SUMMARY GUIDE:

Sampling for M&V: Reference Guide

OVERVIEW

Bonneville Power Administration's (BPA) *Sampling for M&V: Reference Guide* can be used with retrofit isolation M&V protocols when the number of affected systems is too large to meter and analyze. Sampling allows use of a valid sample of the systems.

Sampling for M&V:

- Is used along with M&V protocols:
  - Equipment or End-Use Metering Protocol (EUM)
  - Engineering Calculations with Verification Protocol (ECwV)
- Details how to select valid samples
- Uses a sample of equipment measurements
- Requires groups of similar retrofits (e.g., lighting fixtures)
- Is used to reduce M&V expenses
- Reduces accuracy of reported energy savings
- Includes the use of limited statistics
- Emphasizes validating results of sampled measurements

WHEN TO USE

- Projects that include a 'population' of many similar retrofits
  - lighting upgrades, controls upgrades, rooftop unit replacements, motor replacements, industrial equipment
- Projects using either the EUM or ECwV M&V Protocol
- Sufficient samples to represent the entire population are required
- When additional uncertainty in savings estimates is not important

WHEN NOT TO USE

- Projects that include unique equipment
- Equipment with different operating conditions
- Where Meter-Based Energy Modeling M&V Protocol is used
- When project savings need to be very accurate
- Where metering is sufficient to cover all systems retrofit
- There is significant variability in the 'population' of retrofits

PROCEDURE

Collect Data

Step 1: Group data on planned retrofits

- Inventory all retrofits
- Grouped by their load and operating hours (pre and post)

Define Approach

Step 2: Select a sampling strategy

- Simple random samples
  - homogeneous population
- Stratified random samples
  - multiple groups within a population

Step 3: Assign level of variability

- 0 to 1 for each group

Step 4: Define desired accuracy

- Confidence and precision
- 90% confidence at ±10% precision is recommended

Step 5: Randomly select samples

- Include alternates

Use Samples

Step 6: Measure selected samples

- Include alternate samples

Step 7: Validate Results

- Overall precision of results

REPORTING REQUIREMENTS

- Define sampling procedure used
- Details on population and groups:
  - Population sizes
  - Characteristics of each group (e.g., load, performance, hours)
    - Assumed Cv for each group
    - Sample size selected and used
  - Confidence and precision targeted
  - Actual precision achieved
  - Calculation and adjustments made
- Other M&V details required by M&V protocol used

TIPS

- Use stratified sampling with multiple groups
- Group members of the population with identical characteristics together
  - Ensure groups are homogeneous
  - Exclude unique items and measure separately
  - Characteristics measured using samples must be uniform
- Characteristics include performance and usage metrics (e.g., power, operating hours)
- A large range of values results in a high Cv
- Assume a Cv or 0.5 for most groups
- Samples usually comprise <10% population
- Meter extra samples
- Define a method to field identify alternate samples

TOOLS

Generated random samples (0 to 1) in Excel:

- RAND()

EXAMPLES OF RANDOM SAMPLING

BPA's *Sampling for M&V: Reference Guide* includes three examples of how to apply each type of sampling strategy: simple random sampling, stratified random sampling, and the less common sampling for binomial applications.

APPLICATION 1
Replace multiple similar motors

Method:
Simple Random Sample

Reference:
Sampling pg. 17

APPLICATION 2
Replace multiple HVAC units

Method:
Stratified Random Sample

Reference:
Sampling pg. 18

APPLICATION 3
Identify level of failed lighting fixtures

Method
Bionomial Distribution

Reference:
Sampling pg. 20

BPA RESOURCES

BPA Measurement and Verification Resource Library

Verification by Equipment or End-Use Metering Protocol

Engineering Calculations with Verification Protocol