Business Rules for
M&V for Residential DR in Energy and Capacity Markets

Demand Response
Subcommittee
July 30, 2014
• Issue
  – Current M&V methods for residential customers are based on legacy DLC programs from 20 years ago

• Proposed Solution
  – Interval metered customers: use actual meter data (status quo)
  – Non-interval metered customers: use real-time sample
• Direct load control (DLC) – ability of CSP to directly curtail end use device at end use customer without intervention from end use customer
• Contract – agreement between end use customer and CSP for CSP to perform DLC and offer it as DR in the relevant PJM market
• Enrolled customer – A customer who has a contract with CSP, and for whom CSP has the physical ability to perform DLC
• Registered Customer – An enrolled customer who is registered with PJM
• Sample – customers selected from the registered population of non-interval metered customers who have interval meters installed for the purpose of settling all registered customers
• Population – registered customers
• e.g. A CSP may have 50,000 enrolled customers, but only 45,000 registered customers
• No change in status quo for meter data collection
• Actual hourly meter data for all customer is used
• Not eligible to participate in sampling
Non-Interval Metered Customers

• Real-time sample
  – Random sample of customers with interval meters
  – Hourly data from sample is scaled to population data
  – After data is scaled to population, processes are same as interval metered customers
• Sample design will satisfy 10% precision at 90% confidence

• Interval meters
  – EDC meter level (entire premise/EDC account number) – status quo
  – Meter accuracy – status quo (2%, ANSI compliance, etc.)
Sample size determination
- Less than 10% error at 90% confidence level
- Approximate sample size of 150 (using sample data PJM currently has access to)
- Based on variance study for each sample
- Based on variance of meter data
- PJM may amend requirements for variance study after more experience is gained
Variance Study Requirements

• At least 75 randomly selected participants
• 4 weeks of contiguous hourly meter data
• Data collection during season that end use device is in use/will be curtailed
  – e.g. June – September for ACs
$n = 75 = \text{Number of sampled meters}$

$X_{it} = \text{Meter reading for customer } i \text{ at time } t$

- Calculate the mean and variance across all customers for each minute

$$\text{Mean}(X_t) = \bar{X}_t = \frac{1}{n} \sum_{i=1}^{n} X_{it}$$

$$\text{Var}(X_t) = s_{X_t}^2 = \frac{1}{n} \sum_{i=1}^{n} (X_{it} - \bar{X}_t)^2$$
• Calculate the sample size necessary to get 10% error at 90% confidence for each hourly interval:

\[
M_t = \left( \frac{Z_{\alpha/2}}{e} \right)^2 \frac{s_t^2}{X^{-2}}
\]

Where:

\[Z_{\alpha/2} = 1.645 = \text{critical value at 90% confidence (} \alpha = 0.1)\]

\[e = 0.1 = \% \text{ error}\]
• Sample size required:
  – Average across all one minute intervals to obtain sample size that will have 10% precision at 90% confidence

$$M = \frac{1}{T} \sum_{t=1}^{T} M_t$$

Where:
  $$T = \text{total number of one minute time intervals}$$
• Separate samples
  – EDC
  – End use device/device grouping
    • e.g. AC, water heater, both
  – Curtailment algorithms
    • e.g. 50% cycling, 100% cycling, thermostat set point
  – Different switches with same curtailment algorithm
    • Necessary if switch capability is substantially different
    • e.g. 1985 switches with operability of 60% and 2010 switches with operability of 90% require separate samples. Similar switches with same algorithm from 2010 and 2014 do not need additional sample.
• Sample stratification
  – Control device size in 2 groups roughly at median
    • e.g. median AC size is 3.1 kW, stratification by AC size < 3.1 kW and > 3.1 kW
    • Based on sum of device sizes at EDC account level
  – Geographic Stratification
    • PJM discretion, based on size, variability within region, etc.
    • e.g. AEP wide program would likely require geographic stratification, RECO probably not
  – CSP may propose alternate stratification to reduce variance
  – PJM will adjust stratification requirements as experience is gained to reduce sample size
• **Annual sample calibration**
  – Based on annual sample variance update
  – Proportion of each stratum in the sample must be within +/- 1 sample of population proportion
    • e.g. Sample size = 150 customers
      Population proportion stratum A= 20%
      Stratum A should be 30 customers
      does not need to be recalibrated if 29 – 31 customers
  – Replacements if necessary must be randomly selected, maintain strata integrity, etc.
  – If population is expanded in non-random manner, sample must be expanded appropriately
• 2 way communication
  – Performance factor for each event based on actual population operability
  – Inoperable switch in sample
    • Sample size > requirement: do not report load data from in-operable switch
    • Sample size < requirement: must report load data from switch
  – Can repair faulty switch in sample or population at any time
Switch Operability – 1 way

1 way communication

- Must report data from all switches, even if inoperable
- Cannot repair failed switches until:
  - Repair faulty switches in population
  - OR Reselect entire sample
  - Includes any system/device that would cause end-use device not to reduce load properly in the population

- Metering and metering communication
  - Can be fixed in sample
  - Includes only systems/devices that would not affect load reduction in population
  - Component that is related to both metering and switching cannot be repaired

- Switch failures in sample must be reported to PJM within 2 business days
• NAESB Validating, Editing & Estimating (VEE) Protocol
• Must follow NAESB VEE protocol.
• If 2 intervals or more are missing for 1 meter
  – If still enough meters to satisfy sample size: do not submit data from meter
  – If less than sample requirement - data from that meter must be submitted as PLC value for all intervals
• CSP must submit initial list of customers
  – EDC account number and address

• Replacement
  – Customer who moves from their premises
  – Customer who terminates their own contract with CSP for participation in DLC

• Replacement for IM
  – Economic – any customer
  – Capacity – must be randomly selected

• Replacement for NIM
  – Replacement customer must be randomly selected to maintain integrity of strata
• CSP must maintain a list of all replacements and furnish to PJM within 2 business days of request
  – e.g. PJM requests the list on Tuesday, CSP must submit the list created on Monday of registered customers for Tuesday. CSP must do this by COB Thursday.

• CSP must maintain list of customers for each offer for 2 years from date of offer (economic) or event (capacity)

• Total number of registered customers must be accurate on location in eLRS before an offer is submitted (economic)
• Number of customers offered cannot exceed number of registered customers

• Partial resource offer:
  – Offered customers must be randomly assigned from pool of all registered customers
• CSP must maintain list of:
  – registered customers (daily) – determined day before operating day
  – offered customers (for all eMKT offers) – determined before offer is submitted
  – cycled customers – for all events – determined immediately after cycling is initiated based on actual customers who are cycled
• Data to be furnished to PJM within 2 business days of request
• If data cannot be furnished in timely manner, or number of customers falls below registered/committed value without reporting:
  – CSP may referred to MMU for review
  – Deficiency penalties may be assessed
  – Registered value may be reduced and offered value capped
• M&V Plan
  – Annual
  – Details of variance study
  – Meter qualification
  – Meter quality assurance
  – Data validation, error correction protocol
  – Sample selection and stratification detail
  – PJM to publish template
• PJM will report results 1 year after participation for transparency
• Issue: Residential customers with class average PLCs may not get full credit for load reduction if larger than average

• Actual example (all per participant):

<table>
<thead>
<tr>
<th></th>
<th>PLC (kW)</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class average</td>
<td>1.5</td>
<td>0.4 kW under</td>
</tr>
<tr>
<td>Individual</td>
<td>2.8</td>
<td>0.2 kW over</td>
</tr>
</tbody>
</table>

• Affected EDCs
  – 17 EDCs currently participating in DLC
  – 3 investor owned EDCs use class average
    • Projected to be 1 EDC in 3 years
  – 5 munis/co-ops do not compute PLC or use class average
• Solution: Modified GLD
  – GLD is used for compliance
  – Load reduction not limited by PLC
  – Addback is not limited by PLC
  – Eligible customers
    • Residential
    • no PLC
    • No individual data in PLC
      – Individual = scaled to monthly or hourly data