Short-Term Forecasting of Demand Response

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Introduction

- In this presentation…
  - Why SDGE needed a system to forecast demand response.
    - Regulatory Environment
  - The programs that we are trying to forecast.
  - The methodology of our forecasting models.
  - Some initial results from 2008.

Market Redesign and Technology Upgrade (MRTU) Background

- The California ISO is currently upgrading software systems to operate a redesigned electric market.

- New market will establish the following:
  - Forward wholesale electricity market
    - Economically optimized bids
  - Improved congestion management system
    - Full network model
  - Revised market power mitigation measures

MRTU and Demand Response

- "Participating load" programs will be allowed to submit energy bids directly into the wholesale market.
  - Participating load agreement with CA ISO
  - Demonstrate effective dispatch capability

- "Non-participating load" programs will still be accounted for in procurement process.
  - Adjustment to the CA ISO forecast of demand

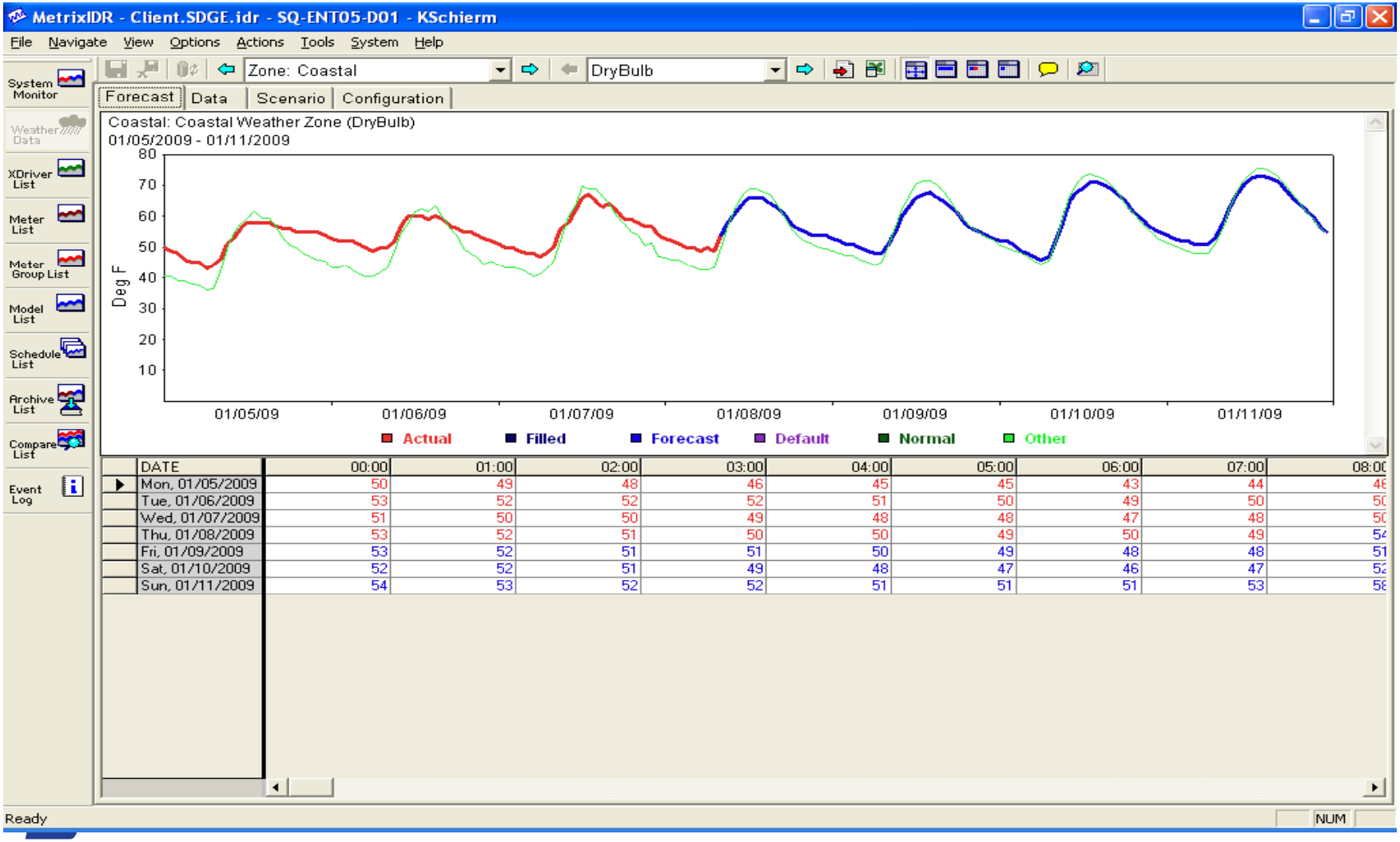
MRTU and DR Forecasting

- SDGE needed to provide the California ISO with a forecast of “non-participating” load.
  - For each demand response program
  - Hourly estimates
- Required Flexibility
  - Demand response programs change over time
  - Reflect participation changes
  - Adapt to requirements set by MRTU working group

Forecasting Software

- Itron's MetrixIDR system
  - Manages required model information.
    - Customer list
    - Weather information
    - Produces DR forecast report for CAISO
  - Incorporates Itron's MetrixND statistical software to derive forecasted estimates.

Software Interface



SDG&E's 2008 DRP Programs

Demand Response Programs	Day-of	Day-Ahead	Description
Critical Peak Pricing-E (CPP-E)	Yes	-	TOU rate with increased cost during 'critical' periods and reduced commodity rate rest of year.
Peak Generation	Yes	-	Customers earn incentives by transferring load from SDGE system to a standby generator.
Base Interruptible Program (BIP)	Yes	-	Customers receive monthly capacity payments in turn for load reduction when requested.
Optional Binding Mandatory Curtailment (OBMC)	Yes	-	Customers can exempt a specific circuit(s) from rotating outages by reducing load when requested.
Summer Saver	Yes	-	Residential & Small Business customers receive an incentive for central A/C cycling during peak periods
CleanGen Program	Yes	-	A third party generator load reduction program: SDGE remotely dispatches customer generators.
Scheduled Load Reduction Program (SLRP)	N/A	-	Customers can schedule load reduction, in advance, for weekday hours during summer months.
Critical Peak Pricing Default (CPP-D)	-	Yes	TOU rate with increased cost during 'critical' periods and reduced commodity rate rest of year.
Commercial & Industrial Peak day Credit (CI2020)	-	Yes	Reduce 10-20% on 'critical' days and receive 10-20% discount on all (on peak) charges for the month.
Demand Bidding Program (DBP)	Yes	Yes	A voluntary, day-ahead or day-of "bid-in" load reduction program.
Capacity Bidding Program (CBP)	Yes	Yes	Customers receive monthly capacity payments (and energy incentives) in return for load reduction

Demand Response Model

$$\text{Load}_h = F\left(\text{Calendar}_{y,m,d}, \text{Events}_h^u, \text{Weather}_h^u\right)$$

Issues:

Load - Participants will change over time.
History contains only a sample of participation.

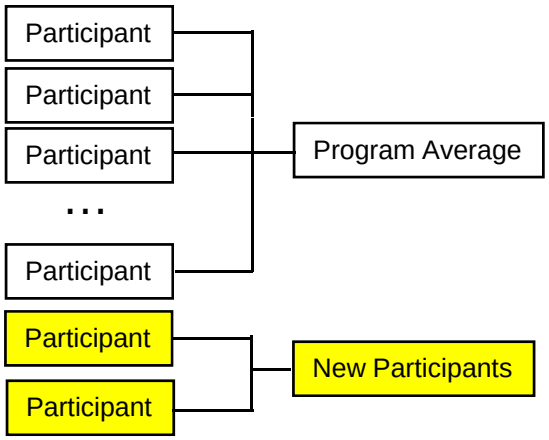
Calendar- Response is expected to vary based on time of year

Events - Events that can be modeled must be identified

Weather - Response is expected to be weather dependent

Demand Response Model: Load

$$\text{Load}_h = F\left(\text{Calendar}_{y,m,d}, \text{Events}_h^u, \text{Weather}_h^u\right)$$



$$Load_h = Load_h^{Sample} \Big/ Scaler^{Sample}$$

Scaler^{Sample} = Tons of AC (AC Saver)
On-Peak kWh (C&I Programs)

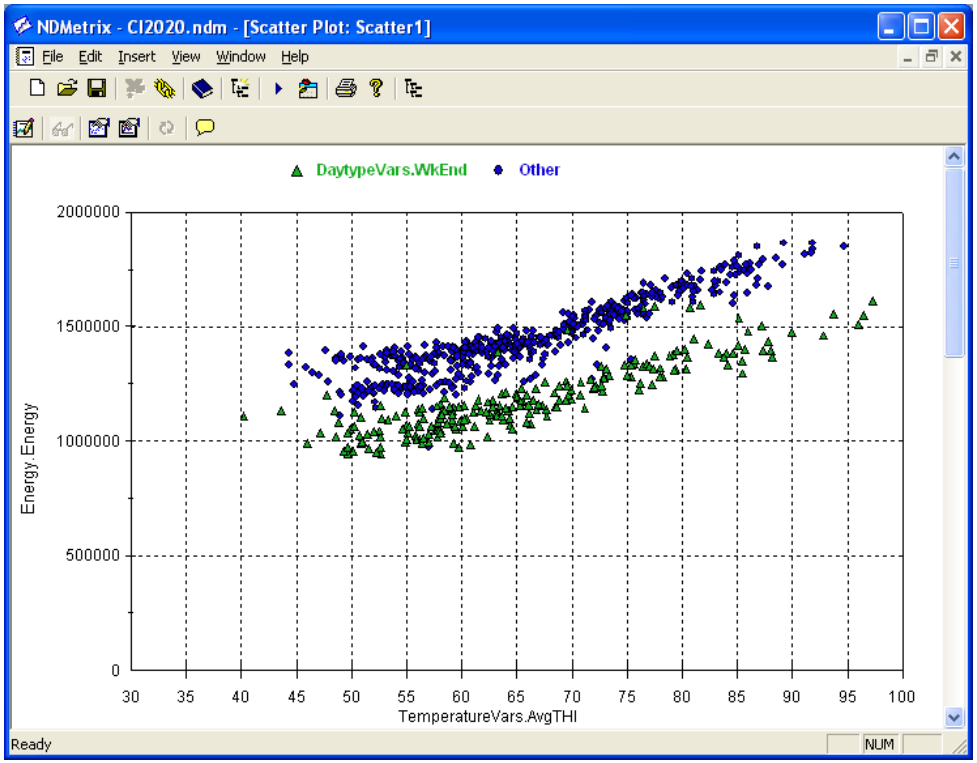
Forecast Load$_h$ = Load$_h$ x Scaler^{Program}

Demand Response Model: Calendar

$$\text{Load}_{h} = F\left(\text{Calendar}_{y,m,d}, \text{Events}_{h}^{u}, \text{Weather}_{h}^{u}\right)$$

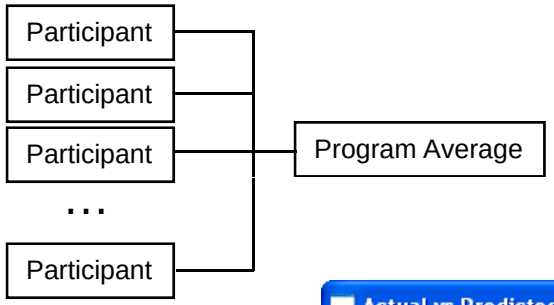
Variables

- Weekend or Day of Week Effect
- Capture Holidays
- Identify seasonal impacts



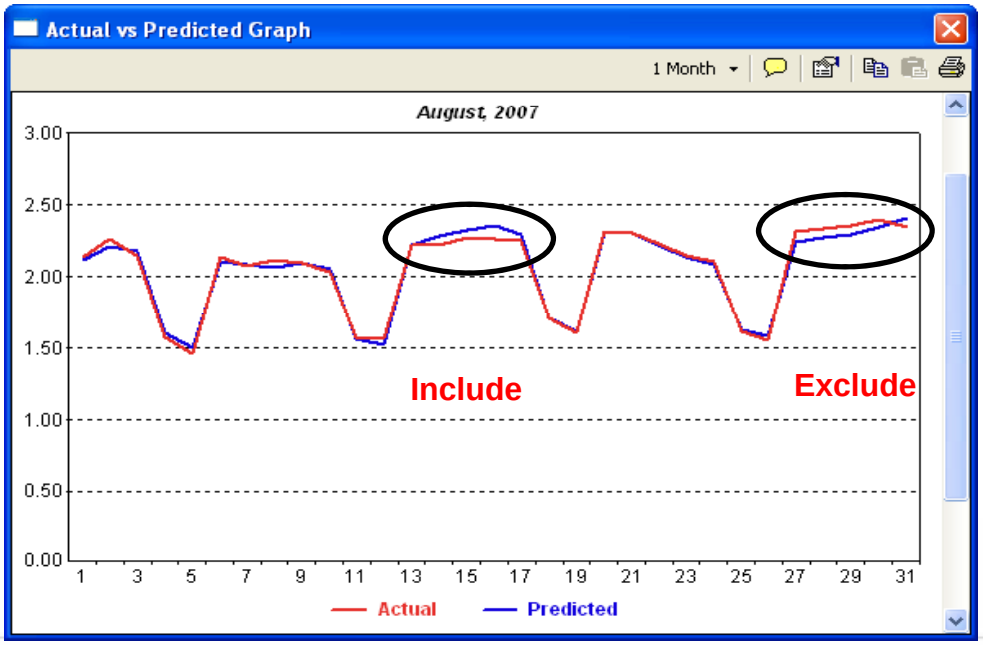
Demand Response Model: Events

$$\text{Load}_h = F\left(\text{Calendar}_{y,m,d}, \text{Events}_h^u, \text{Weather}_h^u\right)$$



$$\text{Load}_h = F\left(\text{Calendar}_{y,m,d}, \text{Weather}_h^u\right)$$

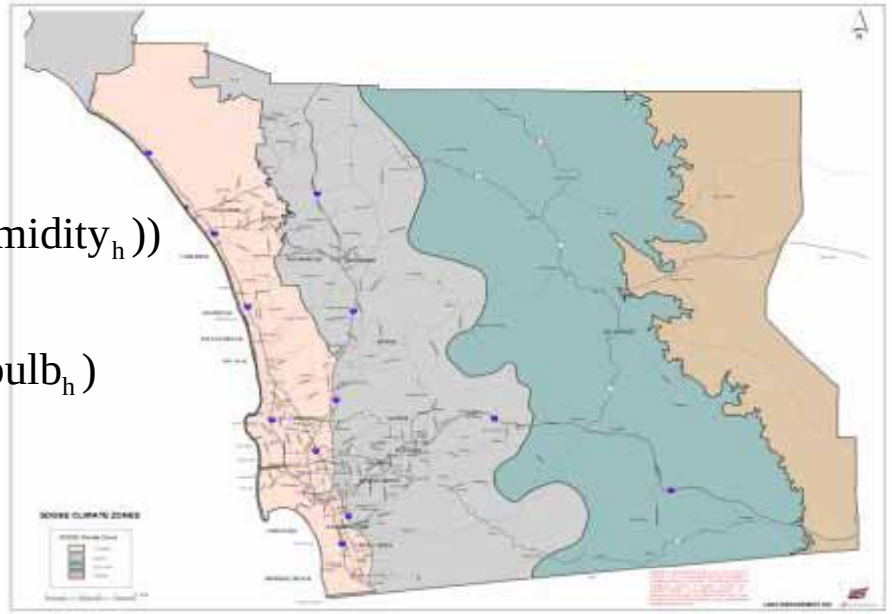
Screening Model helps identify event days to include



Demand Response Model: Weather

$$\text{Load}_h = F\left(\text{Calendar}_{y,m,d}, \text{Events}_h^u, \text{Weather}_h^u\right)$$

Weather Zones
- Coastal
- Inland



Humidity Impacts

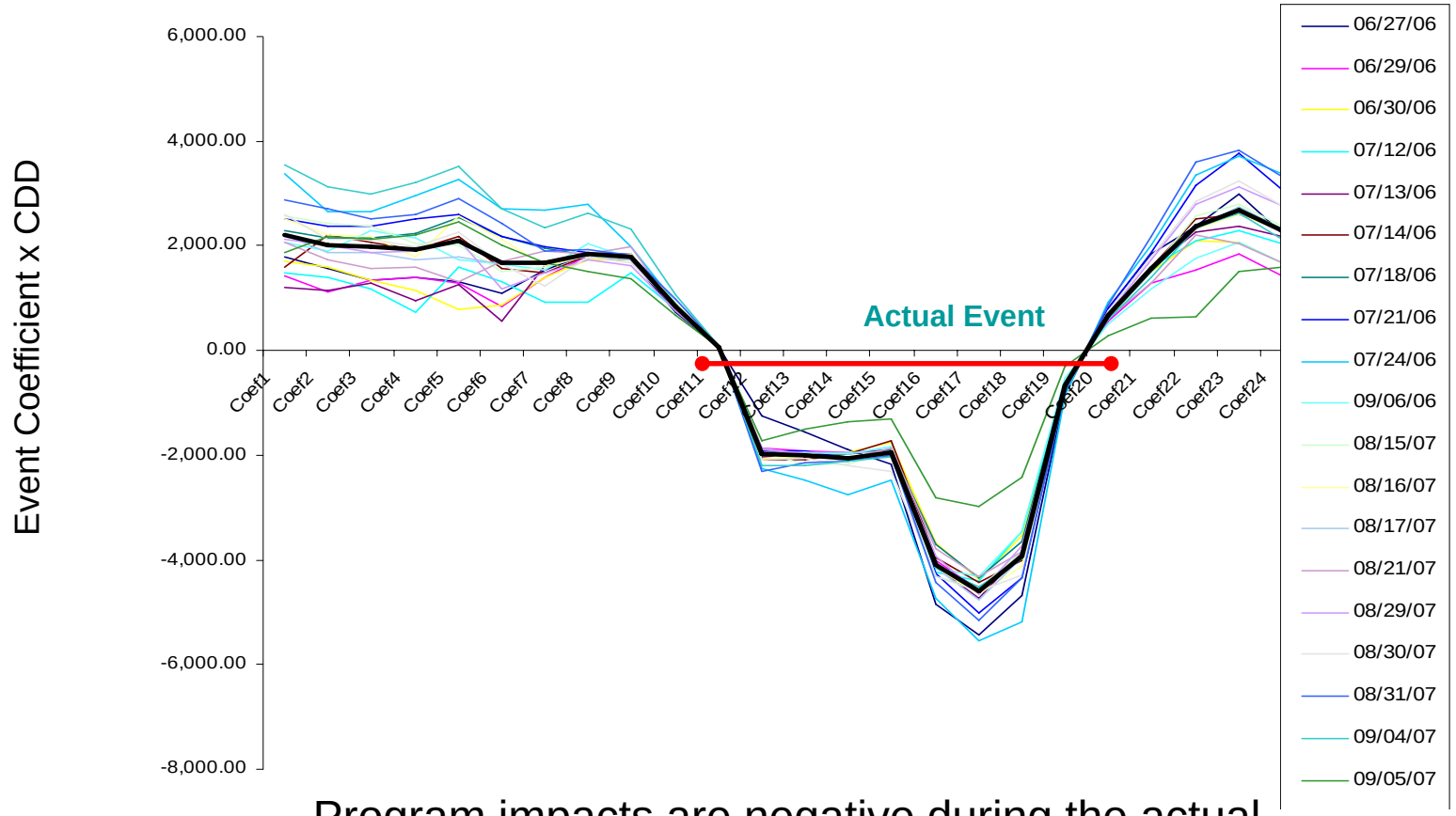
$$\begin{aligned}\text{THI}_h = ((1.98 \times (\text{Drybulb}_h - ((0.55 - (0.0055 \times \text{Humidity}_h)) \\ \times (\text{Drybulb}_h - 58))) - 56.83) \\ \times (\text{Drybulb}_h >= 58)) + ((\text{Drybulb}_h < 58) \times \text{Drybulb}_h)\end{aligned}$$

Temperature Splines
- HDD = Heating THI
- CDD = Cooling THI

Prior Day Impacts
- Lag HDD
- Lag CDD

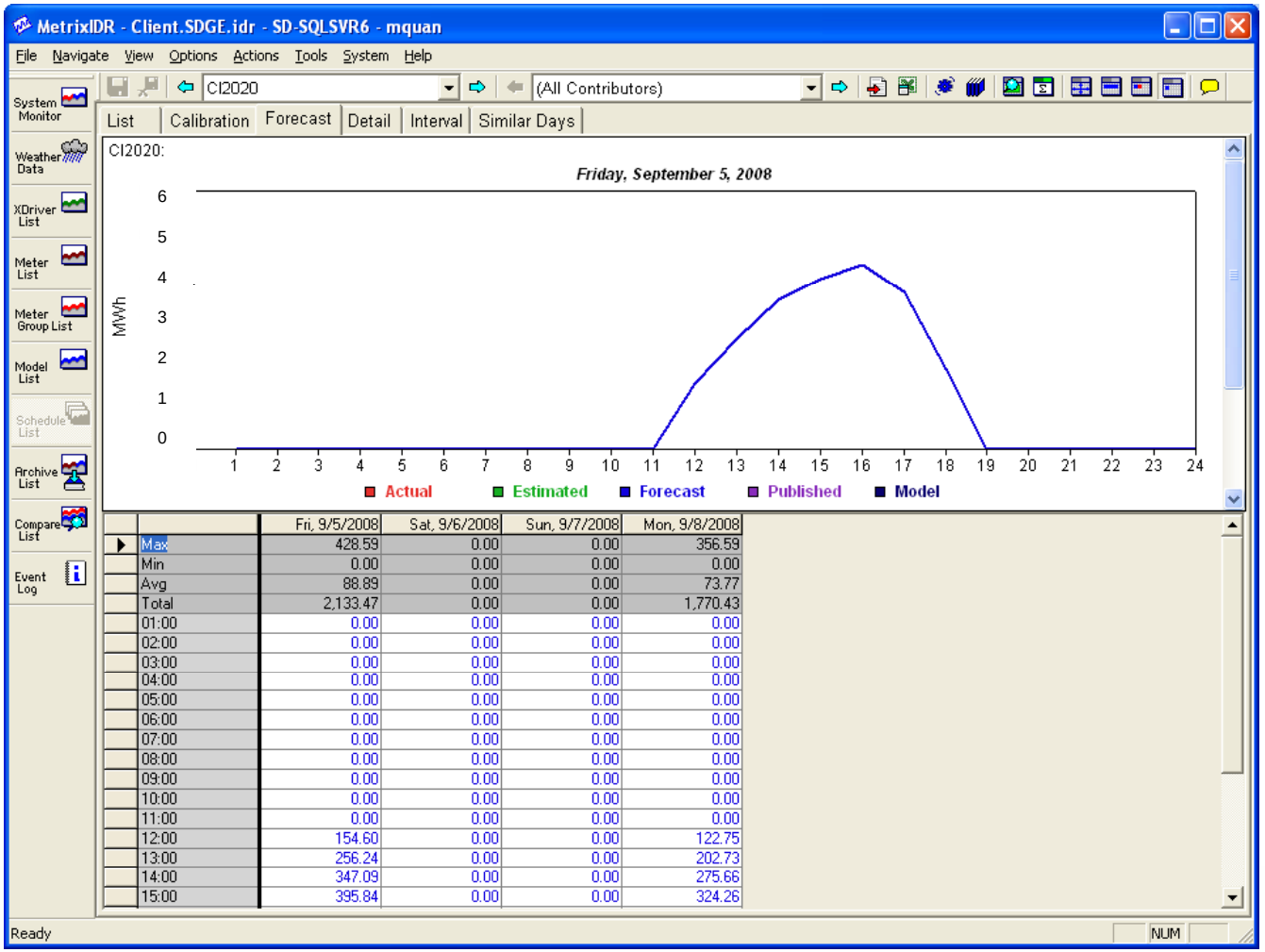
Interactions:
- Weekend Interactions (Weekend x CDD)
- Event Interactions (Event x CDD)

CI 2020 Sample Impact



Program impacts are negative during the actual peak with pre- and post-event increases

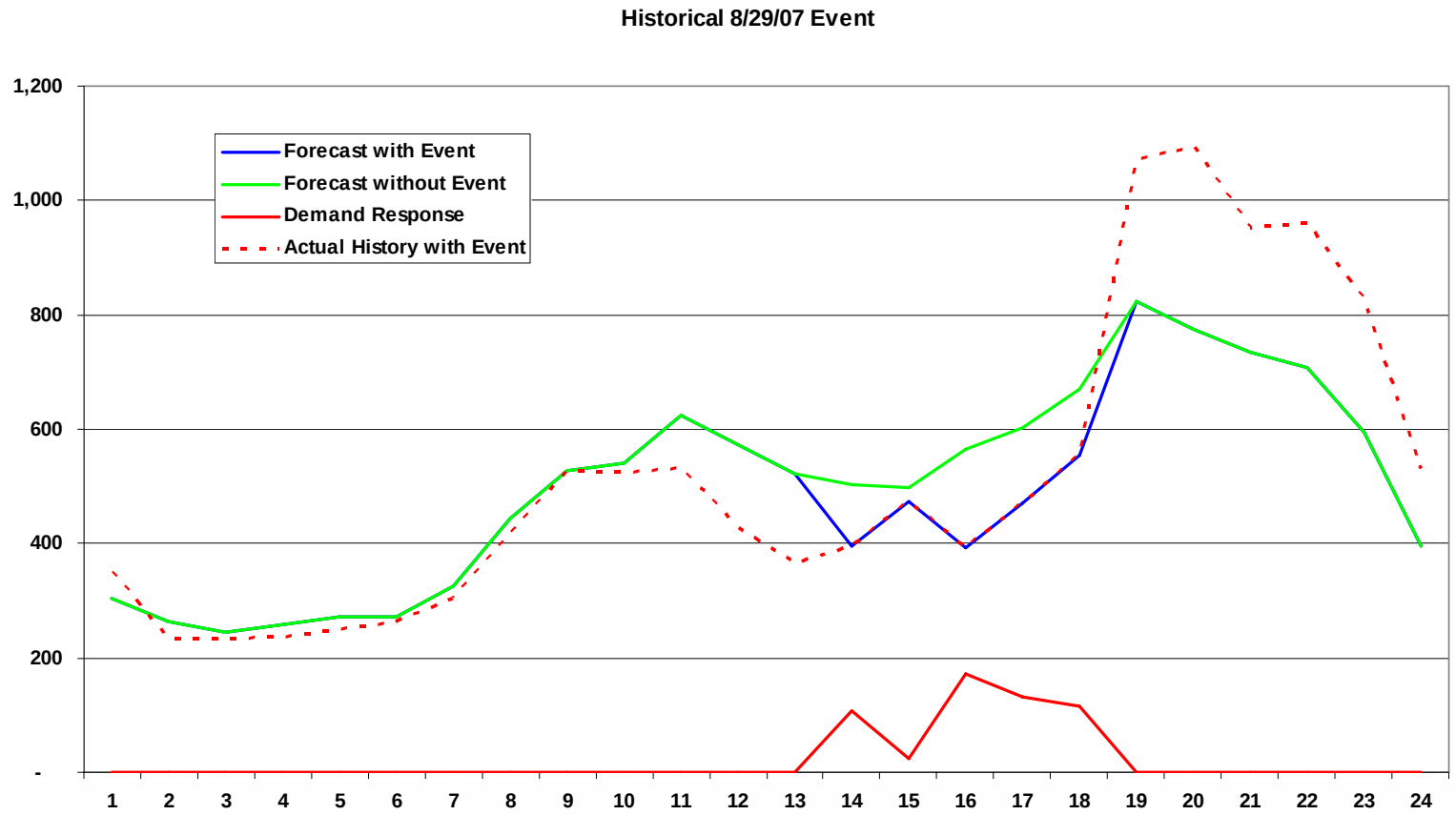
CI2020 Demand Response Forecast



	Fri, 9/5/2008	Sat, 9/6/2008	Sun, 9/7/2008	Mon, 9/8/2008
Max	428.59	0.00	0.00	356.59
Min	0.00	0.00	0.00	0.00
Avg	88.89	0.00	0.00	73.77
Total	2,133.47	0.00	0.00	1,770.43
01:00	0.00	0.00	0.00	0.00
02:00	0.00	0.00	0.00	0.00
03:00	0.00	0.00	0.00	0.00
04:00	0.00	0.00	0.00	0.00
05:00	0.00	0.00	0.00	0.00
06:00	0.00	0.00	0.00	0.00
07:00	0.00	0.00	0.00	0.00
08:00	0.00	0.00	0.00	0.00
09:00	0.00	0.00	0.00	0.00
10:00	0.00	0.00	0.00	0.00
11:00	0.00	0.00	0.00	0.00
12:00	154.60	0.00	0.00	122.75
13:00	256.24	0.00	0.00	202.73
14:00	347.09	0.00	0.00	275.66
15:00	395.84	0.00	0.00	324.26

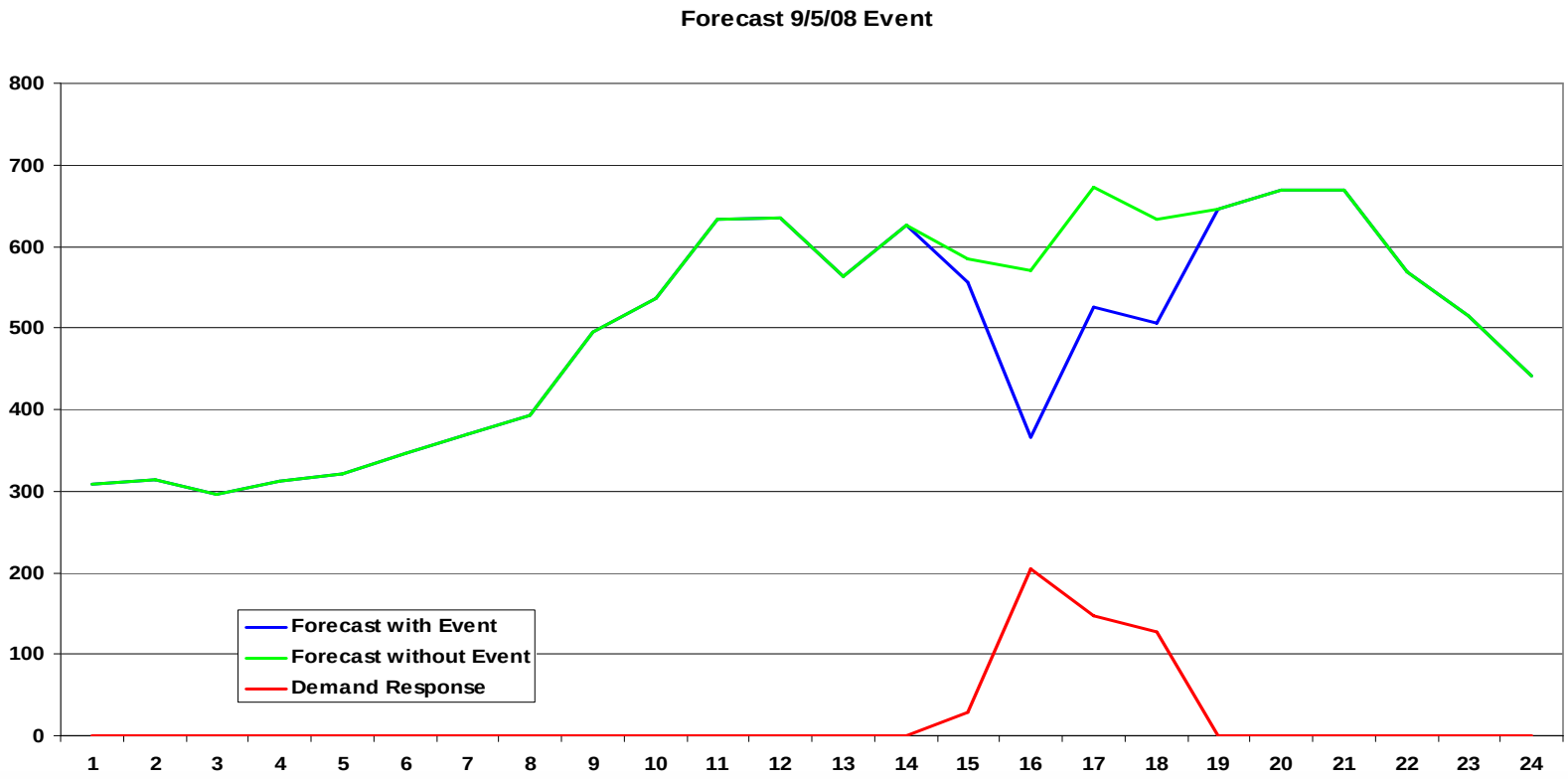
Demand Response Model: Estimation Results

Residential AC, 100 Cycling, Weekend/Weekday, Inland

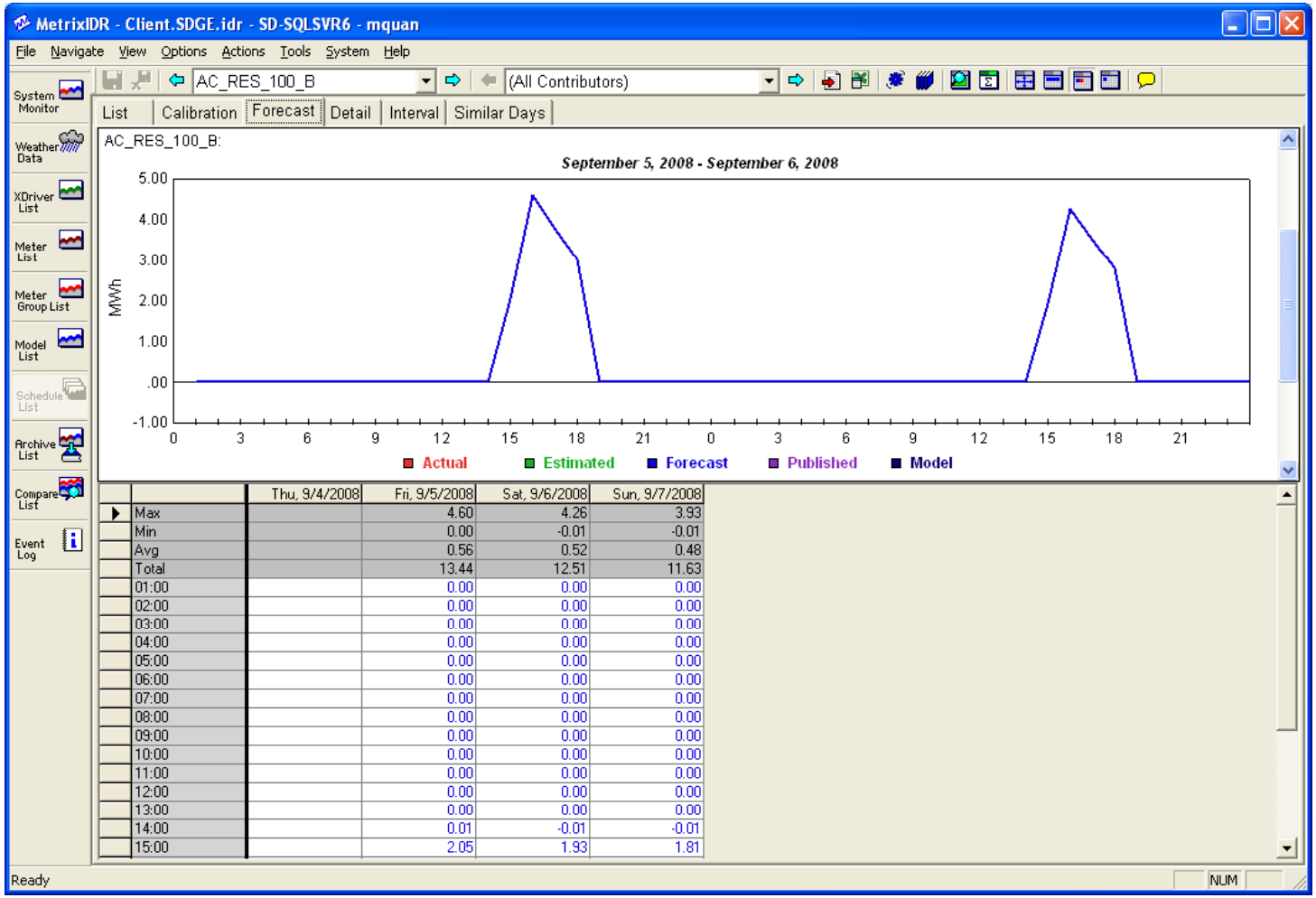


Demand Response Model: Forecast Results

Residential AC, 100 Cycling, Weekend/Weekday, Inland



Residential AC, 100 cycling, Weekday/Weekend Demand Response Forecast



Submitting a Demand Response Forecast

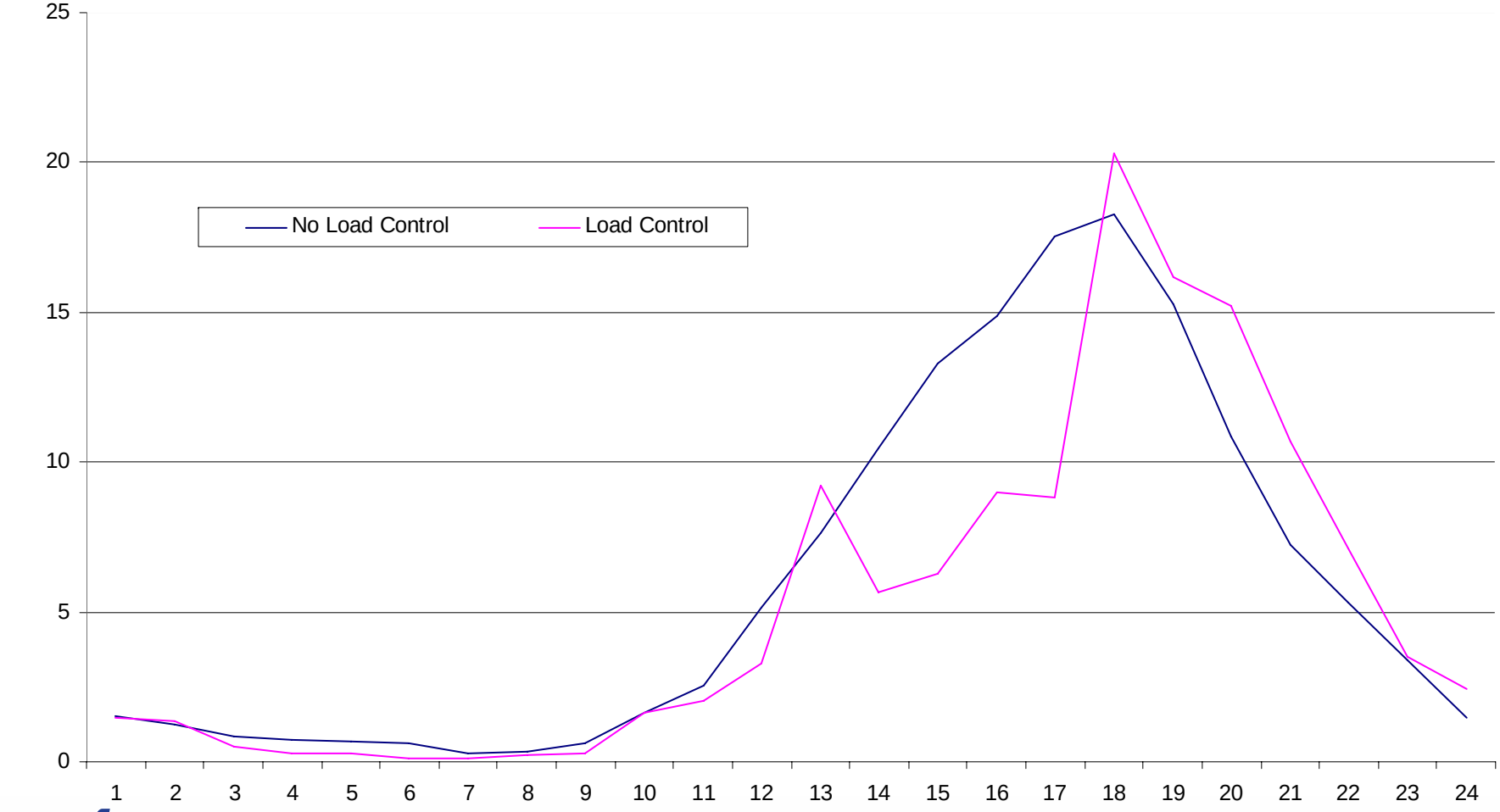
- The CAISO is notified using a manual process.
- The hourly forecasts are broken out by program and day-ahead or day-of notification (since it is used in the day ahead and hour ahead markets).
- Example:

Demand Response Price Responsive Program Forecast for CAISO												
Event Date	*August 4, 2008*											
Demand Response Provider	*name of provider*											
Grand total - DA calls												
Programs	Program Type	# of Accounts	Date/Time Published	HE12 MW	HE13 MW	HE14 MW	HE15 MW	HE16 MW	HE17 MW	HE18 MW	HE19 MW	HE20 MW
CBP_DayAhead	DAYAHEAD	8	08/04/2008 9:20	0.1	0.1	8.5	8.5	8.5	8.5	8.5	0.0	0.0
CI2020	DAYAHEAD	849	08/04/2008 9:20	1.8	3.0	3.9	4.4	4.8	4.0	2.0	0.0	0.0
CPPD	DAYAHEAD	936	08/04/2008 9:20	3.8	6.9	9.2	10.1	10.5	9.0	5.7	0.0	0.0
DBP	DAYAHEAD	356	08/04/2008 9:20	3.5	3.2	3.5	3.7	4.4	3.9	2.8	1.0	0.0
Total Price Response MW				9.3	13.2	25.0	26.8	28.2	25.4	18.9	1.0	0.0

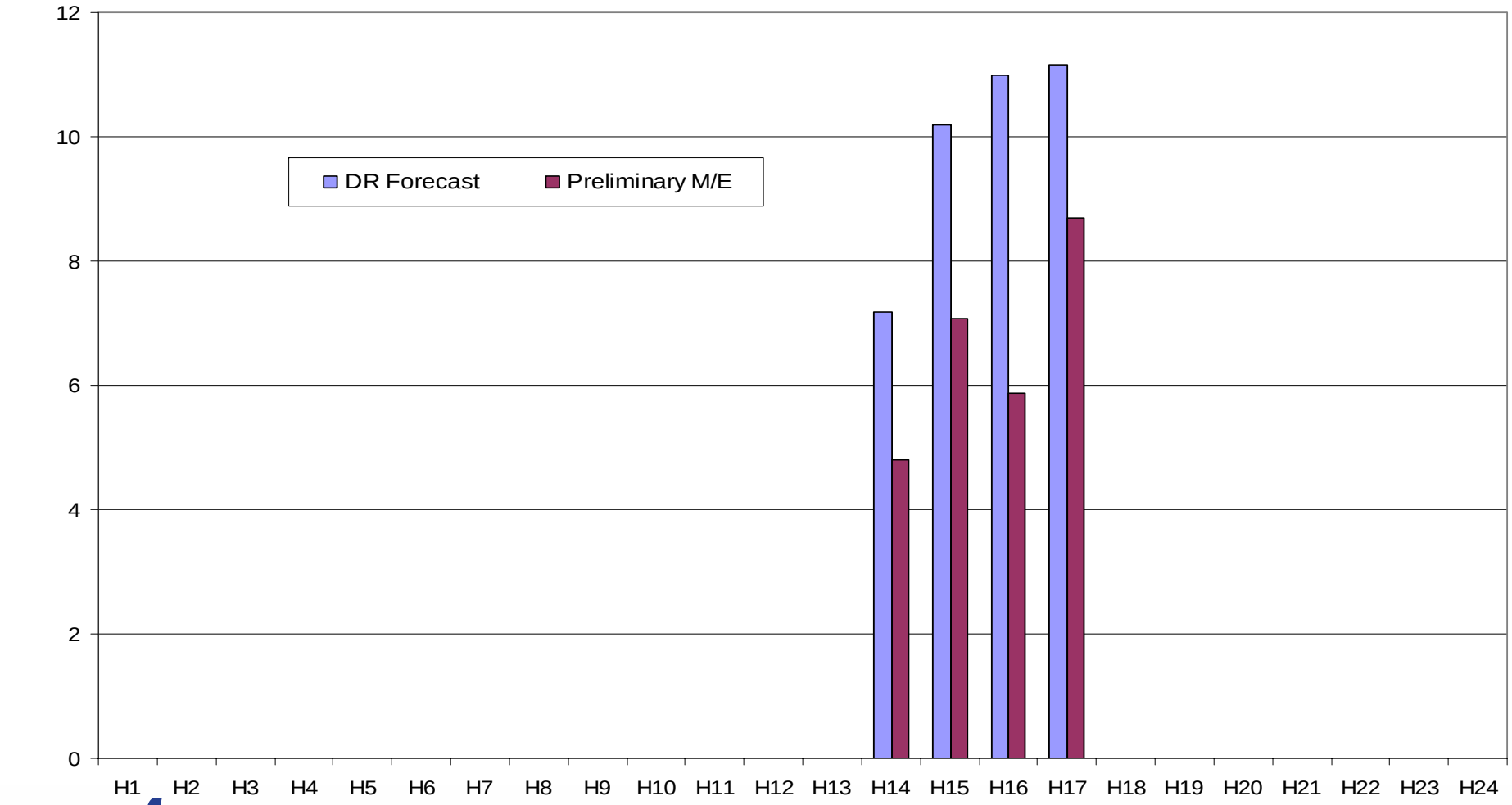
Project Performance

- San Diego experienced a cooler than average summer in 2008.
- SDGE called 2 Summer Saver events during the summer of 2008 compared to 12 events called in 2007.

AC Summer Saver Event
October 8, 2008
Preliminary Estimates



AC Summer Saver Event
October 8, 2008
Forecast vs. Performance
Preliminary Estimates



SDGE

A Sempra Energy utility

Summary & Conclusions

- SDGE has a system in place to provide the California ISO with a forecast of demand response.
  - Final measurement and evaluation results are becoming available from 2008 DR events.
  - Incorporate lessons learned from 2008 into models.
- With AMI, find new ways to take advantage of new information & technology.

Action Items

- If you are developing a system to forecast demand response:
  - Make it flexible
    - Regulatory environments change
    - Demand response programs change
    - Customer behaviors (or composition) change
  - Keep up with these changes and incorporate them in your models.
    - Accuracy is the goal