OVERVIEW

Bonneville Power Adminstration's (BPA) *Verification by Equipment or End-Use Metering Protocol* (EUM) is used for measures that impact isolated equipment or systems and uses monitored energy use and/or other parameters in the baseline and post-installation scenarios. Savings are determined from defined equations based on loads and hours of use in the baseline and post-installation scenarios.

End-Use Metering:

- Energy use characteristics of load and hours of use are defined for baseline and post-installation scenarios
- System or equipment-level parameters are monitored
- Measured energy and operational data are used
- Can use code defined or existing baseline conditions
- Requires field verification and true up of baseline conditions
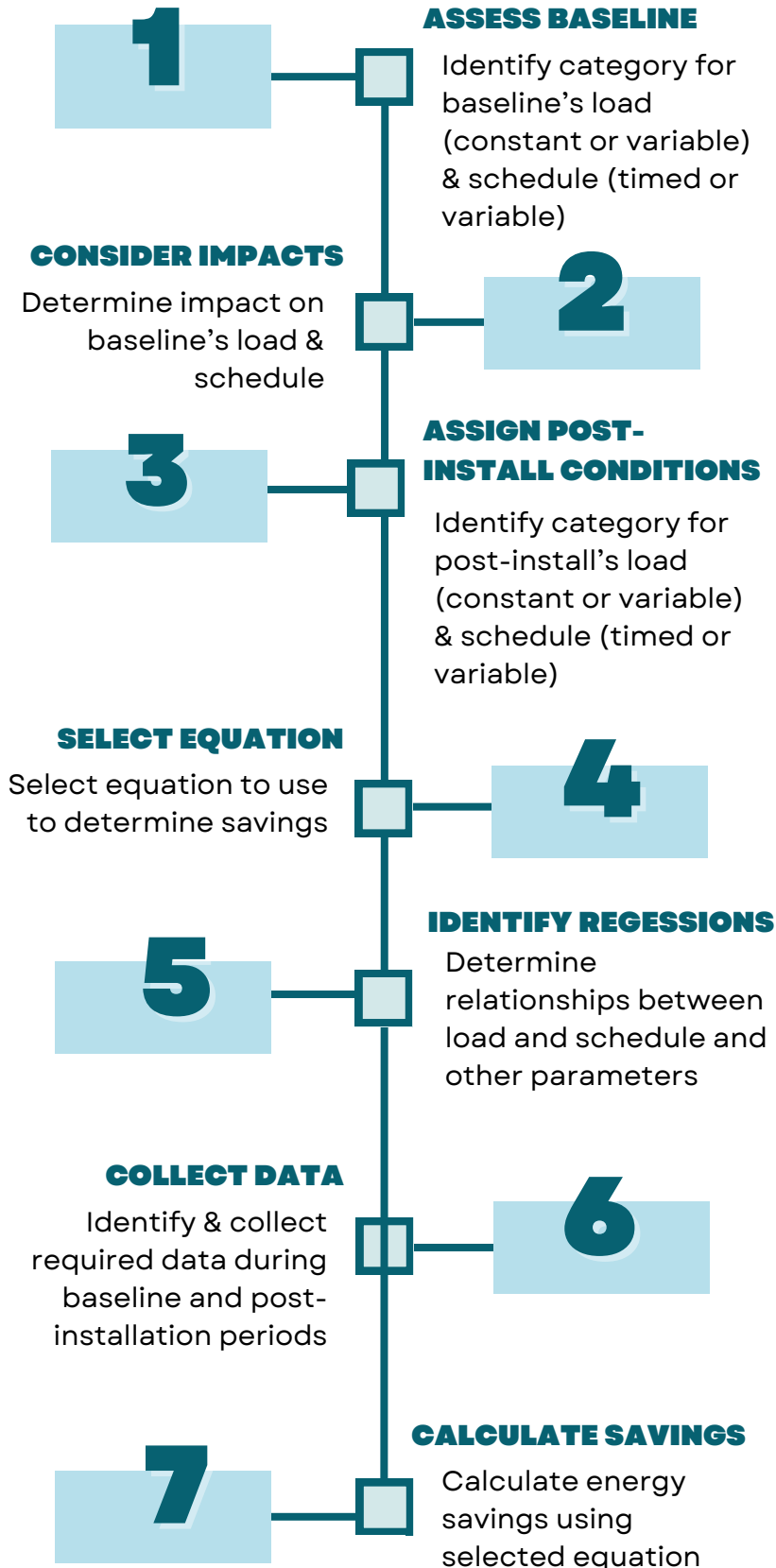- Allows for a range of accuracy depending on data used

WHEN TO USE

- Measures that impact stand alone equipment or systems (e.g., fans, pumps, motors, lighting, chillers, and boilers)
- Equipment and system operations can be monitored
- Retrofit or replacement of existing equipment
- Can apply to end of life or early replacement projects
- Where equipment or system loads and schedules can be monitored or determined from other data

WHEN NOT TO USE

- Measures involving multiple pieces of equipment with complex interactions
- Projects with significant interactive effects
- Where equipment or system level measurements are not feasible
- Metering period(s) are too short to reflect full range of operations
- Projects with random loads or schedules

PROCEDURE

1

ASSESS BASELINE
Identify category for baseline's load (constant or variable) & schedule (timed or variable)

2

CONSIDER IMPACTS
Determine impact on baseline's load & schedule

3

ASSIGN POST-INSTALL CONDITIONS
Identify category for post-install's load (constant or variable) & schedule (timed or variable)

4

SELECT EQUATION
Select equation to use to determine savings

5

IDENTIFY REGESSIONS
Determine relationships between load and schedule and other parameters

6

COLLECT DATA
Identify & collect required data during baseline and post-installation periods

7

CALCULATE SAVINGS
Calculate energy savings using selected equation

REPORTING REQUIREMENTS

- Data for the baseline and reporting periods
- Load and schedule for baseline and reporting periods
  - include sources of data along with necessary data correlations and proxies applied
- The savings equation used
- Operational verification results

TIPS

- Use measured energy and operational data to establish loads and hours of use
- Use the 'Absent Baseline' approach when a code compliant or standard practice baseline is required
- Level of rigor can vary based on the measurements included
- Measure power (kW) when possible and can be done safely
- Develop equations from measurements to characterize variable loads
- Equipment specifications may be used with operating data to determine loads
- Use 'bins' to group data (e.g., hours at a range of temperatures)
- Loads and hours of use from post-installation period can apply to the baseline if unchanged

TOOLS & RESOURCES

- ASHRAE Guideline 14-2014 Annex E for Retrofit Isolation Approach Techniques
- State building energy codes (OR, WA)

APPLICATION SPECIFIC CONSIDERATIONS

Within the EUM Protocol there are two calculation approaches considered: end-use metering and end-use metering absent baseline. Each approach has some specific requirements and considerations summarized below.

	END-USE METERING APPROACH	END-USE METERING ABSENT BASELINE APPROACH
Overview	Savings are determined from monitored data (energy use and operational parameters) in baseline and post-installation periods on isolated equipment or end-use.	Savings are determined from monitored post-installation data (energy use and operational parameters) from isolated equipment or end-use. Post-installation data and code-specified parameters are used to determine baseline energy use.
Approach	Energy use characteristics of the equipment are broken down into load and hours of use components, and whether these components are constant or variable in baseline and in post-installation periods.	
Analysis	Measured load and operating data from the baseline and post-installation are analyzed. Regression analysis can be used to extrapolate measured data to a full year.	Measured load and operating data from the post-installation are used with code requirements to determine baseline loads and hours of use. Regression analysis can be used to extrapolate measured data to a full year.
Use Cases	• Early replacement of equipment in existing buildings • Monitoring equipment exists or temporary loggers can be added	• End of life equipment replacements in existing buildings • Targeted efficiency improvements of equipment or systems in new buildings or major renovations to existing building
Savings	Measured load (kW) and hours of use data are used in defined equations to determine energy savings.	Measured load (kW) and hours of use from the post-installation period and estimated baseline kW and hours of use based on code are used in defined savings equations.

EXAMPLES OF END-USE METERING

The EUM Protocol includes seven examples of how the protocol is applied to different types of energy savings projects. Six of these examples are highlighted below.
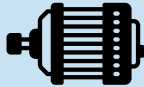
Example 8.1
Scope:
Motor upgrade in existing building
Approach:
EUM - measured kW
Reference: EUM pg. 39

Example 9.1
Scope:
New construction lighting improvements
Approach:
EUM Absent baseline
Reference: EUM pg. 57

Example 8.2
Scope:
New on/off controls for fans
Approach:
EUM - measured kW, hours
Reference:
EUM pg. 42
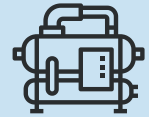
Example 9.2
Scope:
Replacement of failed chiller
Approach:
EUM Absent baseline
Reference:
EUM pg. 58

Example 8.4
Scope:
Constant flow to variable volume
Approach:
EUM - measured kW, flow rate
Reference:
EUM pg. 51

Example 9.3
Scope:
New construction high efficiency motor
Approach:
EUM Absent baseline
Reference: EUM pg. 60

BPA RESOURCES

BPA Measurement and Verification Resource Library

Equipment or End-Use Metering Protocol

M&V Protocol Selection Guide and Example M&V Plan

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