months
    - The last day of the month which is allocated/auctioned is nearly two months in the future from the date it is created
  - *Four months to sixteen months before* time frame for the seasonal CRR process
  - *Four months to ten years and four months before* time frame for the long term CRR process

Impact of Timing on Revenue Adequacy

- **The timing has a large impact on the "state" of the FNM**
- **The FNM may change every day in terms of transmission facilities being in/out of service**
- **The IFM can adapt to this quite easily due to the "short" time frame (i.e., the day before)**
- **CRR process cannot adapt so easily due to the long time frames**
- **Certain provisions built into the CRR process to account for differences in the FNMs used by IFM and CRR processes**
  - Long term process
    - Only allocate up to 60% of full FNM capability
  - Annual process for seasonal CRRs
    - Only allocate up to 75% of full FNM capability
  - Monthly process for monthly CRRs
    - Allocate 100% of the capability taking into account known information at the time of the process
  - Reduced capability in annual processes helps minimize possible feasibility impacts in the monthly process due to outages and reduced constraint values not known at the time of the annual processes

Simple Example

- **In the CRR process a CRR from location A to location B is simultaneous feasible for 100 MW**
- **In the IFM process only 80 MW is feasible from A to B due to outages of certain transmission facilities**
- **Assume generator at location A and load at location B**
- **Assume these are the only resources scheduled in the IFM and let's ignore transmission losses**
- **Assume LMP at location A is $40/MWh, LMP at location B is $50/MWh**
- **Congestion revenue for that hour is (50 – 40) × 80 = $800**
  - Net proceeds paid to CAISO
- **CRR revenue is (50 – 40) × 100 = $1,000**
  - Net proceeds paid to CRR holders
- **Revenue inadequacy occurs because $1,000 > $800**

Impact of Outages

- **What is important for the allocation and auction process is to know *a priori* the outages that will take place during the upcoming month (facilities, start time and duration)**
  - This is also important in the annual process if there will be outages that have very long durations
- **If the CRR team knows the outages that will take place, these outages may be modeled in the CRR FNM**
  - This is consistent with the RA rule
- **Also, transmission constraint values may be reduced**
- **However, not all of the outages that will occur in the upcoming month may be taken out simultaneously**
  - The CRR team can manage or minimize revenue inadequacy by modeling certain outages and reducing transmission capability (via transmission constraint values)
  - The exact criteria that will be used to determine which outages will be modeled and the amount of reduction of transmission constraints is yet to be finalized
- **What is important to know are outages that will occur**

Impact of Outages

- **Outage types**
  - Scheduled
  - Forced
- **Scheduled outages (for transmission facility maintenance purposes) can be categorized as:**
  - Outages known prior to the CRR monthly allocation/auction process for the upcoming month
    - Reported to the CAISO for approval by a certain date
    - Will be modeled by IFM
  - Outages not known prior (not reported) to the monthly allocation/auction process
    - Will be modeled by IFM
  - Outages scheduled but cancelled and thus not modeled in IFM
- **Forced Outages**
  - Not scheduled but forced and possibly modeled in the IFM

Impact of Outages

- **Which outages are important to consider?**
- **Outages that cause relatively large de-rates in transmission constraint values**
- **Outages on transmission facilities that carry large power flows**
  - Higher voltage facilities, e.g., 500 kV & 230 kV
  - When outaged, these large power flows will flow over other facilities
    - Possibly resulting in reduction of generator output (re-dispatching of generation) in the IFM and real-time
  - Outages at the 60 kV and 70 kV level at the load switching centers *may* not be critical, depending on their impact on the flows on the higher voltage level transmission facilities

Help/Assistance from TMCC

- **The CRR Process would benefit from *100% accurate scheduling of transmission facility outages by the specified timeframe***
  - The specified time frame is dependent on when the monthly process starts
  - 100% is generally not possible
  - Thus, try to maximize the accuracy of transmission outage scheduling in the given timeframe
- **Statistical analysis of those scheduled outages that may not be scheduled by the specified timeframe, but nonetheless typically occur (include forced outages also)**
  - Breakdown by transmission owner area
  - By month
  - By voltage level
  - other

Next Steps

- **Possible additional discussions on CRRs**
- **Additional discussions on the help that TMCC can provide to the CRR process**