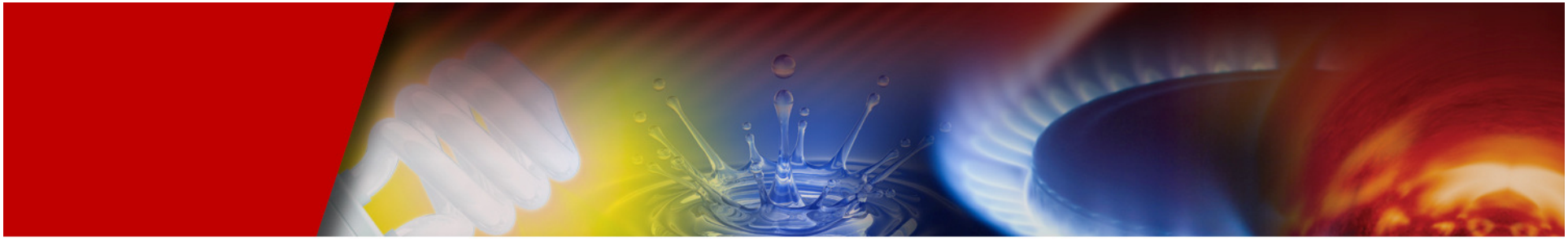

Itron

*Knowledge to Shape Your Future*

**Dave Hanna**
*Director, Consulting & Analysis*
Itron Inc.
San Diego, CA

WLRA Fall Conference
September 27-29, 2010

# Using AMR Data for Dynamic Pricing Evaluations

# History:

- ~12 years ago, AMR was all the rage.
  - New and cheap source of load data for Load Research
- Then came Retail Access
  - Who needs Load Research? The market will take care of everything!
  - Many Load Research departments disappeared
- AMI has come to save the day, or has it?

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# Reality:

- AMI has captured imaginations of many people lately, but the reality is that if your utility has already invested in AMR, they probably won't be investing in full scale AMI anytime soon. Anyone investing in AMR today is probably delaying smart metering by at least 10 years.

- Some AMR systems can provide data with sufficient granularity to be useful for load research and for DR impact evaluation purposes. You just need to make the most of what you have.

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# Mid-West Utility – CPP, PTR & DLC Evaluations

- CPP & PTR Pilot Programs
  - > Started in Q3 of 2009
  - > CPP enrollees = ~160
    - Marketed to existing TOU customers
  - > PTR enrollees = ~630
    - Marketed to existing flat rate customers
  - > 17 PTR & 14 CPP events called this past summer
- DLC Program
  - > Expansion to existing 30k participants in Q3 of 2009
  - > New enrollees = 1200
  - > No events called so far

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# AMR Interval Data – Granularity vs. Quality

- Data Interval Sizes
  - Daily – 1 interval per day
  - Daily TOU – 3 intervals per day
  - Hourly – 24 intervals per day
- Data Quality varies significantly
  - Daily is very good
  - Daily TOU – issues with matching TOU intervals to Daily
  - Hourly – Issues with missing and incomplete intervals

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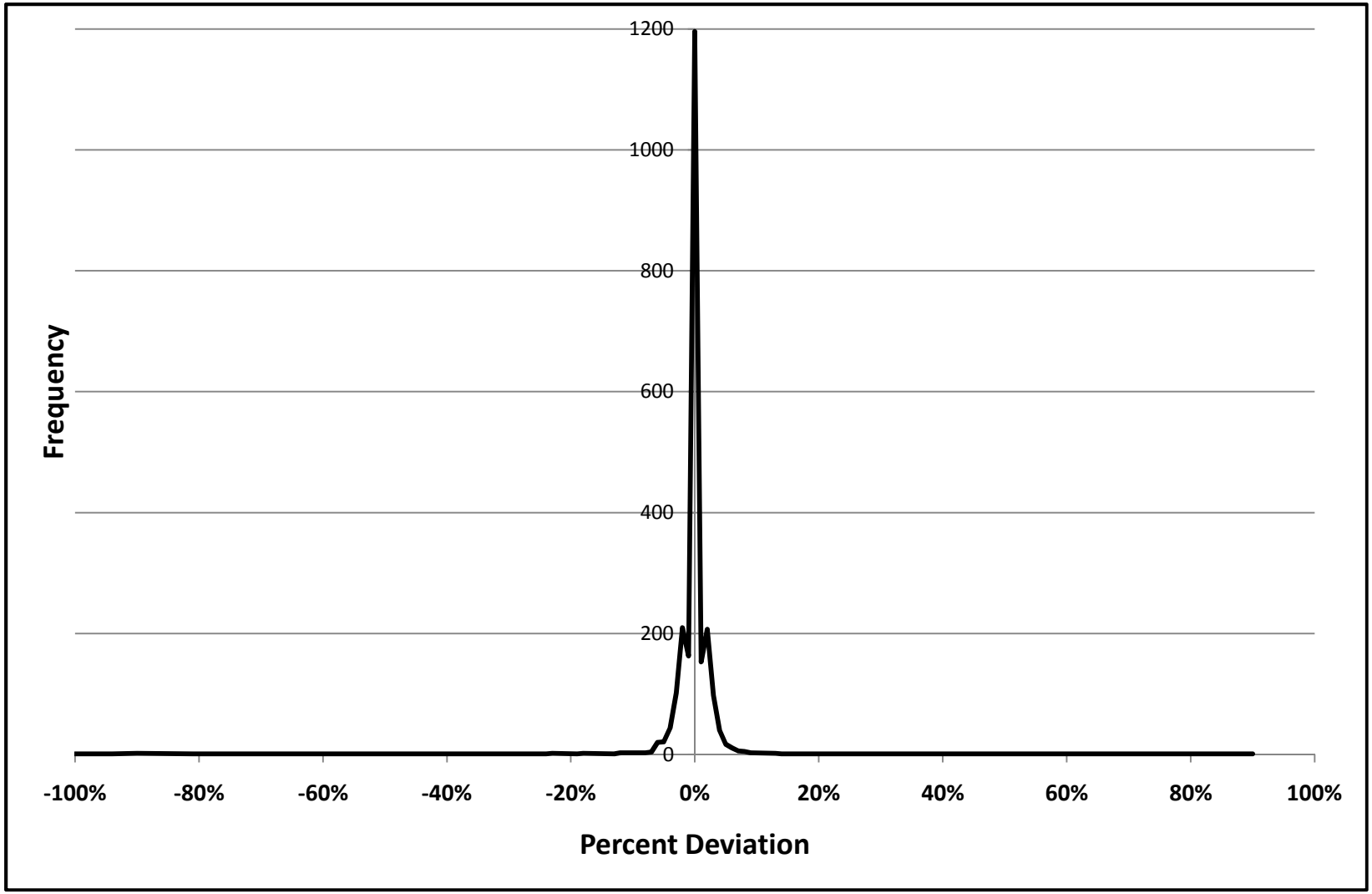
# Daily TOU – Sum of TOU versus Daily Consumption

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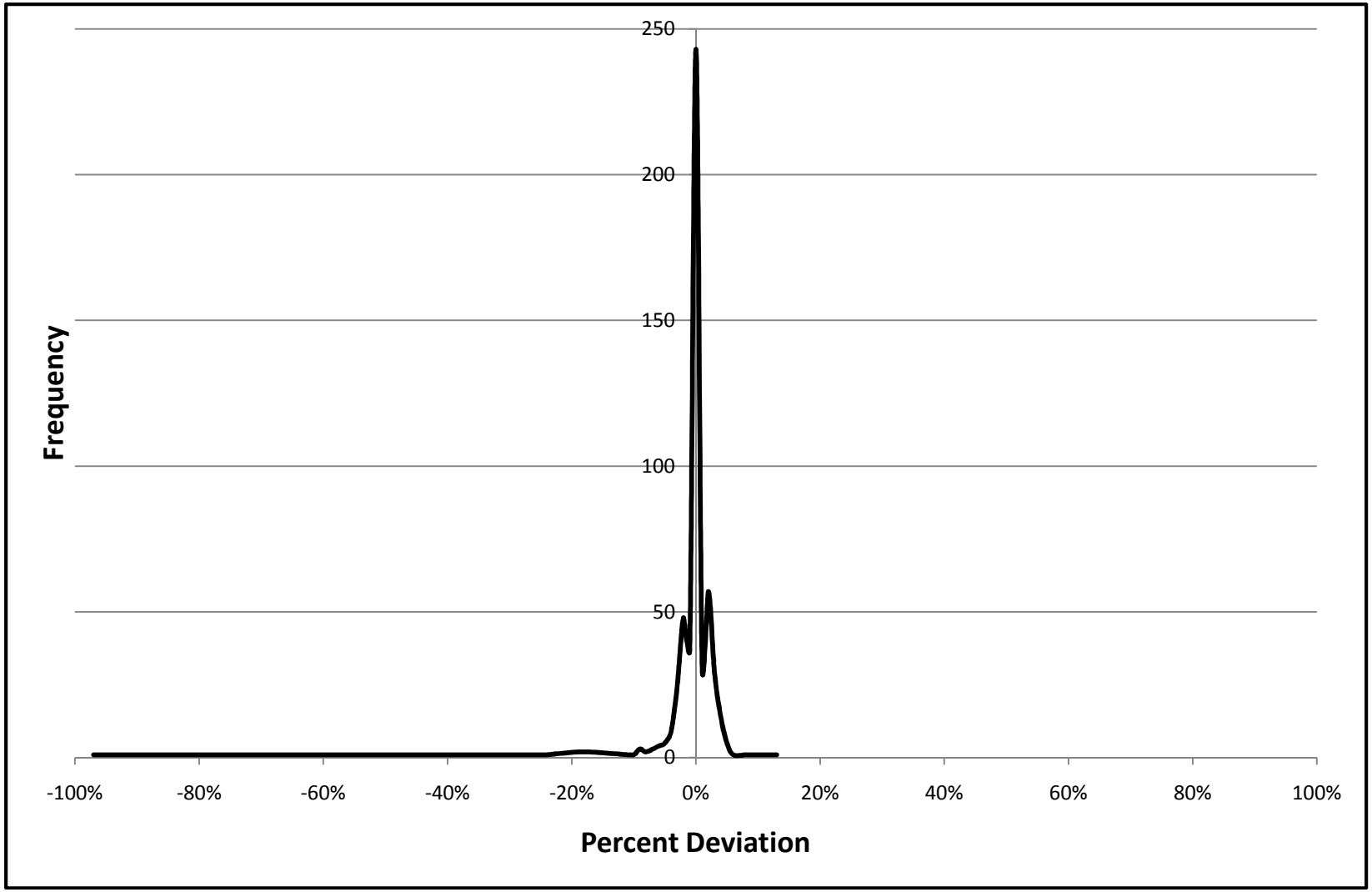
# Daily TOU – Event Days Only

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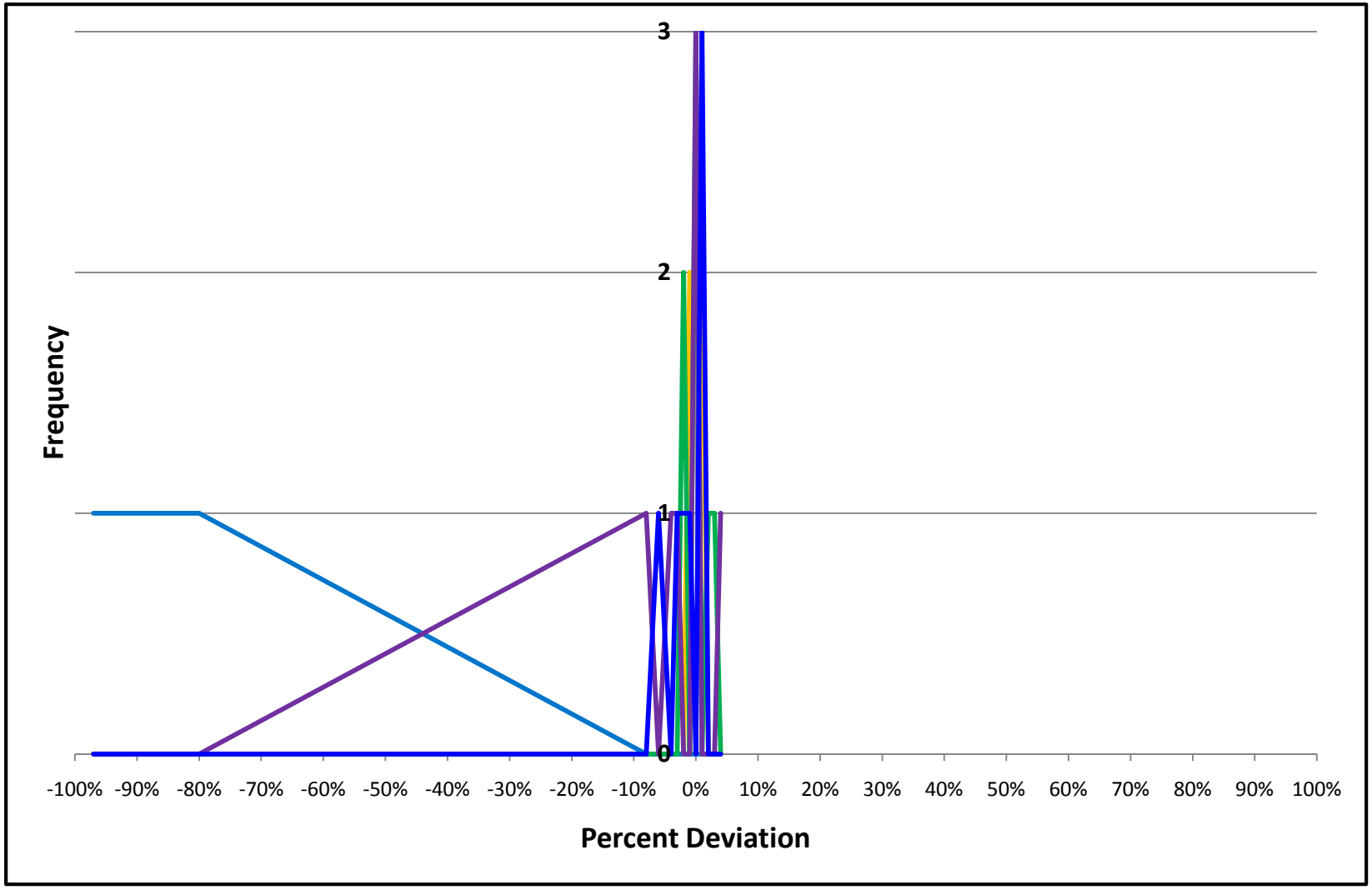
# Daily TOU – Specific Sites on Event Days Only

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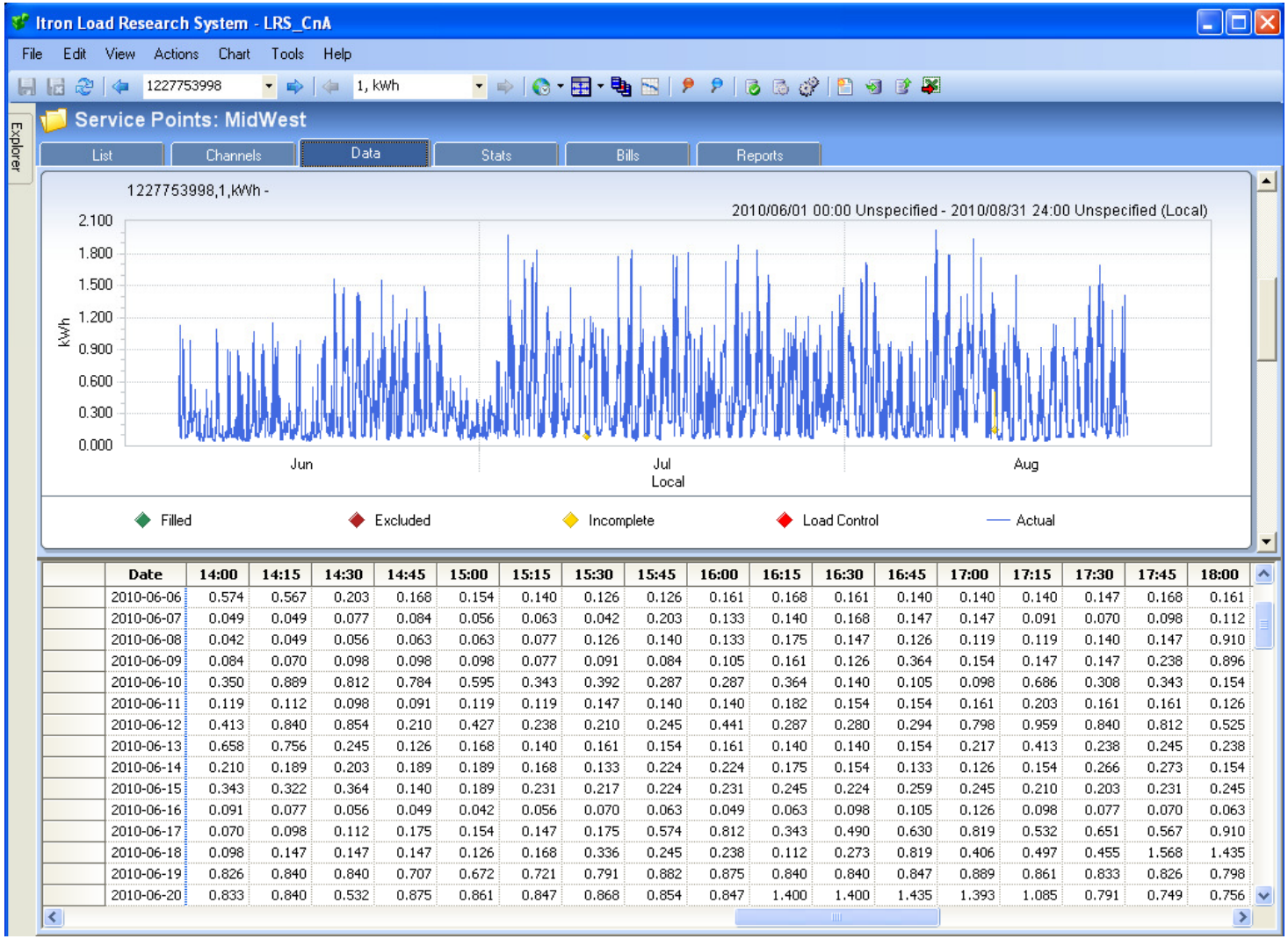
# Hourly AMR Data - It can be good




| Date | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | 16:00 | 16:15 | 16:30 | 16:45 | 17:00 | 17:15 | 17:30 | 17:45 | 18:00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010-06-06 | 0.574 | 0.567 | 0.203 | 0.168 | 0.154 | 0.140 | 0.126 | 0.126 | 0.161 | 0.168 | 0.161 | 0.140 | 0.140 | 0.140 | 0.147 | 0.168 | 0.161 |
| 2010-06-07 | 0.049 | 0.049 | 0.077 | 0.084 | 0.056 | 0.063 | 0.042 | 0.203 | 0.133 | 0.140 | 0.168 | 0.147 | 0.147 | 0.091 | 0.070 | 0.098 | 0.112 |
| 2010-06-08 | 0.042 | 0.049 | 0.056 | 0.063 | 0.063 | 0.077 | 0.126 | 0.140 | 0.133 | 0.175 | 0.147 | 0.126 | 0.119 | 0.119 | 0.140 | 0.147 | 0.910 |
| 2010-06-09 | 0.084 | 0.070 | 0.098 | 0.098 | 0.098 | 0.077 | 0.091 | 0.084 | 0.105 | 0.161 | 0.126 | 0.364 | 0.154 | 0.147 | 0.147 | 0.238 | 0.896 |
| 2010-06-10 | 0.350 | 0.889 | 0.812 | 0.784 | 0.595 | 0.343 | 0.392 | 0.287 | 0.287 | 0.364 | 0.140 | 0.105 | 0.098 | 0.686 | 0.308 | 0.343 | 0.154 |
| 2010-06-11 | 0.119 | 0.112 | 0.098 | 0.091 | 0.119 | 0.119 | 0.147 | 0.140 | 0.140 | 0.182 | 0.154 | 0.154 | 0.161 | 0.203 | 0.161 | 0.161 | 0.126 |
| 2010-06-12 | 0.413 | 0.840 | 0.854 | 0.210 | 0.427 | 0.238 | 0.210 | 0.245 | 0.441 | 0.287 | 0.280 | 0.294 | 0.798 | 0.959 | 0.840 | 0.812 | 0.525 |
| 2010-06-13 | 0.658 | 0.756 | 0.245 | 0.126 | 0.168 | 0.140 | 0.161 | 0.154 | 0.161 | 0.140 | 0.140 | 0.154 | 0.217 | 0.413 | 0.238 | 0.245 | 0.238 |
| 2010-06-14 | 0.210 | 0.189 | 0.203 | 0.189 | 0.189 | 0.168 | 0.133 | 0.224 | 0.224 | 0.175 | 0.154 | 0.133 | 0.126 | 0.154 | 0.266 | 0.273 | 0.154 |
| 2010-06-15 | 0.343 | 0.322 | 0.364 | 0.140 | 0.189 | 0.231 | 0.217 | 0.224 | 0.231 | 0.245 | 0.224 | 0.259 | 0.245 | 0.210 | 0.203 | 0.231 | 0.245 |
| 2010-06-16 | 0.091 | 0.077 | 0.056 | 0.049 | 0.042 | 0.056 | 0.070 | 0.063 | 0.049 | 0.063 | 0.098 | 0.105 | 0.126 | 0.098 | 0.077 | 0.070 | 0.063 |
| 2010-06-17 | 0.070 | 0.098 | 0.112 | 0.175 | 0.154 | 0.147 | 0.175 | 0.574 | 0.812 | 0.343 | 0.490 | 0.630 | 0.819 | 0.532 | 0.651 | 0.567 | 0.910 |
| 2010-06-18 | 0.098 | 0.147 | 0.147 | 0.147 | 0.126 | 0.168 | 0.336 | 0.245 | 0.238 | 0.112 | 0.273 | 0.819 | 0.406 | 0.497 | 0.455 | 1.568 | 1.435 |
| 2010-06-19 | 0.826 | 0.840 | 0.840 | 0.707 | 0.672 | 0.721 | 0.791 | 0.882 | 0.875 | 0.840 | 0.840 | 0.847 | 0.889 | 0.861 | 0.833 | 0.826 | 0.798 |
| 2010-06-20 | 0.833 | 0.840 | 0.532 | 0.875 | 0.861 | 0.847 | 0.868 | 0.854 | 0.847 | 1.400 | 1.400 | 1.435 | 1.393 | 1.085 | 0.791 | 0.749 | 0.756 |

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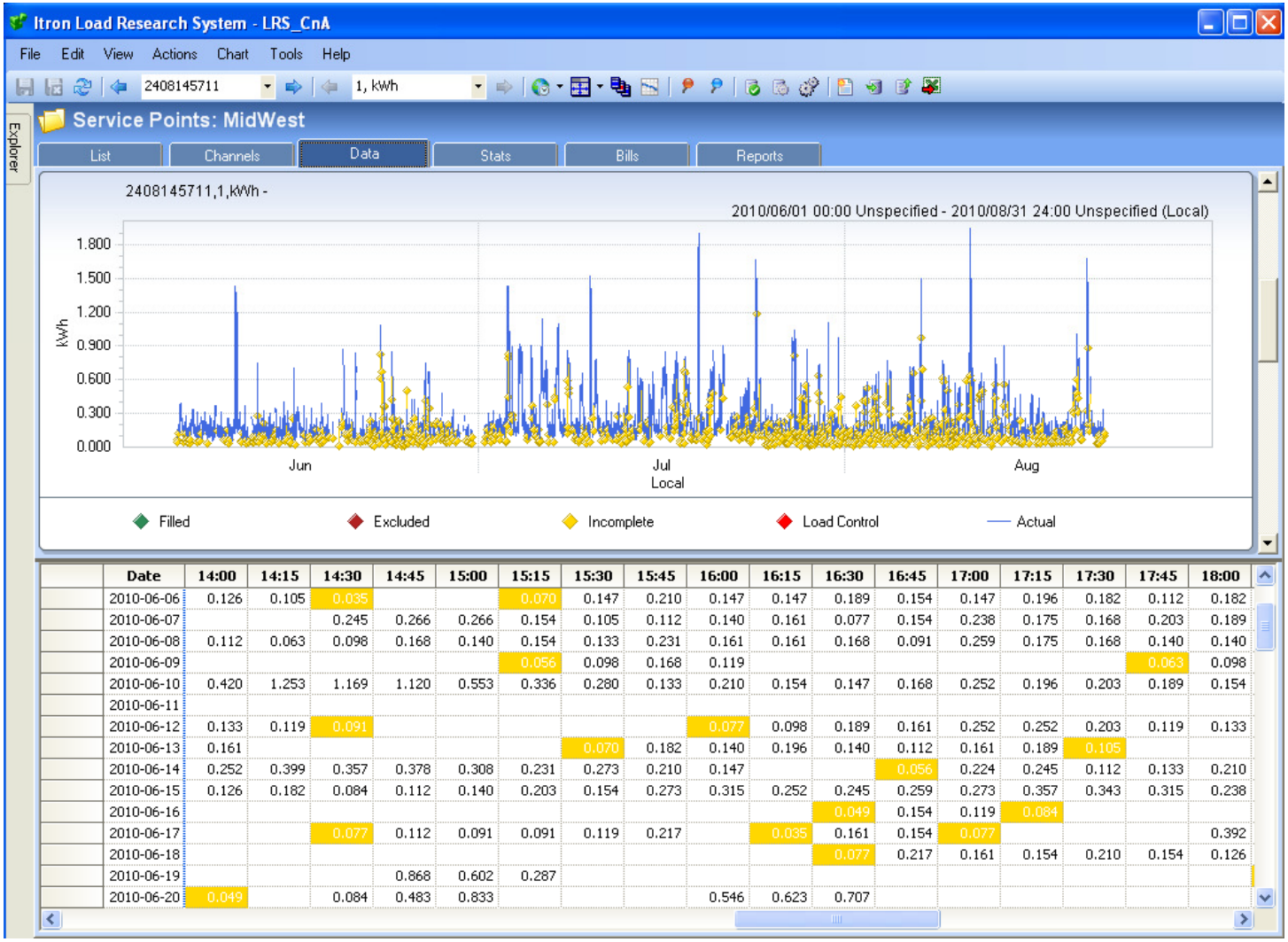
# Hourly AMR Data - It Can Be Bad




| Date | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | 16:00 | 16:15 | 16:30 | 16:45 | 17:00 | 17:15 | 17:30 | 17:45 | 18:00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010-06-06 | 0.126 | 0.105 | 0.035 | | | 0.070 | 0.147 | 0.210 | 0.147 | 0.147 | 0.189 | 0.154 | 0.147 | 0.196 | 0.182 | 0.112 | 0.182 |
| 2010-06-07 | | | 0.245 | 0.266 | 0.266 | 0.154 | 0.105 | 0.112 | 0.140 | 0.161 | 0.077 | 0.154 | 0.238 | 0.175 | 0.168 | 0.203 | 0.189 |
| 2010-06-08 | 0.112 | 0.063 | 0.098 | 0.168 | 0.140 | 0.154 | 0.133 | 0.231 | 0.161 | 0.161 | 0.168 | 0.091 | 0.259 | 0.175 | 0.168 | 0.140 | 0.140 |
| 2010-06-09 | | | | | | 0.056 | 0.098 | 0.168 | 0.119 | | | | | | | 0.063 | 0.098 |
| 2010-06-10 | 0.420 | 1.253 | 1.169 | 1.120 | 0.553 | 0.336 | 0.280 | 0.133 | 0.210 | 0.154 | 0.147 | 0.168 | 0.252 | 0.196 | 0.203 | 0.189 | 0.154 |
| 2010-06-11 | | | | | | | | | | | | | | | | | |
| 2010-06-12 | 0.133 | 0.119 | 0.091 | | | | | | 0.077 | 0.098 | 0.189 | 0.161 | 0.252 | 0.252 | 0.203 | 0.119 | 0.133 |
| 2010-06-13 | 0.161 | | | | | | 0.070 | 0.182 | 0.140 | 0.196 | 0.140 | 0.112 | 0.161 | 0.189 | 0.105 | | |
| 2010-06-14 | 0.252 | 0.399 | 0.357 | 0.378 | 0.308 | 0.231 | 0.273 | 0.210 | 0.147 | | | 0.056 | 0.224 | 0.245 | 0.112 | 0.133 | 0.210 |
| 2010-06-15 | 0.126 | 0.182 | 0.084 | 0.112 | 0.140 | 0.203 | 0.154 | 0.273 | 0.315 | 0.252 | 0.245 | 0.259 | 0.273 | 0.357 | 0.343 | 0.315 | 0.238 |
| 2010-06-16 | | | | | | | | | | | 0.049 | 0.154 | 0.119 | 0.084 | | | |
| 2010-06-17 | | | 0.077 | 0.112 | 0.091 | 0.091 | 0.119 | 0.217 | | 0.035 | 0.161 | 0.154 | 0.077 | | | | 0.392 |
| 2010-06-18 | | | | | | | | | | | 0.077 | 0.217 | 0.161 | 0.154 | 0.210 | 0.154 | 0.126 |
| 2010-06-19 | | | | 0.868 | 0.602 | 0.287 | | | | | | | | | | | |
| 2010-06-20 | 0.049 | | 0.084 | 0.483 | 0.833 | | | | 0.546 | 0.623 | 0.707 | | | | | | |

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# Work With What You Have

- Validation Intensive
  - CPP & PTR – Daily TOU Data
    - All participants read by AMR system
    - Start with all participants for the impact evaluation
    - Remove sites based on degree of data quality
      - Validate the sum of daily TOU intervals to daily consumption
  - DLC – Hourly Data
    - Approximately 90% of participants are read by AMR system, but only 25% have adequate signal reception for hourly data
    - Stratified sampling required
    - Over sample to compensate for bad data
      - Remove sites with excessive bad data
      - Currently investigating validation
        - Sum of hourly versus daily consumption

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# Separate Model for each Participant

$$touavg = \beta_0 + \beta_{event} Event + \beta_{eventcdd} Event \times CDD_{60} - \beta_1 CDD_{60} - \beta_2 HDD_{60}$$
$$+ \beta_3 OnPeak + \beta_4 OffPeak + \sum_{d=1}^{4} \beta_{day_d} Day_d$$
$$+ \sum_{m=9}^{12} \beta_{month_m} Month_m + \varepsilon$$

Where:

*touavg* is the average hourly usage for a participant in the TOU period,
*Event* is a dummy that equals to 1 when there is an event called, 0 otherwise,
*OnPeak* is a dummy variable that equals to 1 for on peak hours, 0 otherwise,
*OffPeak* is a dummy variable that equals to 1 for off peak hours, 0 otherwise,
$Day_d$, $d$ = 1,…,5 are dummy variables for Monday, Tuesday,…, Friday. $Day_5$ was taken out to avoid perfect multicollinearity, and
$Month_m$, $m$ = 8,…,12 are dummy variables for August, September,…, December. $Month_8$ was taken out to avoid perfect multicollinearity.

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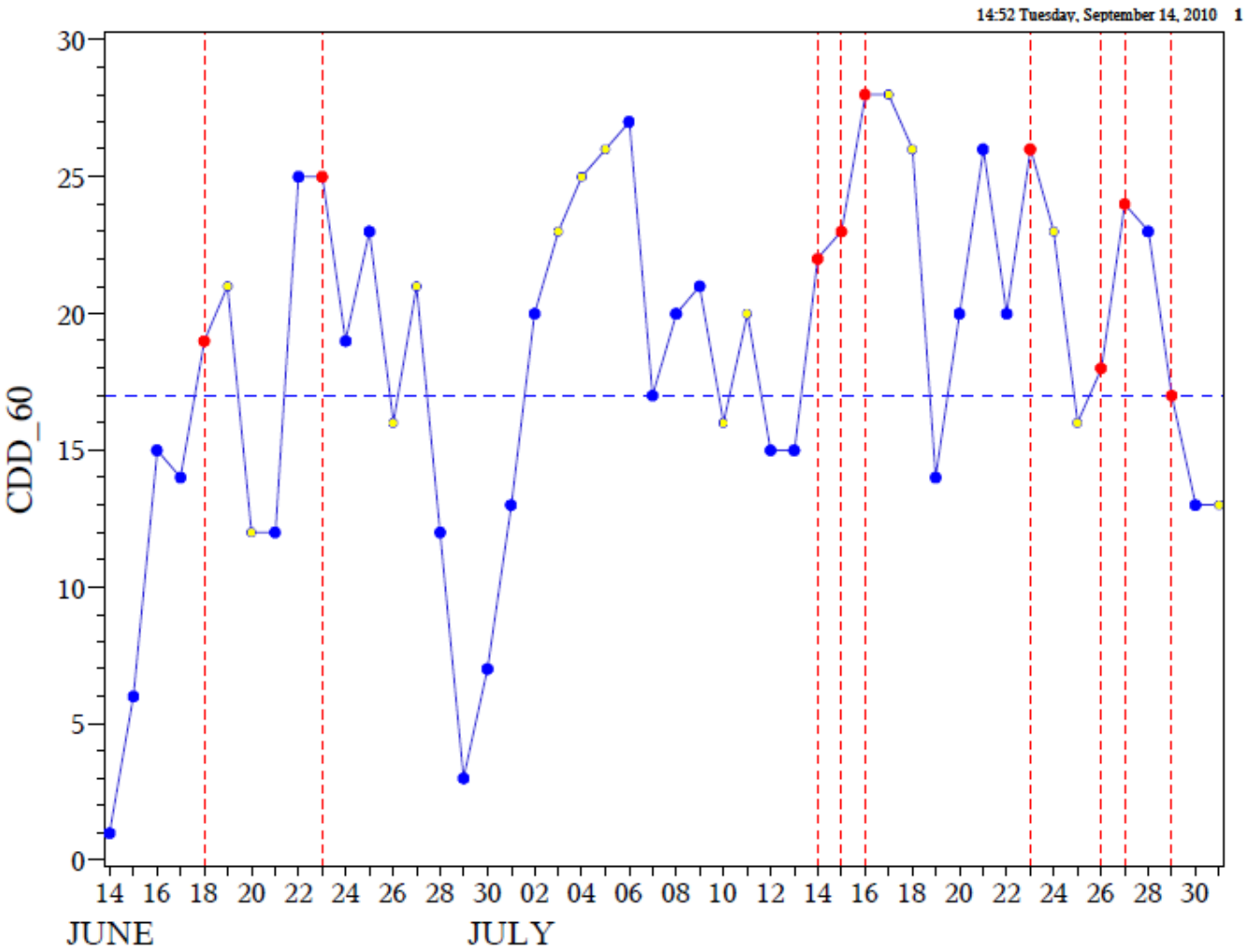
# CPP Event Days - CDD60 in Peak Period

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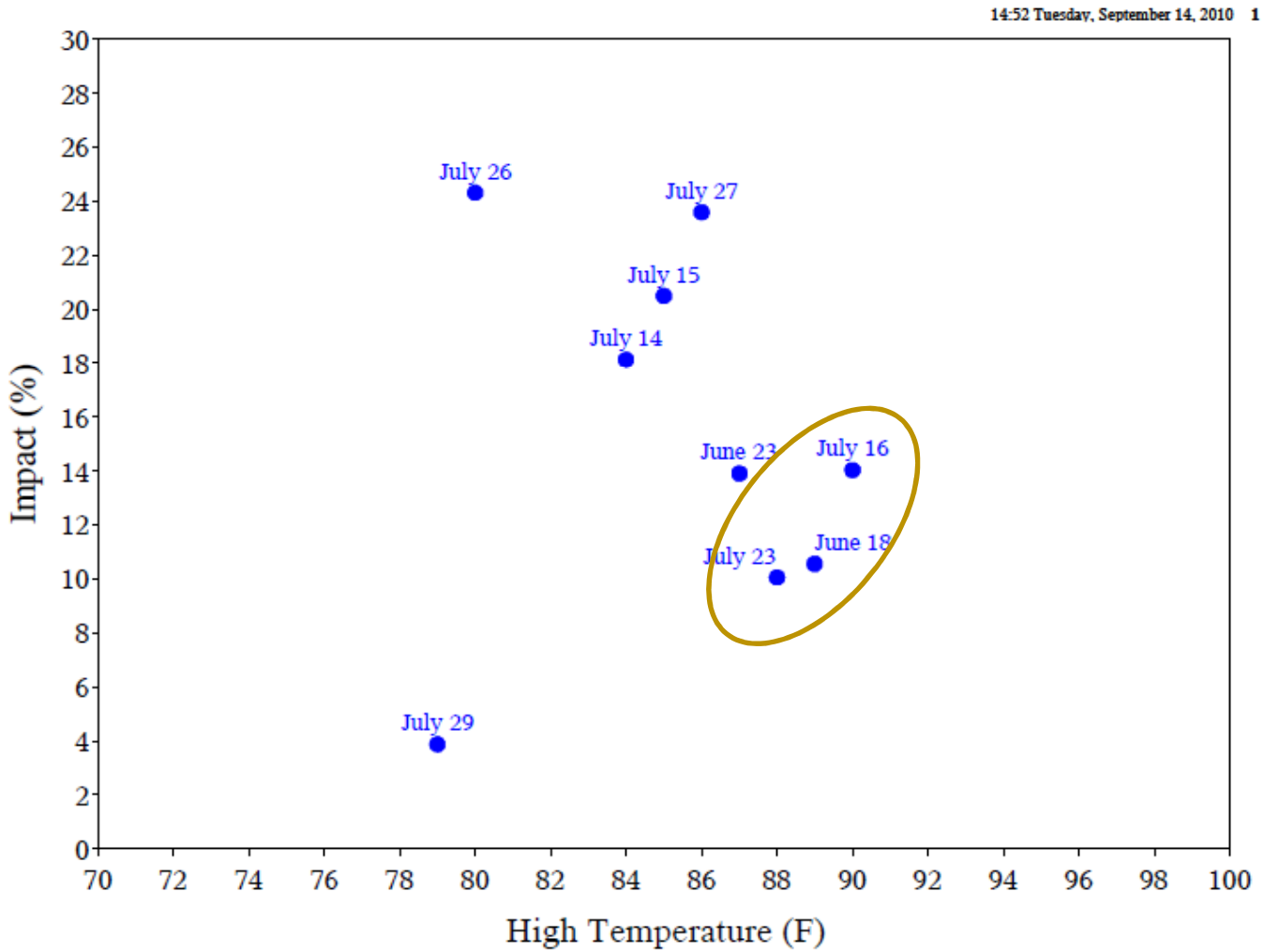
# CPP Preliminary Impacts

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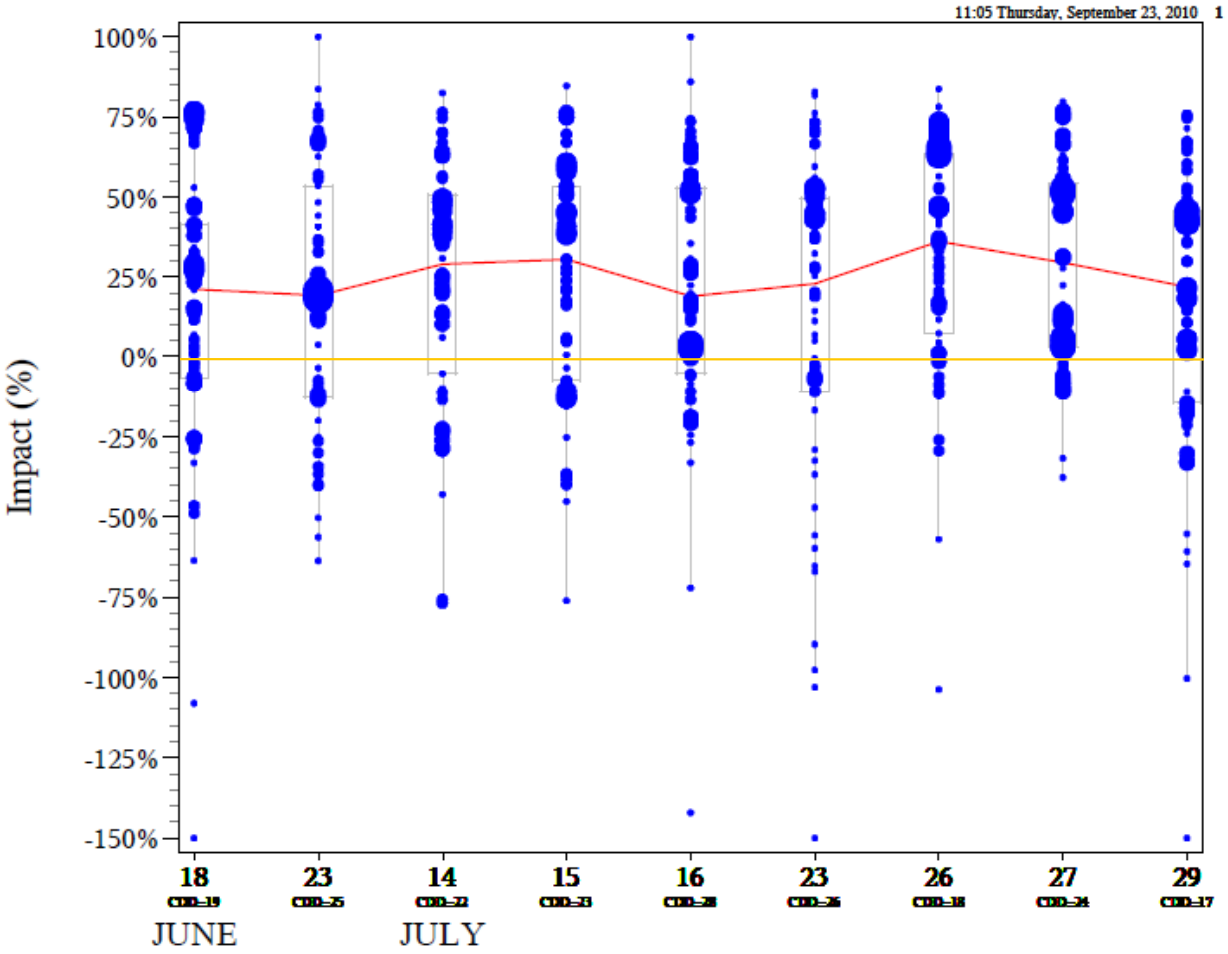
# CPP – Distribution of Impacts by Event

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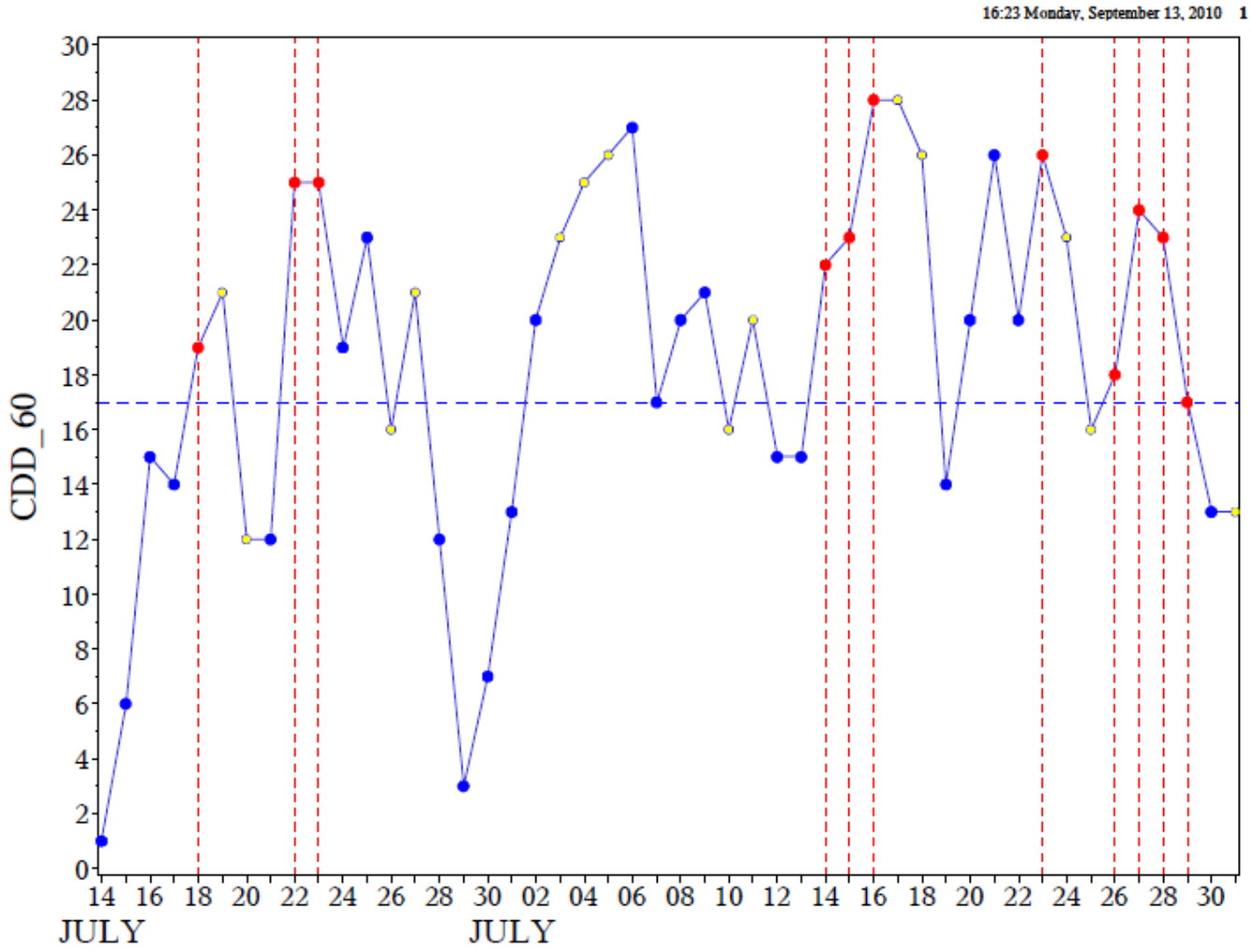
# PTR Event Days

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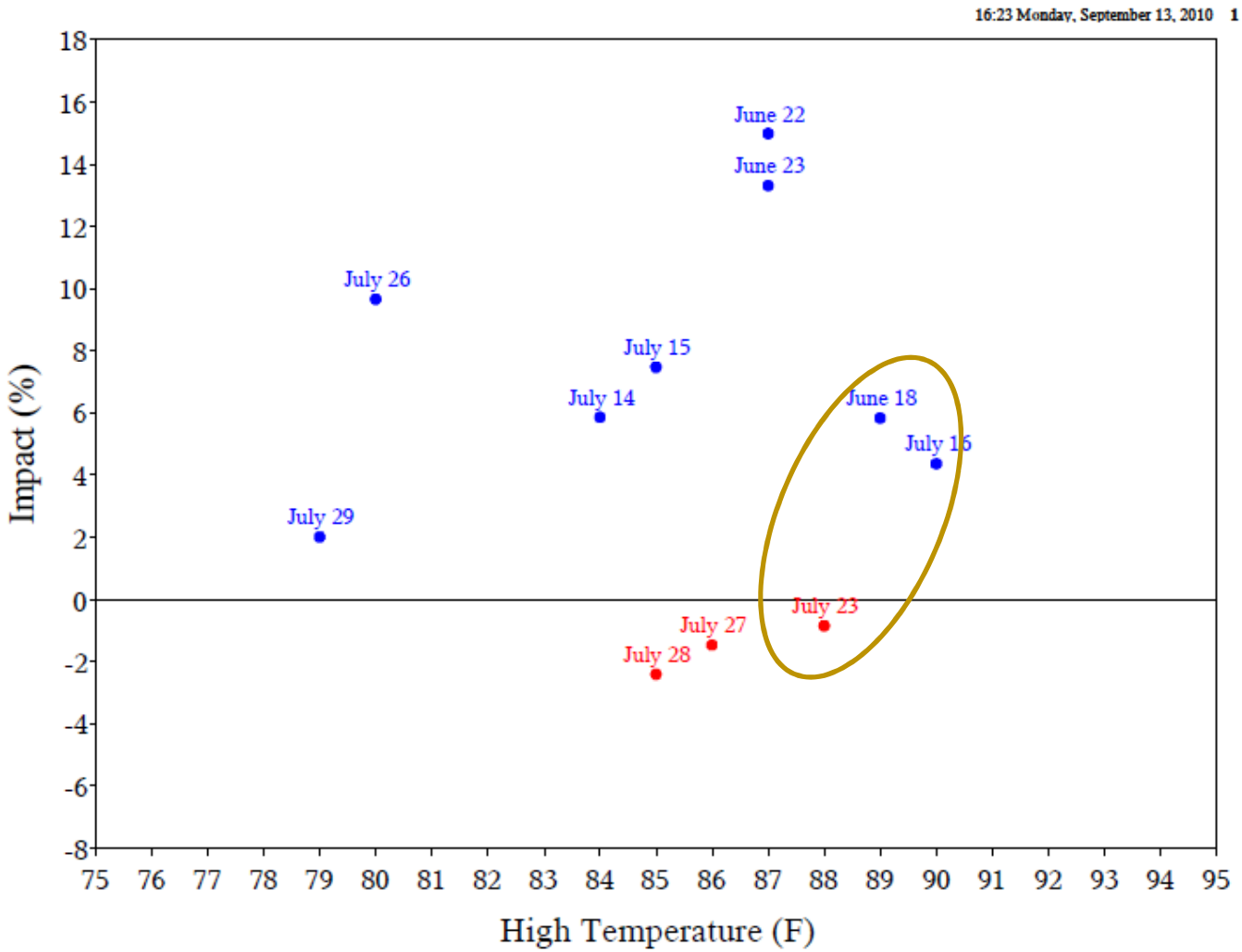
# PTR Preliminary Impacts

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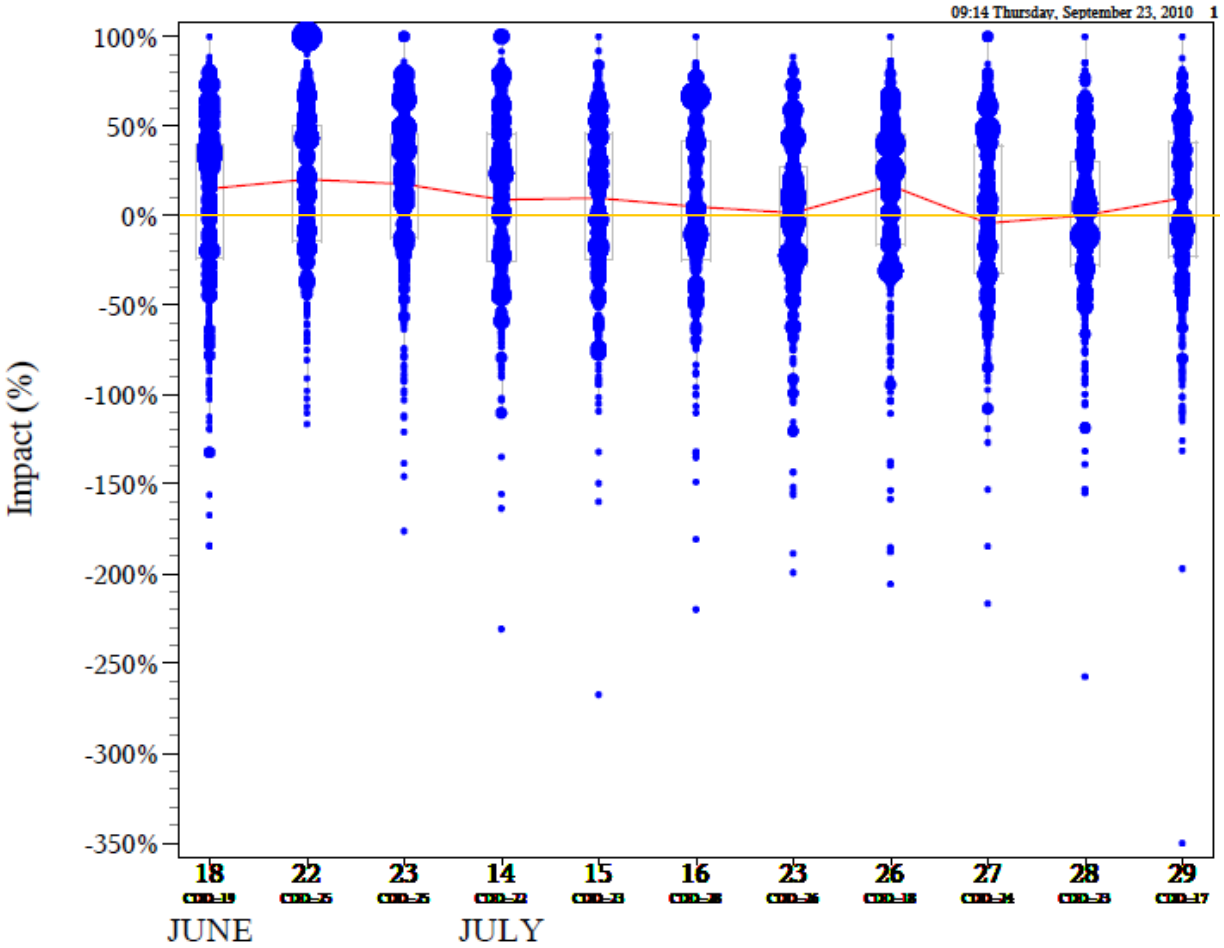
# PTR – Distribution of Impacts by Event

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# Questions?