California Independent
System Operator Corporation

Discussion Paper

MRTU Release 1 Implementation of Preferred Integrated Balancing Authority Area Modeling and Pricing Options

1. Introduction

The California Independent System Operator's ("CAISO") Market Redesign and Technology Upgrade ("MRTU") program encompasses a comprehensive overhaul of the CAISO's electricity markets that will address the structural flaws in the CAISO's current markets. In particular, MRTU will both enhance reliability and increase the efficient utilization of the transmission system through development and application of a detailed and accurate Full Network Model or "FNM" of the CAISO Controlled Grid. Application of the FNM to manage congestion and establish Locational Marginal Prices or "LMPs" will enable the CAISO to align price signals with the CAISO's operating requirements.

While it is sufficient to model interchange transactions with many external Balancing Authority Areas as radial injections, for Balancing Authority Areas that have several interconnections with the CAISO at different locations such that the flow effects between the External Balancing Authority Area are highly integrated with the CAISO Controlled Grid, it is more favorable to utilize a more accurate modeling approach than radial injections. These highly integrated Balancing Authority Areas are referred to as Integrated Balancing Authority Areas ("IBAA") (previously referred to as Embedded or Adjacent Control Areas). An IBAA is one which has multiple free-flowing AC interconnections with the CAISO Balancing Authority Area. The degree of integration of IBAAs varies by IBAA. While there are others that technically fall in the IBAA category, for Release 1, the only External Balancing Authority Areas the CAISO will be able to implement as IBAA are the combination Sacramento Municipal Utility District (SMUD) and Western Area Power Administration (Western) IBAA and the Turlock Irrigation District ("TID") IBAA. It is important to apply the IBAA methodology to these entities right at the start because their parallel transmission network and flows have significant impact on the CAISO Balancing Authority Area.

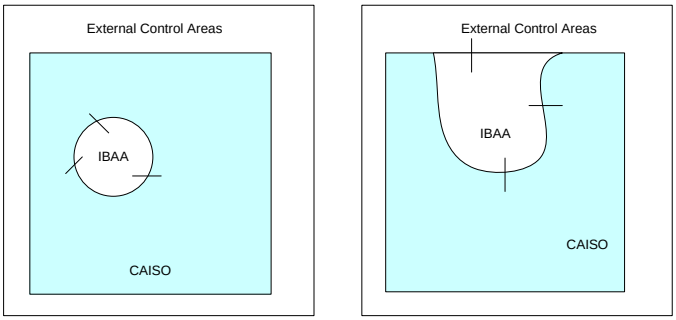

Figure 1: Integrated Balancing Authority Area Concept

Based on analysis of empirical data, the CAISO has determined that continuing to model scheduled transactions between the CAISO and the SMUD/WAPA IBAA and the TID IBAA as radial injections would lead to flow based outcomes that are not consistent with actual flow patterns. Such large differences between actual and scheduled flow could cause either phantom congestion in which the model may indicate congested flows that do not actually exist or could result in situations in which the congestion model does not recognize the congestion that actually occurs in Real-Time. While phantom congestion may result in operational and economic inefficiencies, ignoring congestion in the Day-Ahead Market that actually occurs in Real-Time is less favorable as it may also lead to operational infeasibilities that would be more costly to resolve in the Real-Time.

The CAISO conferred with the affected IBAA entities in the WAPA/SMUD/MID and TID Balancing Authority Areas, to consider and evaluate approaches for modeling of the IBAA within the Full Network Model to be used under MRTU consistent with Section 27.5.3 and Appendix C of the CAISO MRTU Tariff. After the modeling approach was selected, the CAISO considered alternative pricing approaches for transactions between the CAISO and IBAA that would best support the modeling approach selected. The development of the recommended modeling and pricing represents a balance of the following objectives which are consistent with the overall objectives of MRTU:

- Approach improves operational feasibility and efficiency and/or is consistent with actual operational conditions.
- Approach minimizes unintended consequences.
- Approach minimizes the impact on CRR's both from a CRR holder perspective and the impact on the overall market due to risks of revenue adequacy.
- Approach can be implemented and is supported by data and information that is readily available to the CAISO.

Due to the high degree of integration of the SMUD/WAPA/MID and TID Balancing Authority Areas with the CAISO, the CAISO will model and price and settle CAISO Market transactions with the combination of WAPA/SMUD/MID Balancing Authority Area and the TID Balancing Authority Area as an Integrated Balancing Authority Area using the methodology described in this Discussion Paper coincident with the initial

implementation of MRTU scheduled for Trading Day April 1, 2008. The CAISO will evaluate as necessary whether to apply this IBAA modeling, pricing and settlement to other potential IBAA situations after the initial implementation of MRTU and will extend the IBAA modeling and pricing methodology to those other Balancing Authority Areas as soon as it becomes technically feasible to do so.

2. IBAA Modeling Approach

Based on the aforementioned objectives, the CAISO recommends a modeling approach that recognizes the IBAA network and flow interactions that occur between the CAISO and the IBAA network relying on a limited but readily available set of information. The recommended IBAA network model approach will utilize a simplified or equivalent model of the actual IBAA network. However, the IBAA model will fully represent and recognize the interconnections and associated intertie constraints with the CAISO such that parallel flow affects are addressed in the Day-Ahead and Real-Time Markets. Rather than model physical resources internal to the IBAA network, the physical sources and sinks will be replaced and abstracted using individual or aggregations of System Resource injections located at dominant transmission bus locations within the IBAA network where generation from remote locations feeds into and/or load is ultimately served via lower level distribution stations. The individual or aggregate System Resources will be used to distribute and model import and export transactions between the CAISO and the IBAA Balancing Authority Area.

This modeling approach provides the following benefits:

1. Avoids having the IBAA exchange resource specific time-sensitive data for purposes of operating the CAISO Day-Ahead and Real-Time Market.
2. Maintains existing scheduling practices between Balancing Authority Areas.
3. Recognizes how the IBAA and associated entities that act as a sub-systems within the IBAA with their own balancing responsibility operate their systems.
4. Provides a reasonable level of flow model accuracy in cases where simplified radial modeling of interchange transactions is not sufficient.

Under this modeling approach, the CAISO will not be enforcing transmission constraints within the IBAA and will only address marginal losses within the CAISO footprint. This modeling approach is similar to how the Regional Transmission Operators (RTOs) in the Eastern Interconnection model transactions from neighboring Balancing Authority Areas using a "Proxy Bus."[1]

Applying the IBAA approach to SMUD/WAPA/MID and TID IBAA, the CAISO will predefine Resource Identifiers (Resource IDs) to Scheduling Points the supporting individual or aggregate System Resources that the CAISO will model at major junctions

[1] http://www.nyiso.com/public/archive/webdocs/committees/Market%20Structure%20WG/2003-05-29/proxy_buses.pdf

within the IBAA near IBAA generation and/or load.[2] Import and export Schedules will be distributed within the IBAAs, and at the Captain Jack intertie, using predetermined distribution factors to aggregated System Resources. Refer to Figure 2 and 3 for conceptual illustration of the SMUD/WAPA IBAA model. The definition of these aggregated System Resources is subject to further discussion, although the CAISO has presented a preliminary set of definitions as a starting point for discussions, as follows:[3]

[2] At a minimum, Resource IDs will be established that map each IBAA transmission owner's Scheduling Points to System Resources that represent generation owned that transmission owner. Additional Resource IDs will be established as needed.

[3] The distribution factors in this table have been developed from the CAISO's operations model using a simple equivalencing technique that has been discussed in meetings between the CAISO and the IBAA operators, using PTI PSS/E version 29. If this technique is ultimately used, the specific numbers will be revised to be based on the WECC network model. The equivalencing technique consists of three steps, for the limited purpose of computing the distribution factors, as follows:

1. The SMUD IBAA is equivalenced to only the buses that comprise the System Resources, with all generation also being retained at its buses. The resulting load distribution within each aggregated System Resource defines the distribution factors for exports from the CAISO.
2. The SMUD IBAA is then equivalenced to only the buses that comprise the System Resources, but this time with no generation being retained. The difference in load at the retained buses after it is netted with generation, relative to step 1, defines the distribution factors for imports to the CAISO.
3. Because the CAISO anticipates that a single aggregated System Resource will be used for both imports and exports, the distribution factors resulting from steps 1 and 2 are averaged. The specific numbers in this document are illustrative and subject to change.

Table 1: Preliminary Definition of System Resource Aggregations for SMUD/WAPA/MID and TID IBAAs

Aggregated System Resource	Imports to or Exports from CAISO	
	Bus	Distribution Factor
SMUD Hub	37005_ELVERTAS 230kV	0.14
	37010_HURLEY S 230kV	0.31
	37012_LAKE 230kV	0.19
	37016_RNCHSECO 230kV	0.36
WAPA Hub	37545_COTWDWAP 230kV	0.76
	37548_FOLSOM 230kV	0.07
	37585_TRCY PMP 230kV	0.17
MID Hub	38204_PRKR MID 230kV	1.00
TID Hub	38400_WALNT 230kV	1.00
Roseville Hub	37567_ROSEVILL 230kV	1.00
Captain Jack Intertie	45035_CAPTJACK 500kV	1.00

In cases where a generation owner chooses to designate a specific resource for participation in the CAISO Markets, the IBAA modeling approach would allow a resource to be either a Dynamic Resource-Specific System Resource or a Non-Dynamic Resource-Specific System Resource.[4] An example could be SMUD's Cosumnes power plant, which could be distinguished from being part of an aggregated SMUD System Resource. If a generation owner establishes a Resource-Specific System Resource such as Cosumnes, the CAISO will not include its capacity in another aggregation, and the distribution factors for the remaining aggregated System Resource would be adjusted to reflect the remaining generation. If a Resource-Specific System Resource is established, such a resource would be settled at its LMP and not the SMUD aggregate price. A Resource-Specific System Resource will need to provide sufficient information including telemetry to allow the CAISO to monitor its compliance of following instructions at the specific location.

The CAISO's proposed set of definitions includes a separate System Resource for Roseville because Roseville's status as a Scheduling Coordinator (SC) makes it feasible to identify its Schedules. Other specific entities could be similarly identified if

[4] Participation using Dynamic Resource-Specific System Resource or a Non-Dynamic Resource-Specific System Resource is subject to applicable Tariff provisions.

Resource IDs are established to ensure which specific physical locations are being served.

The CAISO will establish Resource IDs for each combination of Scheduling Points and individual or aggregate System Resources that is being scheduled. The default presumption in establishing Resource IDs is that the individual or aggregate System Resource represents supply that is controlled by the transmission owner for the boundary Scheduling Point, for which the CAISO will determine appropriate distribution factors, or is an import from another Control Area at Captain Jack for which the CAISO will receive Tags for the interchange transactions. The CAISO will evaluate requests from Scheduling Coordinators for other combinations of individual or aggregate System Resources and Scheduling Points, and assign the Resource ID for the SC along with appropriate distribution factors. Such requests will be evaluated based on legitimate need and CAISO may require data submittal by the requesting entity in order to verify the appropriateness of assignment and use of the Resource ID. The CAISO will then expect that the Resource IDs are being correctly associated with supply or demand at the designated locations (including aggregated locations, such as subsystems of an IBAA), and will monitor compliance with the definitions of the Resource IDs. One of the requirements for establishing a Resource-Specific System Resource is the provision of telemetry that will allow the CAISO to validate the resource's compliance with Dispatch Instructions, including Schedules, in the CAISO Markets.

3. IBAA Pricing and Settlement Approach

Based on the recommended modeling approach of the IBAA, the CAISO is also proposing a pricing and settlement approach that supports and aligns the settlement of transactions between the IBAA and the CAISO with the operational reality of the system. The recommended pricing approach would price transactions based on a single or aggregate locational price that is designed to reflect as close as possible the location(s) where the transactions are being sourced or sink within the IBAA. Therefore, in the case where the IBAA represents a single Balancing Authority, a single aggregate IBAA price would be used based on the weighted average price of the nodes where System Resources have been modeled in the IBAA. However, for an IBAA, such as the SMUD/WAPA IBAA, that represents an aggregation of individual sub-systems that operate with their own balancing responsibility, the recommended approach would establish prices for each operationally relevant sub-system (aggregate price), based on the weighted average price (using the Generation Distribution Factors) of the System Resources that are used to distribute transactions from the sub-system within the IBAA. When registering intertie Market Resources IDs, a Scheduling Coordinator will be required to identify sub-system individual System Resource or aggregated System Resource that is the source or sink of the market transaction. The CAISO will not enforce transmission constraints within the IBAA. Furthermore, measures will be taken to exclude the marginal transmission losses within the IBAA from affecting the prices within the IBAA and the CAISO. Therefore, the prices used for settlement of the IBAA are not affected by congestion or losses within the IBAA and only represent the marginal effect of losses and congestion within the CAISO Controlled Grid.

The recommended pricing and settlement approach provides the following benefits:

1. Aligns the pricing of the expected source/sink of interchange transactions between the CAISO and the IBAA with the operational reality.
2. Value of energy associated with transactions between CAISO and the IBAA are based on the impact on congestion and losses in the CAISO Balancing Authority Area.
3. Avoids unintended opportunities associated with pricing transactions at the intertie point which can be selected arbitrarily to extract value based on the price difference of the intertie points, when in fact the actual source of the transaction is the same
4. Provides consistency with how the CRR system is modeling the source and sinks from the IBAA and thus reduces opportunity for CRR revenue inadequacy
5. Avoids a single price for IBAA when sub-system operations exists that may result in operational inaccuracies and inefficiencies between markets

Under the proposed pricing approach, using the same underlying modeling methodology, a "hub" price would be established for different operational sub-system areas within each IBAA. For example, with respect to the SMUD IBAA, separate hubs could be created for SMUD, Western, MID, and/or regions within each area.

Different prices for the separate hubs in the proposed pricing approach may create the potential for undesirable arbitrage opportunities for price differences between the different hub prices. To mitigate these undesirable opportunities, some monitoring and mitigation measures may be deployed under this pricing approach. Monitoring measures may include analysis of available telemetry and tag data to ensure that a delivered transaction is indeed being sourced from the System Resource(s) that are associated with the scheduled interchange transaction. Other monitoring of the proposed pricing approach may be deployed to identify circular scheduling behavior that is being sourced and sunk in the same IBAA to take advantage of price differences of the different sub-system hub prices within the same IBAA.

Multiple Resource IDs may exist in the CAISO Markets at each intertie Scheduling Point, and each will be mapped to a predefined set of System Resources. The predefined aggregation of System Resources that is mapped for some Resource IDs at any Scheduling Point may differ from the System Resources that are mapped for other Resource IDs at the same Scheduling Point, as illustrated in Figure 1. In this case, the CAISO's price for the different Resource IDs could be different from the same Scheduling Point, to reflect the value to the CAISO of injections at their own aggregations of System Resources. When the same aggregation of System Resources is mapped from multiple Scheduling Points, the value to the CAISO system due to injections from the aggregation of System Resources would be the same, regardless of which intertie Scheduling Point is used, and the CAISO's price would be the same. The CAISO will expect that Scheduling Coordinators will provide the CAISO accurate

information, subject to the CAISO Tariff, when registering the linkage between System Resources to Resource Ids to ensure realistic identification of the set of System Resource injections that support their Schedules.

Other Balancing Authority Areas settlement, such as settlement of inadvertent interchange (deviations between actual and scheduled interchange), would occur as it does currently and would not be affected by the proposed IBAA modeling or pricing approach.

4. IBAA and Congestion Revenue Rights (CRRs)

As stated in the CAISO's Business Practice Manual for Congestion Revenue Rights (section 1.5), "Congestion Revenue Rights (CRRs) are financial instruments that enable holders of such instruments to manage variability in Congestion costs that occur under a Congestion Management protocol that is based on locational marginal pricing. CRRs are acquired by qualified entities primarily, but not solely, for the purpose of offsetting costs associated with Congestion costs that occur in the Day-Ahead Market."

The CAISO recognizes that the amount of Congestion cost that will be charged in the Day-Ahead Market for Schedules to or from an IBAA will need to be consistent with the proposed pricing approach, but this does not affect the acquisition of CRRs whose purpose is to offset costs associated with Congestion costs that occur in the Day-Ahead Market. This is because Settlement of CRRs will pay the CRR Holder on the same basis for Schedules to or from an IBAA as these Schedules are charged for Congestion in the Day-Ahead Market. The same System Resource pricing aggregation(s) will be used for future CRR Settlements as are used in the Day-Ahead Market, so CRR Settlement will be consistent with how the resource locations are ultimately established for the IBAAs' Settlement for Congestion costs. For example, if a CRR is acquired for exports at Tracy to serve SMUD, and it is determined that exports to SMUD that occur at Tracy will be settled at a "hub" price, the CRR that is acquired at Tracy will be settled at the same "hub" price. Therefore, the ultimately adopted pricing approach should not impact participation in the CRR allocation process for acquiring CRRs whose purpose is to offset Congestion costs that occur in the Day-Ahead Market.

Figure 2:

Implementation Concepts for Scheduling Intertie Resources
in Integrated Balancing Authority Area Modeling Approach

Note: MID and TID are not shown in this diagram in the interest of avoiding further complexity

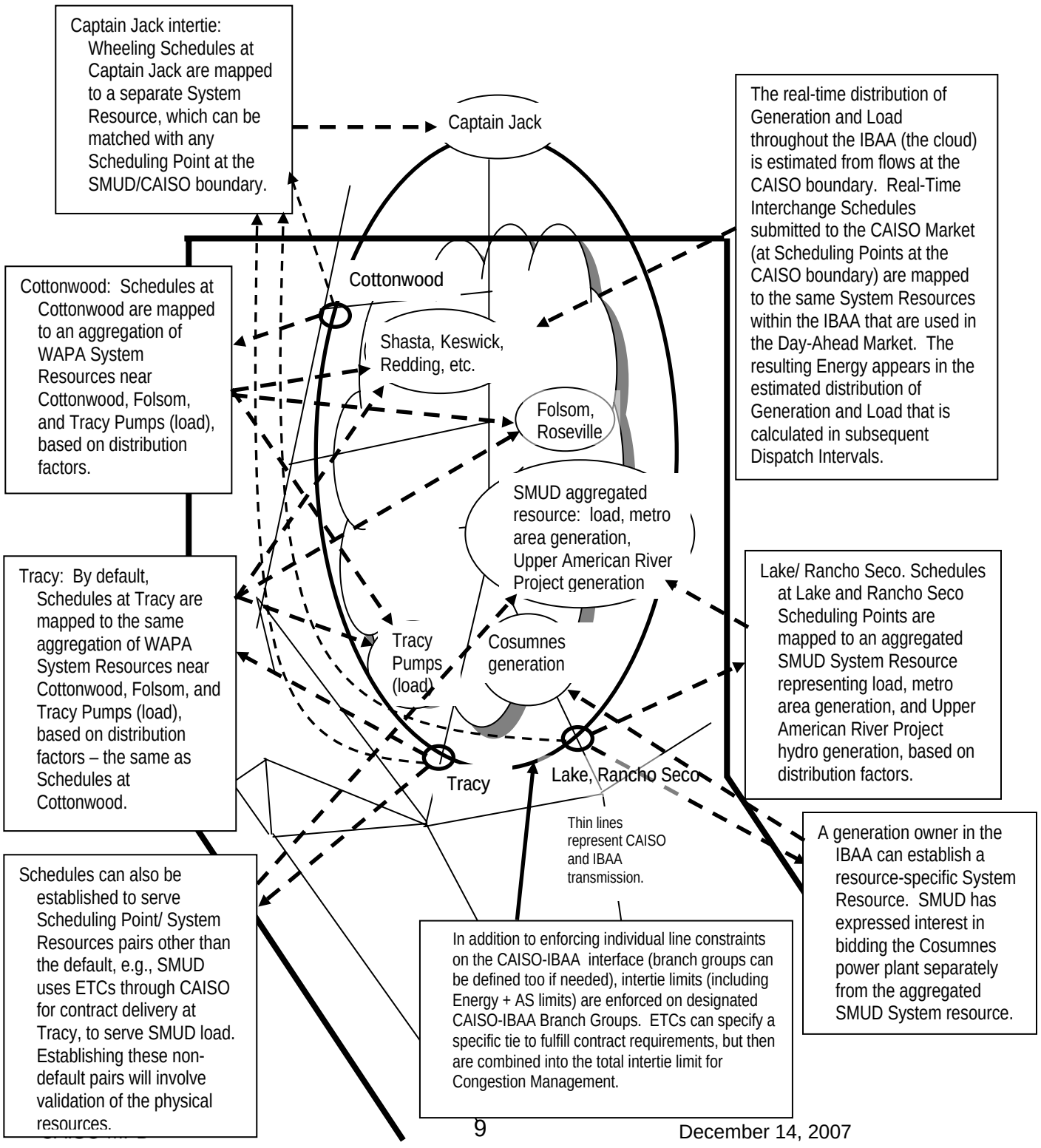

Figure 3:

Implementation Concepts of SMUD/WAPA/MID and TID IBAA Network with System Resources