



California ISO
Your Link to Power

Real-Time Daily Market Watch Metric Catalog

Version 1.0

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

ISO Market Services

VERSION HISTORY

Date	Version	Description	Author
7/17/2009	1.0	Creation of document	Rahul Kalaskar

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

TABLE OF CONTENTS

Introduction4

RTD Default LAP LMPs5

Selected HASP Tie Point LMPs (Hourly Average)6

Selected RTD Transmission Corridor Shadow Prices.....7

Selected RTD Intertie Shadow Prices.....8

Selected RTD Transmission Line and Transformer Shadow Prices9

Selected RTD Nomogram Shadow Prices10

Load Schedule, Forecast, and Actual Load11

RTD Net Cleared Quantity13

RTD Bias15

System Summary Statistics16

RTPD A/S System Requirement.....17

RTPD A/S Average Price.....18

RTPD A/S Procurement.....19

RTD LMP Statistics for On and Off-Peak Hours (\$/MWh).....20

Appendix I.....21

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Introduction

The Market Information group has published a Day-Ahead and a Real-Time Daily Market Watch (DMW) for each trading day. These reports contain various graphs and tables pertinent to the trading day, and it also contains comments about the market performance compiled by an analyst from the Market Information group. The Real-Time DMW Metric Catalog provides a description of all the graphs published in the Real-Time DMW.

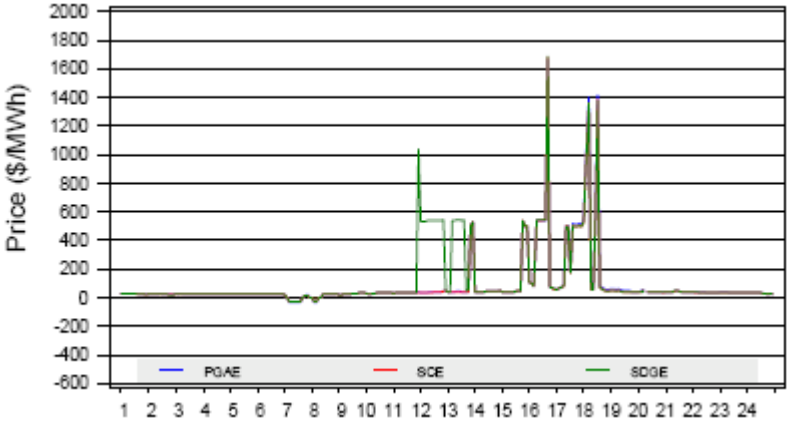
For any questions regarding the Real-Time DMW reports or the Real-Time DMW Metric Catalog please send an email to MarketServices@caiso.com

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

RTD Default LAP LMPs¹

Figure 1 shows the Real-Time Dispatch (RTD) Locational Marginal Prices (LMPs) for default Load Aggregation Points (LAPs) - PG&E, SCE and SDGE-for each of the 5-minute intervals.

Figure 1: RTD Default LAP LMPs



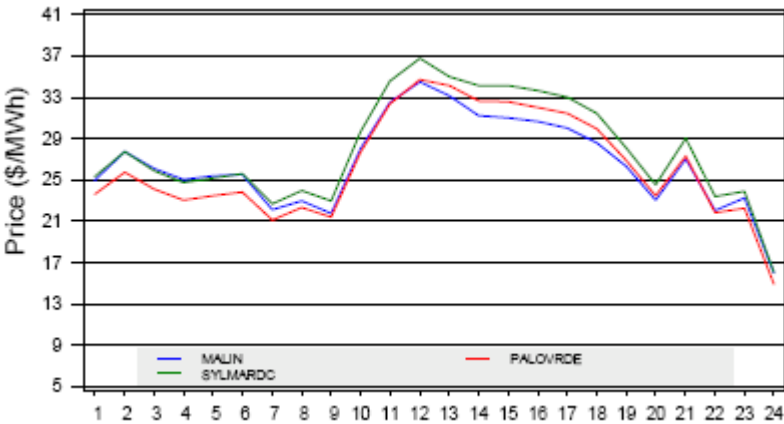
¹ The “DMW_RTD_Lap_LMP.sas” program is used to obtain data for this graph. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Selected HASP Tie Point LMPs (Hourly Average)²

Figure 2 shows the hourly average LMPs of three selected tie points, taken by averaging across the four 15-minute interval LMPs from the Hour-Ahead Scheduling Process (HASP) for the corresponding trading hour, because the tie point schedules are settled at the HASP hourly average LMPs. The three selected tie points are Malin, Palo-Verde and Sylmar DC, which highlight the LMPs at the PACI, Palo Verde and NOB interties, respectively. These tie points are chosen for this graph because on average more than 50% of imports into the CAISO area are scheduled on them. Please note that, Pnode names in the CAISO Full Network Model (FNM) for Malin and Sylmar DC scheduling points are MALIN_5_N101, and SYLMARDC_2_N501, respectively. And the Apnode name in the FNM for Palo Verde is PALOVRDE_ASR-APND.

Figure 2: Selected HASP Tie Point LMPs (Hourly Average)



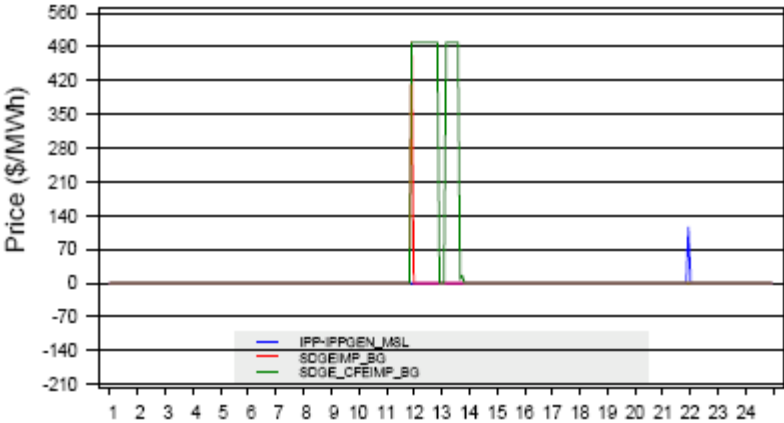
² The “DMW_RTPD_Tie_LMP.sas” program is used to obtain data for this graph. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Selected RTD Transmission Corridor Shadow Prices³

Figure 3 shows the RTD shadow prices by transmission corridors for each of the 5-minute intervals. At most four transmission corridors are displayed in this graph. The logic used to select four transmission corridors is explained in [Appendix I](#).

Figure 3: Selected RTD Transmission Corridor Shadow Prices



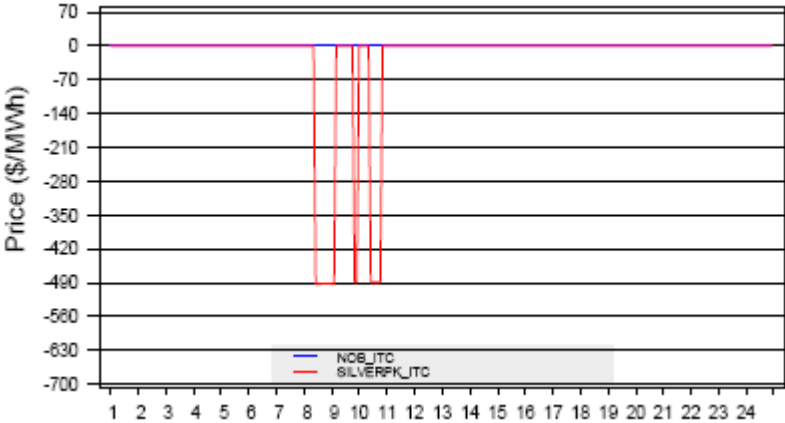
³ The “DMW_RTD_Binding_TCOR.sas” program is used to obtain data for this graph. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Selected RTD Intertie Shadow Prices⁴

Figure 4 shows the RTD shadow prices by interties for each of the 5-minute intervals. At most four Interties are displayed in this graph based on the methodology explained in [Appendix I](#).

Figure 4: Selected RTD Intertie Shadow Prices



⁴ The “DMW_RT_D_Binding_Tie.sas” program is used to obtain data for this graph. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

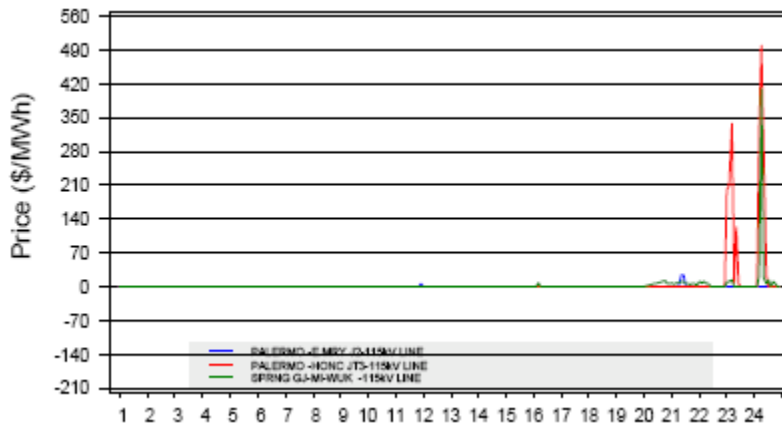
Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Selected RTD Transmission Line and Transformer Shadow Prices⁵

Figure 5 shows the RTD shadow prices for selected transmission lines and transformers. The transmission lines and transformers shown in the graph below have a rating of 230 kV or less. At most four transmission lines or transformers combined are displayed in this graph based on the methodology explained in [Appendix I](#).

Please note that the transmission line and transformer names used in this graph are different from those used in the FNM. The transmission line and transformer names are condensed by extracting the first eight characters of the originating substation and the destination substation. These two sets of eight characters are joined together with a hyphen, and followed with an appropriate voltage level of the transmission line or transformer, along with the key word “Line” or “XFMR” appended at the end. For example, the FNM name of the particular transmission line 33912_SPRNG GJ_115_33914_MI-WUK _115_BR_1_1 is condensed to SPRING GJ-MI-WUK-115KV LINE.

Figure 5: Selected RTD Transmission Line and Transformer Shadow Prices



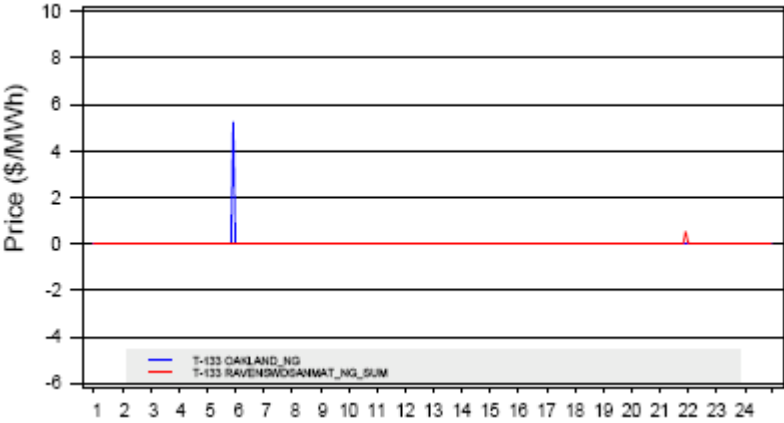
⁵ The “DMW_RTD_Binding_LINE.sas” program is used to obtain data for this graph. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Selected RTD Nomogram Shadow Prices⁶

Figure 6 shows the RTD shadow prices by nomograms for each of the 5-minute intervals. At most four nomograms are displayed in this graph. The logic used to select these four nomograms is explained in [Appendix I](#).

Figure 6: Selected RTD Nomogram Shadow Price



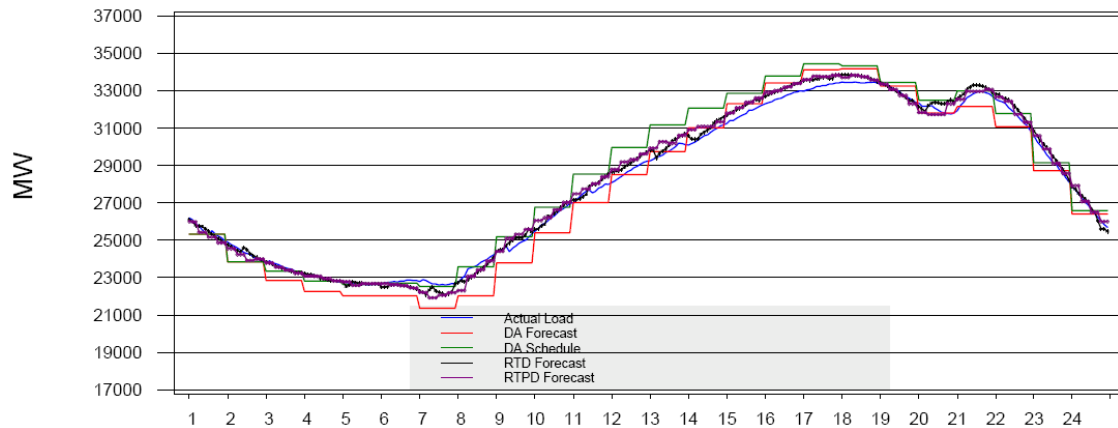
⁶ The “DMW_RTD_Binding_Nomo.sas” program is used to obtain data for this graph. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Load Schedule, Forecast, and Actual Load⁷

Figure 7 compares the Actual Load, DA (Day-Ahead) Forecast, DA Schedule, RTD Forecast and Real-Time Pre Dispatch (RTPD) Forecast. The Actual Load⁸ data is obtained from PI database. The DA Forecast shown in this graph is the DA CAISO forecast published on the CAISO OASIS website. The DA Schedule shown in this graph is the CAISO demand cleared in the DA market and is calculated as (Total Generation + Imports) – Exports. Both the RTD Forecast and RTPD Forecast quantities shown in this graph differ from the 5-minute CAISO forecast and the 15-minute CAISO forecast. The RTD Forecast in this graph is in fact the RTD market requirement which is calculated as the sum of the (CAISO 5-minute forecast), operator bias and pump schedules. The 5-minute market requirement is shown in this graph instead of the RTD forecast because it includes the operator bias and the pump schedules which are not captured in the 5-minute load forecast and these quantities could have significant impact of market outcomes. Similarly, the RTPD Forecast is the RTPD market requirement which is the sum of the CAISO 15-minute forecast, operator bias and pump schedules. The Actual Load and RTD Forecast information is plotted every five minutes. The RTPD Forecast is plotted for every fifteen minutes and the DA Schedule and DA Forecast is plotted for every hour.

Figure 7: Load Schedule, Forecast, and Actual Load



⁷ The “Upload_Actual_Load.sas” program and “DMW_DA_PD_RT_Forec_Actload.sas” program are used to obtain data for the graph and the table in the next page. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

⁸ The “AGCISO .ISO TOTAL LOAD_AGC _MWX .AV” tag is used to obtain the Actual Data.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Table 1 below shows DA Forecast, DA Schedule, RTD Forecast, Actual Load, DA Schedule Deviation, RTPD Forecast Deviation and RTD Forecast Deviation. In this table the RTD Forecast is the hourly average of five minute data. The Actual Load is the hourly average of 5-minute data. The RTPD data is the hourly average of 15-minute quantities.

DA Schedule Deviation = (Actual Load – DA Schedule)
RTPD Forecast Deviation = (Actual Load – RTPD Forecast)
RTD Forecast Deviation = (Actual Load – RTD Forecast)

Table 1: Load Schedule Forecast and Actual Load

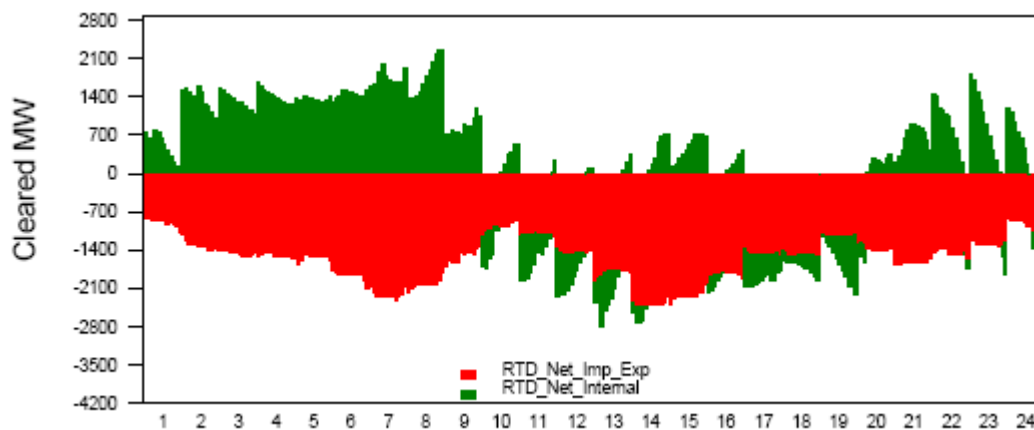
HE	DA Forecast	DA Schedule	RTD Forecast	Actual Load	DA Schedule Deviation	RTPD Forecast Deviation	RTD Forecast Deviation
1	24,640	24,405	24,634	24,703	298	98	69
2	23,552	22,906	23,577	23,622	715	177	45
3	22,769	22,346	22,903	23,139	793	179	236
4	22,479	22,436	22,566	22,848	413	308	283
5	22,902	22,866	22,858	23,151	285	92	293
6	24,081	23,767	24,295	24,247	481	-74	-48
7	25,219	25,870	25,772	25,695	-175	-98	-77
8	27,163	28,019	27,901	27,493	-526	-417	-408
9	29,353	29,893	29,805	29,295	-598	-596	-510
10	31,295	31,845	31,790	31,128	-717	-619	-662
11	32,866	33,577	33,605	32,834	-743	-813	-770
12	34,101	34,545	34,631	33,899	-646	-955	-731
13	35,263	35,690	35,611	34,812	-878	-870	-799
14	36,655	36,771	36,453	35,909	-862	-847	-544
15	37,896	37,791	37,674	36,997	-794	-680	-678
16	38,770	38,378	38,360	37,441	-938	-983	-919
17	39,084	38,401	38,281	37,514	-887	-935	-767
18	38,515	37,449	37,275	36,777	-672	-636	-498
19	36,975	36,293	35,938	35,596	-697	-344	-342
20	35,132	34,795	34,614	34,402	-393	19	-213
21	35,497	35,261	35,562	35,027	-233	36	-535
22	33,963	33,606	34,171	33,986	380	87	-185
23	30,929	30,403	31,149	30,959	556	-130	-190
24	28,036	27,700	28,576	28,092	392	-305	-485

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

RTD Net Cleared Quantity⁹

Figure 8 shows the RTD net cleared quantity split into internal generation and net import or export. The green bars represent the net internal CAISO generation and the red bars represent the net import or export. A positive value could be interpreted as an incremental dispatch in RTD market and the negative value could be interpreted as a decremental dispatch. Both the incremental and decremental dispatches are with respect to the DA market. These RTD quantities are calculated as follows:

Figure 8: RTD Net Cleared Quantity



$$\text{RTD_Net_Imp_Exp} = (\text{RTD_Imp_Exp} - \text{DA_Imp_Exp})$$

The DA_Imp_Exp is the difference between the total import and total export scheduled at CAISO tie points. The RTD_Imp_Exp is the difference between the total import and total exports scheduled at CAISO tie points. In Real-Time, majority of the imports and exports into the CAISO area are hourly schedules which are dispatched in HASP. The hourly schedules are sent to Control Area Scheduler (CAS) system for tagging. The Scheduling Coordinators (SCs) tag each of the import and export schedules, where the tag contains the source and sink information of the transaction. All imports and exports which are tagged by SCs are then passed to RTD as self-schedules. There are few imports (dynamic resources) at CAISO tie points which are dispatchable on five minute basis. These resources are dispatched by RTD process.

⁹ The "DMW_RTNet_Cleared.sas" program is used to obtain data for this graph. This file is located at \\csfiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

$RTD_Net_Internal = (RTD\ Internal\ Generation - DA\ Internal\ Generation)$

$RTD\ Internal\ Generation = RTD\ Cleared\ Value - RTD\ imports$

$DA\ Internal\ Generation = DA\ Cleared\ Value - DA\ imports$

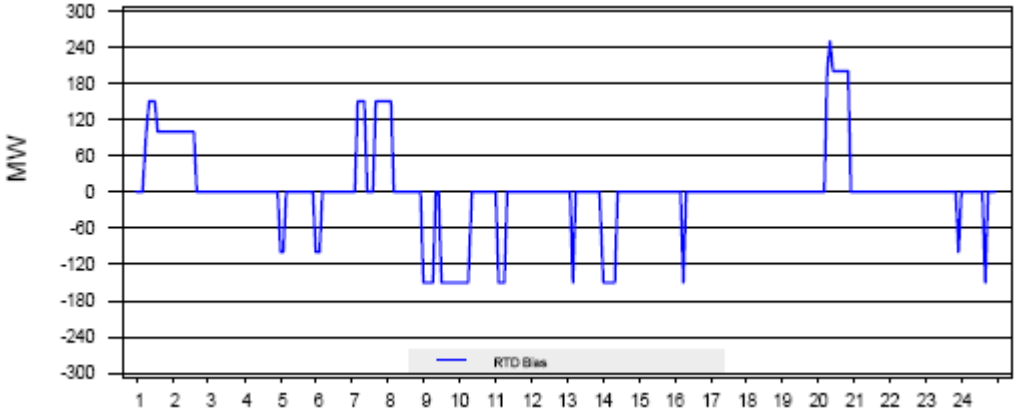
The RTD cleared value and DA cleared value are sum of generation within the state of California and total imports scheduled at tie points.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

RTD Bias¹⁰

Figure 9 shows RTD Bias which is the quantity used by operators to bias the RTD market requirement. The bias shown in this graph applies only to the CAISO system region.

Figure 9: RTD Bias



¹⁰ The "DMW_RTD_Bias.sas" program is used to obtain data for this graph. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

System Summary Statistics¹¹

Table 2 below shows numerous system summary statistics. A brief description is provided below:

1. Prev Day Peak: the Peak Load MW for the previous trade date. This quantity is obtained from PI database using the Microsoft Excel PI function.

Table 2: System Summary Statistics

Prev Day Peak	32,223 MW
Peak Load Time	17:27
Peak MW	34,486 MW
FCST Error avg	617 MW
FCST Error STDEV	246 MW
Average Load	27,860 MW
RTD AVG BIAS	13 MW
RTD STD BIAS	108 MW

2. Peak Load Time: the time when peak load occurred on the trade date.
3. Peak MW: the peak load MW for the trade date. This quantity is obtained from PI database using the Microsoft Excel PI function.
4. FCST Error Avg: the simple average of forecast error for all trading hours, where forecast error is difference of actual load and the RTD forecast.
5. FCST Error StdDev: the standard deviation of forecast error.
6. Average Load: the simple average of actual load for trading hours.
7. RTD AVG Bias: the simple average of RTD bias for CAISO system.
8. RTD Std Bias: the standard deviation of RTD bias.

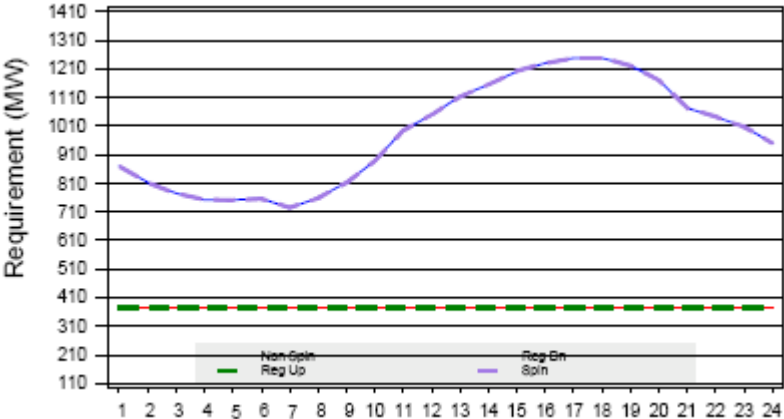
¹¹ The "Upload_Actual_Load.sas" program and "DMW_RT_Metrics.sas" program are used to obtain data for this table. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

RTPD A/S System Requirement¹²

Figure 10 shows the Real-Time Pre-Dispatch (RTPD) hourly Ancillary Service requirements for Regulation Up, Regulation Down, Spin and Non-Spin for the CAISO expanded region.

Figure 10: RTPD A/S System Requirement



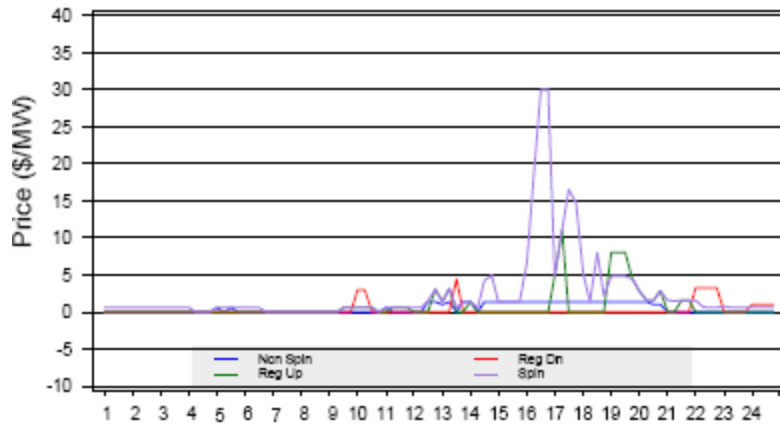
¹² The “DMW_RTPD_AS.sas” program is used to obtain data for this graph. This file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

RTPD A/S Average Price¹³

Figure 11 shows the average price from the RTPD for all four types of Ancillary Services for each of the 15-minute intervals. The average price for a particular type of Ancillary Service is the ratio of total cost of procuring non-self scheduled Ancillary Service and the total non-self scheduled procured quantity. Note that all the Day-Ahead Ancillary Service awards are taken as the self-scheduled quantities in RTPD.

Figure 11: RTPD A/S Average Price



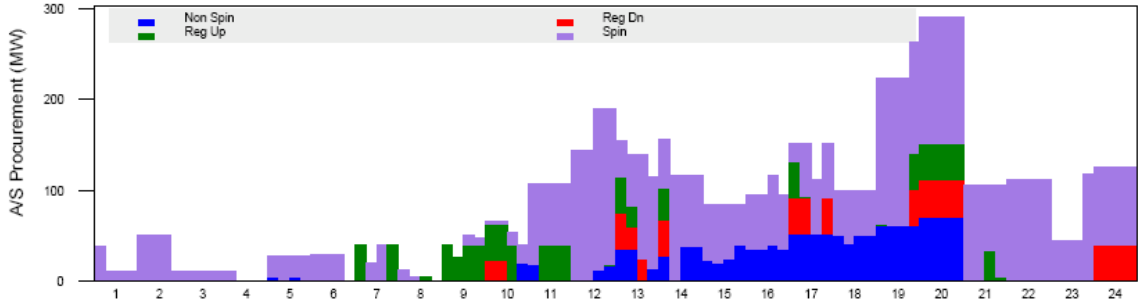
¹³ The "DMW_RTPD_AS.sas" program is used to obtain data for this graph. The file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

RTPD A/S Procurement¹⁴

Figure 12 shows the quantity procured in the RTPD for each type of Ancillary Services for each of the 15-minute intervals.

Figure 12: RTPD A/S Procurement



¹⁴ The “DMW_RTPD_AS.sas” program is used to obtain data for this graph. The file is located at \\csifiapp613\MARketops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

RTD LMP Statistics for On and Off-Peak Hours (\$/MWh)¹⁵

Table 3 shows the maximum, mean and minimum of the RTD LMPs for three default LAPs and three Trading Hubs by on-peak and off-peak hours. Peak hours are defined as Monday through Friday, excluding North American Electric Reliability Council (NERC) holidays, from 7:00 AM to 11:00 PM (the hour ending 0800 to the hour ending 2300). All other hours are off-peak hours.

Table 3: RTD LMP Statistics for On and Off-Peak hours (\$/MWh)

	NP15			SP15			ZP26			PG&E			SCE			SDGE		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
OFF	36.51	27.10	19.48	36.05	26.17	18.49	35.62	26.32	18.72	37.64	27.87	19.06	36.89	26.81	18.93	37.07	26.67	18.79
ON	1596.17	108.15	-30.39	1637.40	112.52	-28.98	1593.55	106.47	-29.33	1664.36	113.65	-31.15	1679.12	111.45	-29.49	1686.96	161.86	-29.31

¹⁵ The "DMW_RTD_LMP_Stat.sas" program is used to obtain data for this table. The file is located at \\csifiapp613\MARKetops\Market Analysis\MRTU Daily Market Watch \SAS_DMW_Prod\DMW_RT_Data_Prep.

Real-Time DMW Metric Catalog	Version No.:	1.0
	Effective Date	08/07/09

Appendix I

Numerous graphs in the Real-Time DMW display shadow prices of binding constraints on interties, transmission corridors, nomograms and transmission lines and transformers. On any given day, there could be anywhere between no binding constraints to more than 10 binding constraints. This report highlights only important market events; as a result, all graphs show at most four binding constraints. The top four binding constraints are selected based on their congestion rents as explained below.

$$C_{ijk} = (\text{Shadow_Price}_{ijk} * \text{Flowlimit}_{ijk})$$

C_{ijk} is the congestion rent for binding constraint i at interval j of hour k
 $i = 1$ to M, where M is the total number of binding constraints for a particular trade date.

$$D_i = \sum_{k=1}^H \sum_{j=1}^{12} C_{ijk}$$

Where D_i = Daily total congestion rent for binding constraint i.

H = Total number of trading hours for a particular trade date

$$T = \sum_{i=1}^M D_i$$

Where T = Total congestion rent for a particular type of binding constraint, viz., intertie, transmission corridor, nomogram, transmission line and transformer.

$$P_i = \frac{D_i}{T}$$

Where P_i is the percentage of congestion rent for binding constraint i.

Graphs show the top four binding constraints based on the rank of percentages.