Customer Baseline Load Review and Recommendation

California ISO

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Utility Integration Solutions, Inc.

May 26, 2009

References

- 2008 Load Impact Evaluation of California Statewide Aggregator Demand Response Programs Volume 2: Baseline Analysis of AMP Aggregator Demand Response Program by Christensen Associates Energy Consulting, LLC (May 1, 2009)
- Evaluating Baselines for Demand Response Programs 2008 AEIC Load Research Workshop by Clifford Grimm, DTE Energy (February 25, 2008)
- Estimating Demand Response Load Impacts: Evaluation of Baseline Load Models for Non-residential buildings in California, Berkeley Lab, January 2008
- Various ISO-NE, NYISO, and PJM documents

Common Analysis Findings

- There is no single CBL method that fits all needs
- Several methods work reasonably well in most cases
- Adjusted baselines are usually better than non-adjusted
- Highly variable loads are most difficult to predict

Approach

- Identify core CBL methodology
- Establish processes for:
  - Submitting variations to CBL
  - Submitting alternative CBL methods

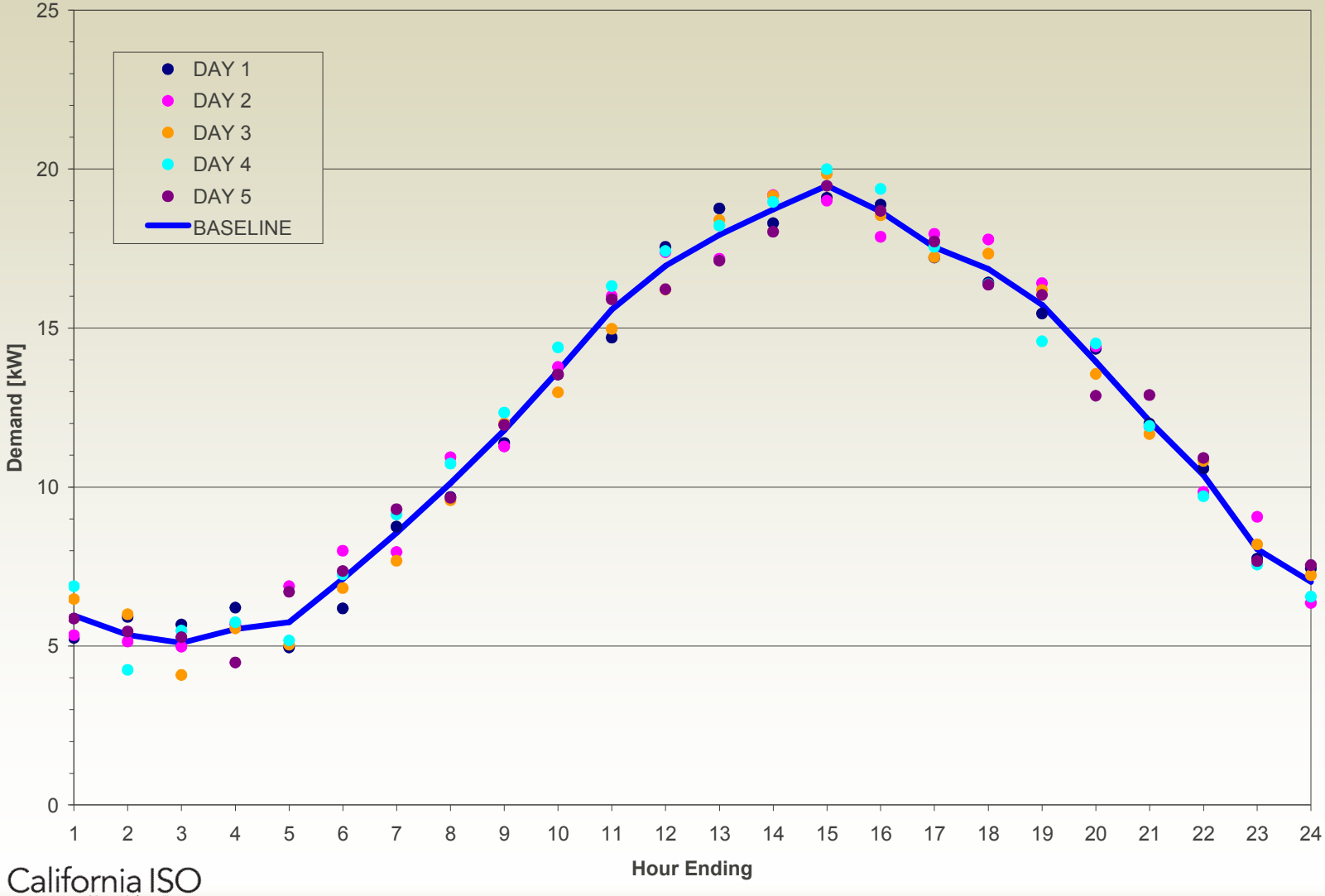
Baseline Fundamentals

- X days out of Y days (e.g. 4 of 5, 3 of 10, 10 of 10)
  - Typically discard some number of high and/or low days
- Number of day types
  - Only consider day types that are similar to event day
  - 2 day types = Weekdays, Weekends+Holidays
  - 5 day types = Mon, Tues-Thur, Fri, Sat, Sun+Holidays
- Lookback window
  - 30, 45, 60 days? Need a larger window when a larger sample is required, or more day types are used.
  - Constant or variable? Some markets have rules for allowing the lookback window to grow on certain conditions

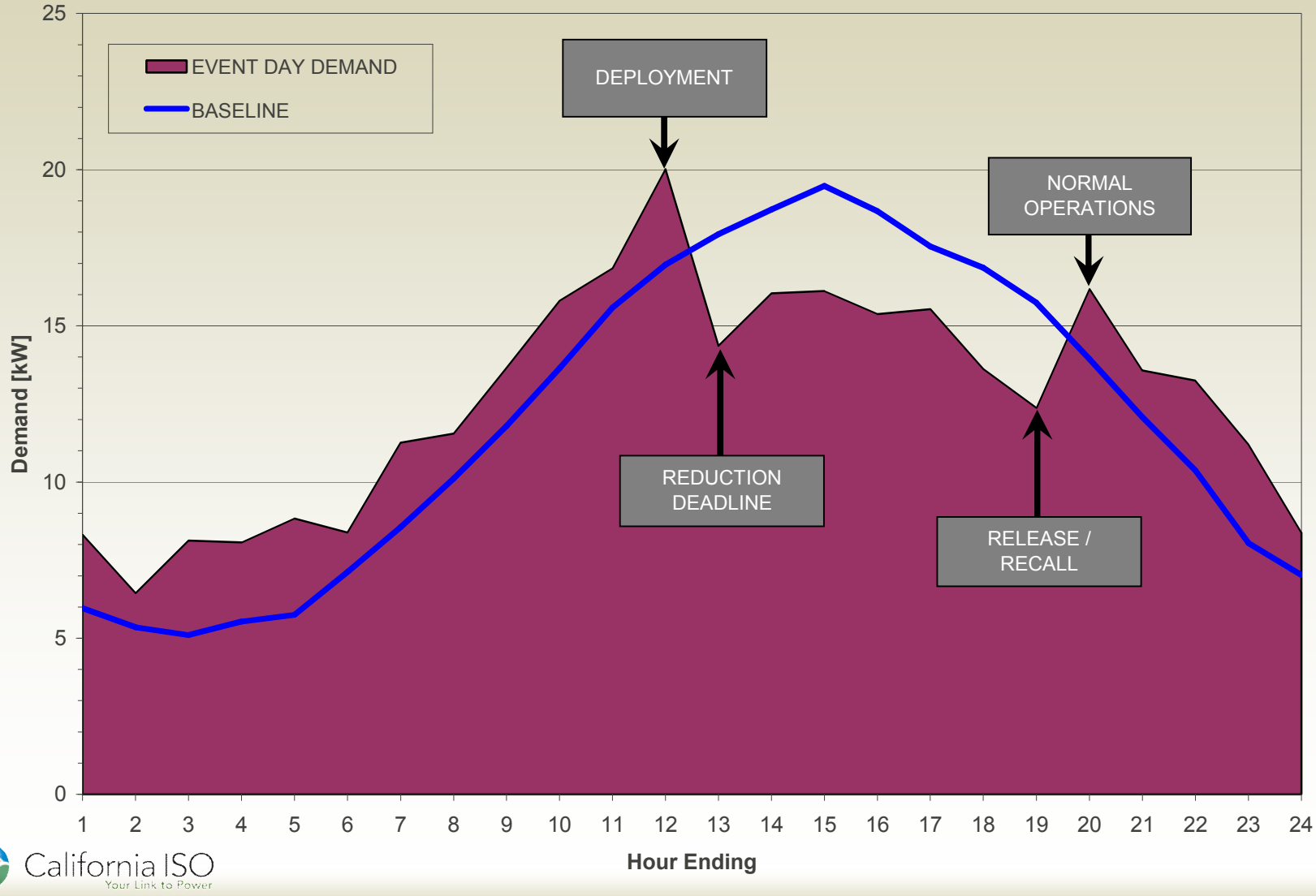
Baseline Fundamentals (cont)

- Threshold
  - Exclude abnormally high and/or low days (e.g. <25%)
- Prior event days
  - Exclude prior event days, unless there are an insufficient number of normal load days in the lookback window
- Load point adjustment (morning adjustment)
  - Method of adjusting the calculated baseline by using the morning hours prior to the event to normalize
- Weather sensitive adjustment
  - Method of adjusting the calculated baseline by using weather data and resource-specific weather sensitivity regression factors

Determine Baseline



Examine Demand Response Event Stages



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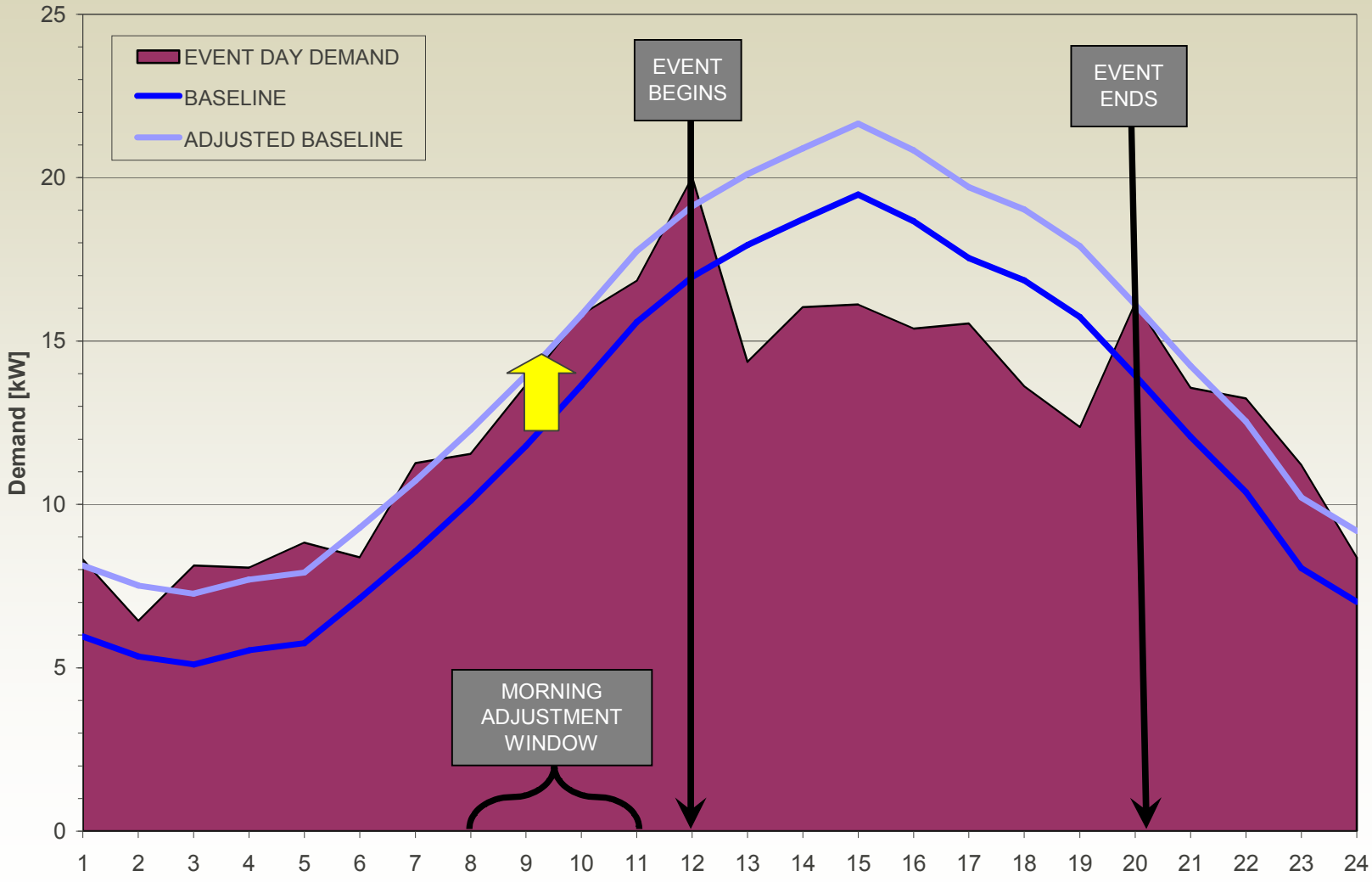
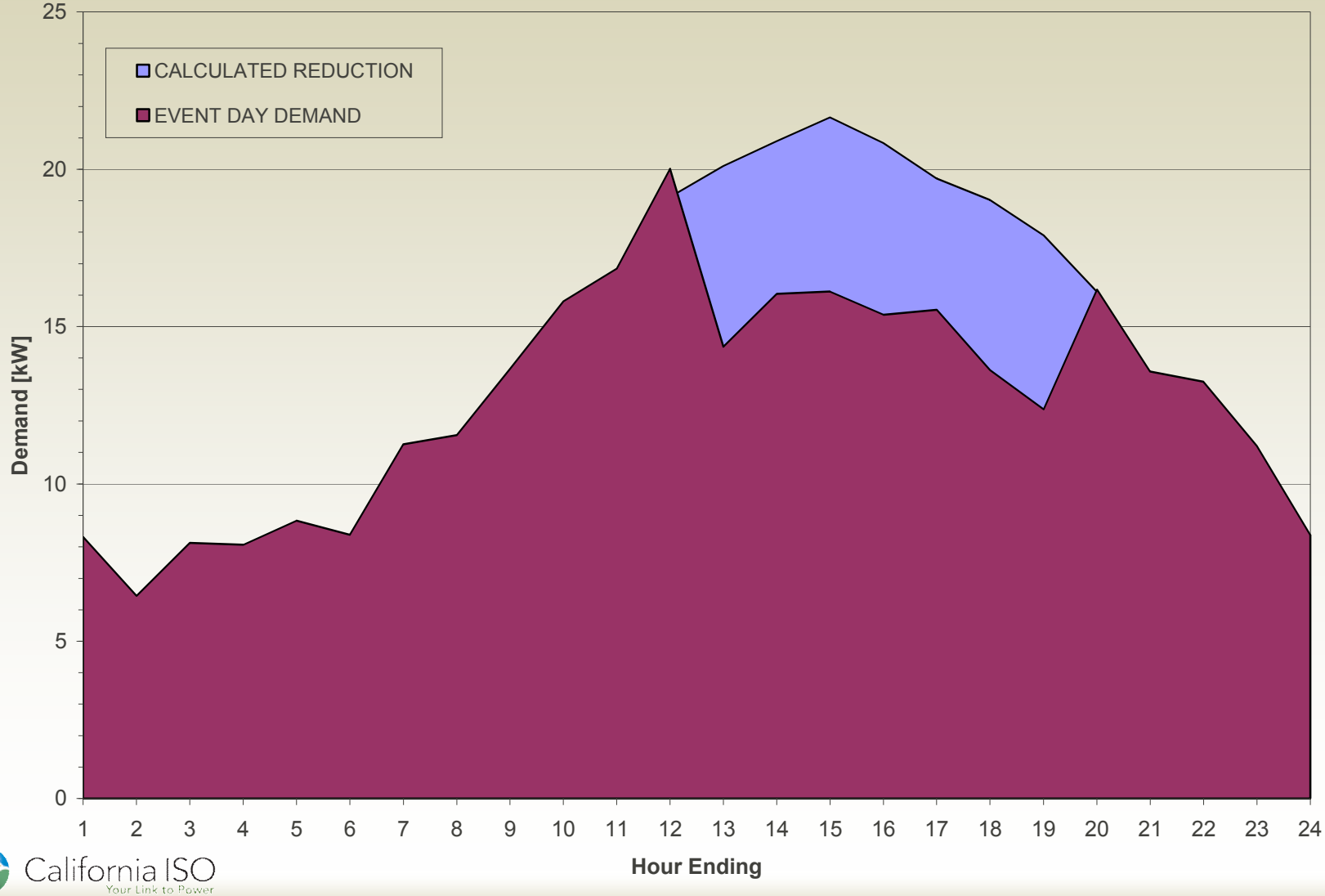
Your Link to Power

Apply “Morning Adjustment”



Calculate Demand Reduction



PJM Analysis

	Run#	Current (High 5 of 10)	Proposed Majority (High 5 of 7)	Proposed Minority (High 4 of 5)	Top Performer Mid 6 of 10 w/adjustment
Day Type	RunDate	4/20/2007	4/20/2007	5/7/2007	4/26/2007
Weekdays	Use Median or Avg. for CBL	Average	Average	Average	Average
Weekdays	CBL Basis Window	10	7	5	10
Weekdays	CBL Basis Window Limit	None	45	30	45
Weekdays	Start Selection from Days Prior to Event	2	1	1	1
Weekdays	Exclude Holidays	Y	Y	Y	Y
Weekdays	Exclude Previous Curtailment Days	Y	Y	Y	Y
Weekdays	Exclude Avg. Event Period Usage Less	75%	25%	25%	25%
Weekdays	Exclude # of High Usage Days	0	0	0	2
Weekdays	Exclude # of Low Usage Days	5	2	1	2
Weekdays	Additive Adjustments	N	N	N	Y
Weekdays	Allow Negative Adjustments	N	N	N	Y
Weekdays	Adjustments Start (HE0-x)	0	0	0	2
Weekdays	Adjustment Basis Hours	0	0	0	3
OffPeakDays	Use Median or Avg. for CBL	Average	Average	Average	Average
OffPeakDays	CBL Basis Window	3	3	3	3
OffPeakDays	CBL Basis Window Limit	60	60	45	60
OffPeakDays	Start Selection from Days Prior to Event	1	1	1	1
OffPeakDays	Exclude Holidays	Y	Y	Y	Y
OffPeakDays	Exclude Previous Curtailment Days	Y	Y	Y	Y
OffPeakDays	Exclude Avg. Event Period Usage Less	0%	25%	25%	0%
OffPeakDays	Exclude # of High Usage Days	0	0	0	0
OffPeakDays	Exclude # of Low Usage Days	1	1	0	0
OffPeakDays	Additive Adjustments	N	N	N	Y
OffPeakDays	Allow Negative Adjustments	N	N	N	Y
OffPeakDays	Adjustments Start (HE0-x)	0	0	0	2
OffPeakDays	Adjustment Basis Hours	0	0	0	3
Empirical Performance					
MdAPE	Accuracy (median absolute pct error)	6.60%	6.50%	5.80%	5.50%
MdPE	Bias (median percent error)	3.40%	1.40%	0.80%	0.00%
SDPE	Variation (standard deviation pct error)	17.70%	16.00%	13.70%	11.90%

Berkeley Lab Analysis

Table 3: Summary of BLP models evaluated

Code	Description
BLP1	10-Day simple average baseline with morning adjustment
BLP2	Weighted average formula using previous 20 admissible days with morning adjustment
BLP3	Simple average over the highest 3 out of 10 previous admissible days with morning adjustment
BLP3n	Simple average over the highest 3 out of 10 previous admissible days without morning adjustment
BLP4	Simple average over the highest 5 out of 10 previous admissible days with morning adjustment
BLP5	Seasonal regression baseline with morning adjustment
BLP6	10-day regression baseline with morning adjustment
BLP7	Limited seasonal regression baseline with morning adjustment

Berkeley Lab Analysis

Table 5: Metrics for the percent hourly error e(d,h) by site and model

			Median of e(d,h) (Bias measure)							Average of |e(d,h)| (Accuracy measure)						
site	var	ws	m1	m2	m3	m3n	m4	m5	m6	m1	m2	m3	m3n	m4	m5	m6
Office2	h	h	0.0	0.1	-0.8	2.4	-0.5	4.4	1.6	3.9	4.0	3.9	8.3	3.8	5.9	4.8
Office3	h	h	0.7	0.5	-1.0	3.6	-0.7	7.5	1.1	7.5	7.5	8.2	10.5	8.0	11.2	8.6
Detention Facility	h	h	-0.6	-0.8	0.5	1.9	0.2	-0.6	0.0	7.9	7.7	8.3	8.0	8.6	7.2	8.2
Office/LM7	h	h	-2.3	-2.4	1.0	1.8	0.1	-4.7	0.2	5.3	5.4	5.2	11.2	5.3	6.8	5.1
Retail4	h	h	-0.9	-0.5	-0.5	2.0	-0.5	-1.0	-0.2	3.0	2.9	3.5	5.4	3.4	3.0	3.5
Retail6	h	h	-0.3	-0.4	-0.7	2.2	-0.5	-1.1	-0.3	1.9	2.0	2.1	5.0	2.0	2.0	2.1
*School1	h	l	-7.1	-7.2	-3.8	7.3	-7.8	0.2	0.0	31.0	31.6	33.5	55.1	32.3	44.5	34.6
*Museum	h	l	1.2	3.4	1.6	3.5	1.6	4.4	1.6	15.0	15.8	16.2	23.6	15.4	14.9	18.2
*School2	h	l	-0.2	0.1	-1.2	7.0	-3.4	1.6	2.6	18.9	20.7	18.3	34.4	18.1	27.5	22.7
Office/Lab3	h	l	-4.7	-4.9	0.3	5.1	-3.5	-1.9	-0.7	10.6	10.6	10.9	16.5	11.1	8.1	11.4
Office5	h	l	-1.4	-2.0	0.1	2.1	-0.2	-2.1	0.2	3.6	3.7	3.6	7.4	3.5	4.6	3.6
Office/LM1	h	l	-1.4	-1.1	1.8	2.0	0.0	-0.7	-0.2	5.8	5.7	6.1	8.1	5.8	6.1	6.0
Office/LM4	h	l	-2.7	-2.9	0.0	3.4	-1.4	-4.8	-1.6	5.1	5.1	4.9	8.3	4.9	6.1	4.4
Office/LM6	h	l	-1.0	-1.3	2.4	4.0	0.7	8.3	0.9	7.7	7.8	10.5	29.3	9.1	12.1	12.0
Office/LM8	h	l	-0.4	-0.8	0.1	0.5	-0.4	6.7	-1.2	4.7	4.8	4.5	8.9	4.8	9.3	5.1
Office/LM9	h	l	-2.9	-3.1	-1.0	8.9	-1.6	-11.1	1.0	7.2	7.0	9.0	27.4	8.0	13.9	10.8
Office1	l	h	-2.4	-2.7	0.2	2.3	-0.5	1.1	0.1	5.3	5.2	5.4	8.9	5.3	4.2	4.9
Office4	l	h	-1.9	-2.0	-0.8	-1.5	-0.9	0.2	-0.6	4.3	4.3	4.5	8.0	4.3	3.6	4.5
Office/Lab2	l	h	0.7	0.6	0.5	-0.4	0.8	-0.4	0.4	4.4	4.1	4.5	5.1	4.2	4.8	4.9
Retail1	l	h	1.0	1.4	-0.2	-0.9	0.4	1.2	0.4	2.5	2.5	2.7	5.0	2.6	2.6	2.5
Retail2	l	h	-0.7	-0.9	-0.3	2.8	-0.4	0.6	0.0	4.7	4.7	4.5	5.1	4.9	4.1	5.2
Office/DC1	l	h	1.7	1.3	0.7	0.6	0.7	3.3	0.7	2.4	2.1	1.9	3.2	2.1	4.1	2.8
Supermarket	l	h	-1.6	-1.6	-0.4	1.0	-0.5	0.3	-0.3	2.7	2.5	2.5	4.0	2.3	2.1	2.0
Office/LM5	l	h	-1.0	-1.3	0.7	0.5	0.1	0.3	0.2	2.6	2.7	2.9	5.6	2.7	1.9	2.4
Office/DC2	l	h	-4.0	-5.3	-1.7	-1.6	-2.4	-0.1	-3.2	5.8	6.7	5.2	7.1	5.1	4.3	5.1
Office/DC3	l	h	-3.4	-3.9	-0.5	0.4	-2.1	-1.0	-1.1	5.1	5.4	4.8	7.3	4.8	3.3	3.9
Retail3	l	h	-0.7	-0.8	-0.1	1.3	-0.2	-0.2	0.2	2.0	2.1	2.1	3.8	2.0	2.2	2.3
Retail5	l	h	-2.0	-2.2	0.0	0.5	-0.6	0.0	0.4	4.2	4.2	4.1	6.1	4.1	2.7	3.5
Office/Lab1	l	l	-2.1	-1.9	1.6	0.3	-0.7	0.7	-0.3	4.4	4.4	4.2	6.0	4.3	4.2	5.1
Office/LM2	l	l	0.2	-0.5	0.6	1.4	0.5	0.9	-0.8	5.2	5.0	5.6	6.2	5.3	5.3	5.7
Office/LM3	l	l	-0.9	-1.1	0.8	2.7	-0.6	1.4	-0.8	5.4	5.3	5.8	7.8	5.7	5.3	6.4
Bakery	l	l	0.6	0.8	0.0	3.7	0.0	0.2	-0.1	4.4	4.3	5.2	5.6	4.6	6.6	5.4

blue/white = best performance | grey/black = worst performance

Christensen Findings

Accuracy - Event Type Days						
	Aggregator			Sum of Customers		
	3-in-10	5-in-10	10-in-10	3-in-10	5-in-10	10-in-10
Unadjusted Baselines	0.056	0.062	0.083	0.075	0.062	0.083
Adjusted Baselines	0.029	0.028	0.027	0.051	0.043	0.036

Bias - Event Type Days						
	Aggregator			Sum of Customers		
	3-in-10	5-in-10	10-in-10	3-in-10	5-in-10	10-in-10
Unadjusted Baselines	2.47%	3.75%	7.24%	-0.90%	1.55%	7.15%
Adjusted Baselines	-0.71%	-0.36%	0.26%	-2.25%	-1.52%	0.70%

Accuracy - Event Days						
	Aggregator			Sum of Customers		
	3-in-10	5-in-10	10-in-10	3-in-10	5-in-10	10-in-10
Unadjusted Baselines	0.074	0.085	0.103	0.086	0.085	0.103
Adjusted Baselines	0.027	0.028	0.037	0.054	0.05	0.047

Bias - Event Days						
	Aggregator			Sum of Customers		
	3-in-10	5-in-10	10-in-10	3-in-10	5-in-10	10-in-10
Unadjusted Baselines	2.91%	4.77%	8.06%	-0.44%	2.55%	8.03%
Adjusted Baselines	-1.24%	-0.44%	0.60%	-2.46%	-1.34%	1.15%

Other Baselines

- ISO-NE Rolling baseline calculation
- “Customer/Resource Specific”
- Historical model
- Meter before/Meter after
- Metered generation
- Statistical estimates

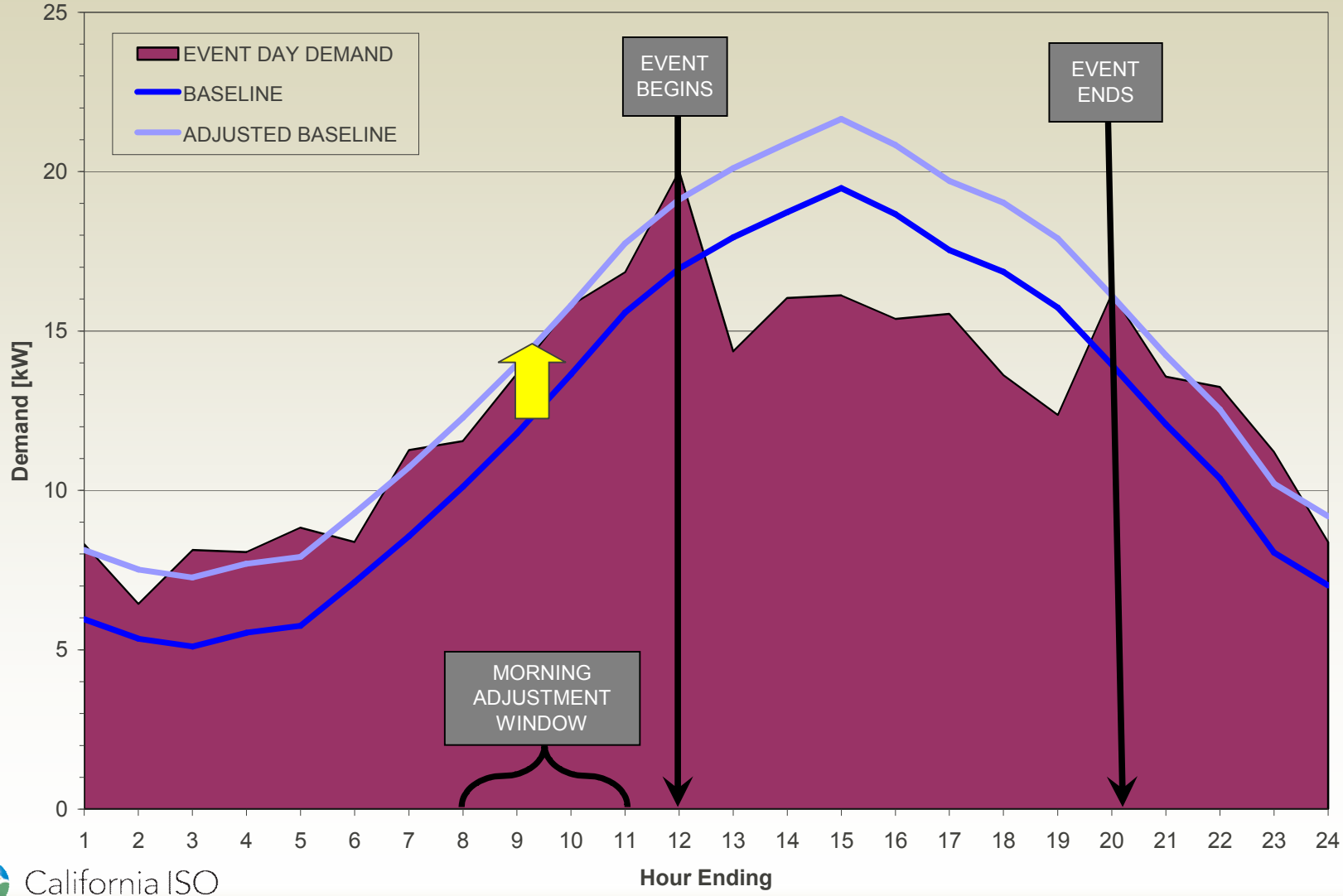
Possible CBL Methods

- Customer/Resource specific is overhead/data intensive
- Rolling baseline method at ISO-NE appears to be somewhat new
- CA Aggregator and PJM methods have been heavily studied
- 4 of 5 method at PJM is complex
  - Multiple day types, variable lookback window, load thresholds, prior event exclusion rules, load point adjustments
- 10 in 10 method has familiarity in CA market

CAISO Proposal

- Start with 10 in 10 CBL method
  - No elimination of abnormally low days
- Lookback window of 45 days
  - No window extensions
- Like days are M-F exclusive of weekends/holidays
  - Is a variation necessary for weekends/holidays - e.g. 5 of 5?
- Use highest event days if 10 like days cannot be found
- Load point adjustment as default
  - Weather adjustment requires resource specific sensitivity factors, and misses other secular effects

Apply “Morning Adjustment”



“Morning Adjustment” Alternatives

- X = Average Load on event day for 3 hours prior to event
  - Skip the hour immediately before the event?
- Y = Average Load of baseline for same 3 hours
- Multiplicative adjustment
  - Ratio is X / Y
  - Adjusted baseline = Each hour of baseline event load * (X / Y)
  - Adjustments to be capped at +/- 20%
- Alternative - Additive adjustment (used by PJM, ISONE)
  - Difference is X – Y
  - Adjusted baseline = Each hour of baseline event load + (X – Y)