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Get More From Energy

# MAC Presentation

EnerNOC Discussion Paper – Relevant Demand

Pablo Campillos 9 February 2011



# the current approach

## The RD's Fundamental Problem

The **R**elevant **D**emand measure is a "baseline" designed to forecast what energy demand would have been in lieu of a dispatch from System Management.

Yet, the current (and proposed) RD employs a **static** baseline methodology that is **inherently unable** to accurately predict CL/DSP load:

- Cannot predict usage at different times of day, different days of the week, or different seasons of the year
- Lacks a mechanism to adjust the baseline forecast based on actual conditions on the day of a dispatch
- Can reward end-users who have not actually curtailed load ("incidental performance"), and penalise customers who have indeed curtailed load but were operating above their baseline

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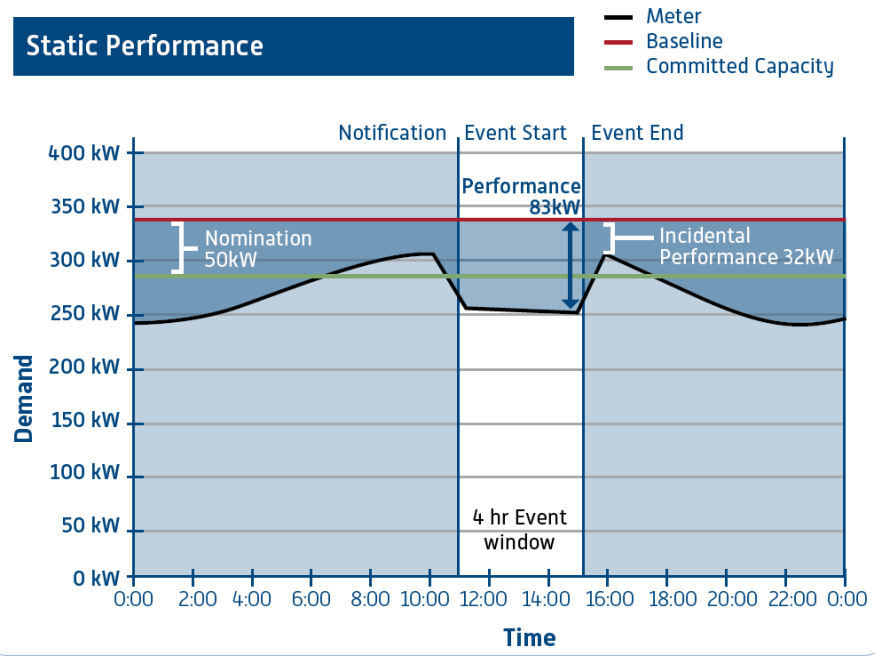


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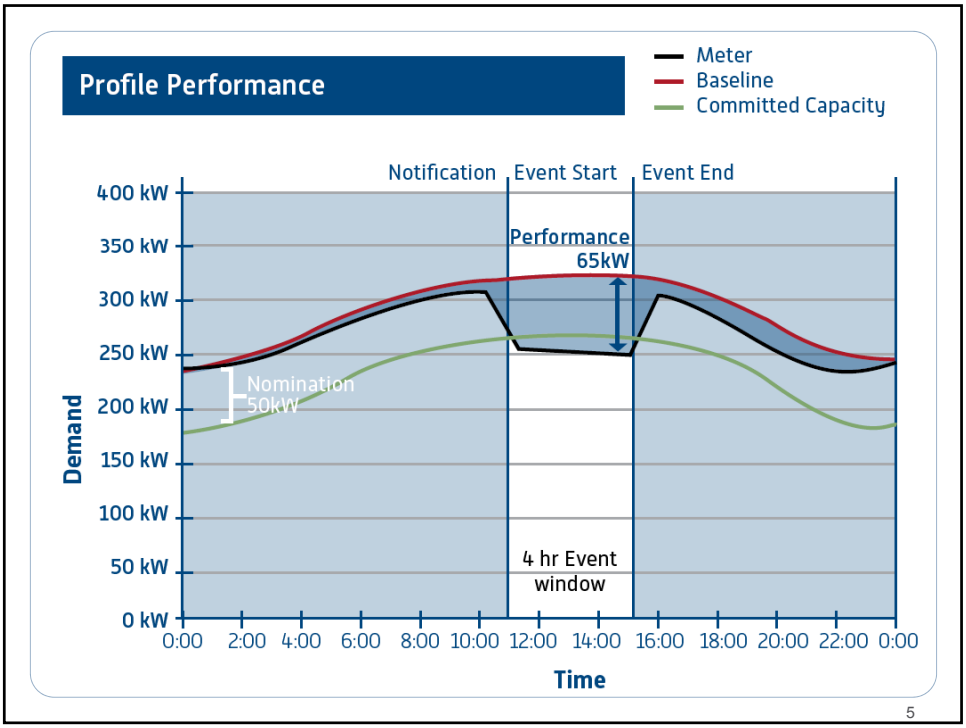
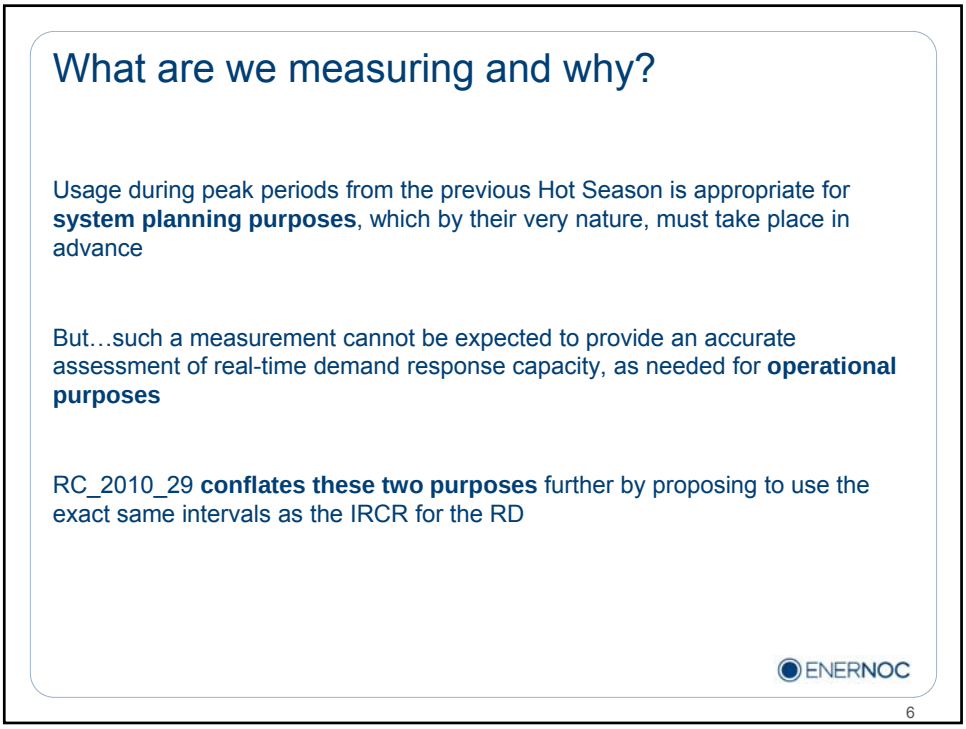

Profile Performance
Meter
Baseline
Committed Capacity
Notification
Event Start
Event End
400 kW
350 kW
300 kW
250 kW
200 kW
150 kW
100 kW
50 kW
0 kW
Demand
Performance
65kW
Nomination
50kW
4 hr Event
window
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
5


What are we measuring and why?
Usage during peak periods from the previous Hot Season is appropriate for **system planning purposes**, which by their very nature, must take place in advance
But…such a measurement cannot be expected to provide an accurate assessment of real-time demand response capacity, as needed for **operational purposes**
RC_2010_29 **conflates these two purposes** further by proposing to use the exact same intervals as the IRCR for the RD
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# a better way

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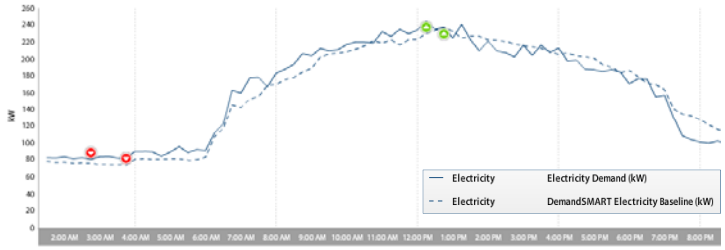
## “Profile” baselines

- Profile baselines are a popular methodology used in many of the world’s most mature electricity markets with DSM participation, as well as in numerous utility-administered DSM programs.
- Such methodologies use an average of a customer’s actual demand on an interval by interval basis, over a recent period of time prior to dispatch, creating a shaped baseline that closely follows a site’s load profile:




Actual EnerNOC customer meter data and profile baseline – University student center – 28 January 2011

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## How Does it Work?

The most common type of profile baseline uses what is known as a **High X of Y** methodology which looks back over a specified number of days Y and uses the meter data from the X days with the highest load within those Y days.

- Selecting Y (the "look-back window"):
  - Y must be short enough to capture recent trends, but long enough to combat opportunities for gaming
  - Y must only include appropriate days (i.e. non-event, Business Days)
- Selecting X:
  - Because dispatches are most likely to occur on days with above-average temperature/demand, using all days in Y would result in an understated baseline
  - Using a subset of X days with the highest energy usage during program hours helps to offset this downward bias
- The average usage during each interval on the X days is then averaged together to create a forecast for each interval on the current/future day

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## An Illustrative Example: High 5 in 10

In this case, Y = 10 days and X = 5 days with the highest average demand. As denoted by the blue coloring, the five highest days are days 2, 4, 6, 7, and 9.

| Day | Interval 1 (kW) | Interval 2 (kW) | Interval N (kW) | Average usage (kW) |
|---|---|---|---|---|
| 1 | 2,000 | 2,100 | 2,000 | 2,033 |
| 2 | 2,100 | 2,200 | 2,100 | 2,133 |
| 3 | 2,000 | 2,100 | 2,000 | 2,033 |
| 4 | 2,200 | 2,500 | 2,200 | 2,300 |
| 5 | 2,000 | 2,100 | 2,000 | 2,033 |
| 6 | 2,100 | 2,200 | 2,100 | 2,133 |
| 7 | 2,400 | 2,300 | 2,400 | 2,367 |
| 8 | 2,000 | 2,100 | 2,000 | 2,033 |
| 9 | 2,600 | 2,700 | 2,600 | 2,633 |
| 10 | 2,000 | 2,100 | 2,000 | 2,033 |
| **Baseline** | **2,280** | **2,380** | **2,280** | |

Baseline for interval 1: (2,100 + 2,200 + 2,100 + 2,400 + 2,600) / 5 = 2,280

Baseline for interval 2: (2,200 + 2,500 + 2,200 + 2,300 + 2,700) / 5 = 2,380

And so on…

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# Day of Adjustment

- Because the dispatch of DSPs is often correlated to spikes in demands as a result of extreme weather, it is important to ensure that the RD can accurately reflect such periods of anomalous usage
  - A static baseline does this by measuring usage during peak periods and using that as the value all the time, even though grid conditions vary daily. The downside of this approach is the problem of "**incidental performance**."
  - A profile baseline on the other hand seeks to combat "incidental performance" and be applicable (and accurate) throughout all periods. The way a profile baseline addresses demands during peak periods is to use **actual meter data to make a real-time adjustment** – a more accurate method.
- Studies by KEMA, the international energy consulting firm, and Lawrence Berkley National Laboratory in the United States – among others – identify a day of adjustment as crucial to ensuring baseline accuracy.

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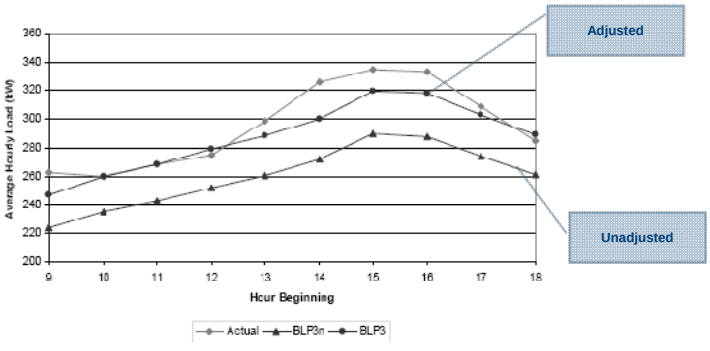
# Illustrative Example: LBNL Study




The unadjusted High 3 in 10 baseline (BLP3n) clearly understates Actual metered load.

But, once a day-of-adjustment is applied, the adjusted baseline (BLP3) comes very close to tracking the Actual metered load.

Lawrence Berkeley National Laboratory, "Estimating Demand Response Load Impacts: Evaluation of Baseline Load Models for Non-Residential Buildings in California", January 2008

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## Day of Adjustment: detailed view

There are a variety of ways to implement a day of adjustment that must be considered so the type chosen best matches the program in question

Timing of Adjustment

- With advanced notification to a dispatch, it is important to apply the adjustment at the point of notification and not the event start time, since the latter could both penalise early curtailment actions and create an opportunity for gaming

Direction of Adjustment

- For programs where DR is as likely to be dispatched during shoulder periods, a customer may be equally likely to be above or below their unadjusted baseline (symmetric adjustment)
- But, for programs/markets like the WEM, where DR is likely to be dispatched during extreme weather and demand periods, a customer is far more likely to be above their baseline (asymmetric adjustment)
- The length of the notification period is also important – in the WEM, a CL/DSP could be dispatched as early as 8am for an event starting at noon – load conditions at/before that point in time are likely to be below normal (asymmetric adjustment)

Method of Adjustment

- The adjustment can be applied on an additive (kW) or scalar (%) basis, but the literature does not show one to be clearly better than the other

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## our recommendation

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# EnerNOC's recommended RD measure

## High 5 in 10

- Consideration of the last 10 non-event, business days allows a robust number of days to be considered without going too far in the past in which load behaviour is different than current realities.
- Using only the top 5 days allows some of the lower usage days to be excluded, bringing the baseline forecast more in line with expected conditions during a dispatch.

## Asymmetric Adjustment

- Asymmetric to reflect the likely dispatch patterns by SM in the WEM (during peak periods of the Hot Season), in light of the inherent downward bias of an X in Y baseline.
- Symmetric adjustment would be highly problematic due to the long lead time (8am notification for a noon event would look at consumption at/before 8am, where loads may not even be operating)
- Applied at the time of dispatch to ensure baseline integrity, additive (kW)

## Calculated Individually and summed to create the DSP RD

- Unlike a static RD, there can be significant differences between individually-calculated and portfolio-calculated profile baselines
- Example on the following slide

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# Impact of Aggregation on Baseline Accuracy

**Impact of Aggregation on Baseline Accuracy:**
**Individual and Aggregate 5-in-10 Peak Load, kW**

| | Participant 1 | Participant 2 | Participant 3 | Aggregate Load |
|---|---|---|---|---|
| Day 1 | 200 | 65 | 100 | 365 |
| Day 2 | 200 | 65 | 80 | 345 |
| Day 3 | 200 | 65 | 70 | 335 |
| Day 4 | 200 | 130 | 80 | 410 |
| Day 5 | 200 | 130 | 60 | 390 |
| Day 6 | 0 | 130 | 80 | 210 |
| Day 7 | 0 | 130 | 110 | 240 |
| Day 8 | 150 | 130 | 100 | 380 |
| Day 9 | 150 | 65 | 125 | 340 |
| Day 10 | 150 | 65 | 100 | 315 |
| *5-in-10, Individual* | *200* | *130* | *107* | *378* |
| *5-in-10, Aggregate* | *190* | *104* | *84* | *378* |

The top five loads are highlighted in blue for each participant and for the aggregate load. The average of the highlighted loads in each column is shown under *5-in-10, Individual*. The average of each participant's loads on the five peak days for the aggregate load is shown under *5-in-10, Aggregate*.

- Using the High Days for the aggregate portfolio of sites, Days 1, 2, 4, 5, and 8 would be used.
- While Participant 1's High 5 days match 80% to the portfolio, only 60% of Participant 2's do, and only a third of Participant 3's High days align.

Bill Monsen's CDRC Testimony before the CA Public Utilities Commission, A08-06-001, November 2008

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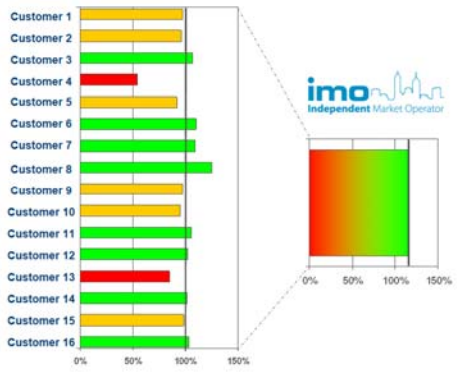
# Individual RDs ≠ Individual Performance

- Baselines should be calculated individually, since end-user loads can vary greatly. A baseline methodology based on the coincident peak of a portfolio will never be able to accurately predict usage on a dispatch day.
- Performance should be calculated on a portfolio basis to allow for aggregation:

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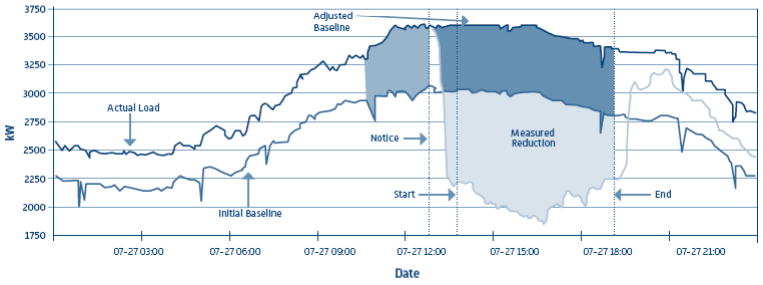
# Putting it all together

An illustrative example of a 5 in 10 CBL in action:

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# questions?

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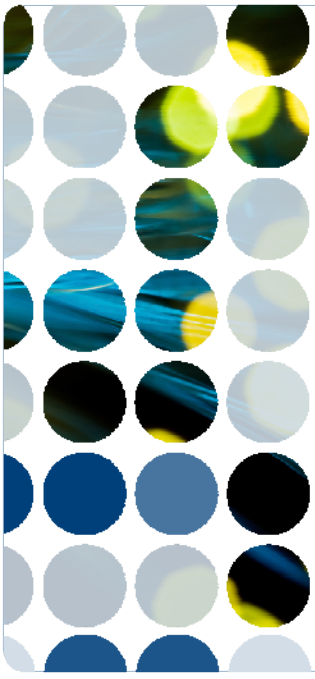


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