



THE
CADMUS
GROUP, INC.

EM&V Uniform Methods Project (UMP)- HVAC (Single-Packaged and Split System Unitary AC)

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Agenda

- Overview of Measure Covered
- Who Reviewed Protocol
- Who Wrote Protocols
- Overview of Protocol
- Major Points Requiring Reconciliation
- Key Assumptions
- Comparison to Industry Practices
- Questions/Comments

Measures Covered by Protocol

- Normal/Time of Replacement/New Construction Single-Packaged and Split System Unitary Air Conditioning(3–50 ton range)
- Various delivery mechanisms
 - Standard Rebate (majority)
 - Upstream markdown/buydown

Who Wrote Protocol??

- David Jacobson, Jacobson Energy Research
 - Former Manager of Evaluation for National Grid
 - Mechanical Engineer with 30 years experience in EE analysis and evaluation
 - Involved with EM&V of this measure for 15 years
 - Key input from Jared Metoyer of KEMA, Project Manager of NEEP study employing methods recommended in Protocol; Justin Spencer/Navigant supplied alternative approach; and Pete Jacobs(TAC member)

Who Reviewed Protocol??

- TAC Members:
 - Kevin Cooney, Justin Spencer-Navigant
 - Eric Kozubal, Tau Kung - NREL
 - Pete Jacobs - Building Metrics
 - Joe Danes/Dick Spellman - GDS
 - Sami Khawaja - Cadmus
- SC Members
 - Steve Schiller
 - Amy Royden Bloom
 - Bill Newbold
- Others
 - Jared Metoyer - KEMA

Overview of Protocol

Using Prevailing TRM Equation-

$$\text{kWh Saved} = (\text{Size kBtu/hr}) \times (1/\text{eff}_{\text{baseline}} - 1/\text{eff}_{\text{installed}}) \times (\text{EFLH})$$

where eff = EER, SEER or IEER

- EER = peak efficiency at full load; SEER/IEER = seasonal efficiency, IEER just becoming available- not used yet by MOST programs
- Use of manufacturers AHRI ratings data for size and efficiency

Overview of Protocol(con't)

- Meter/Measure Equivalent Full Load Hours(ELFH) using power as proxy for cooling load:

$$\text{ELFH} = \text{Annual kWh} / \text{peak kW}$$
$$\text{peak kW} = \text{Peak Cooling in Btu/hr} / \text{EER}$$

- Annual kWh based on regression: kW vs day of week, outdoor conditions(THI) and variables accounting for the number of hot days in a row

Major Points for Reconciliation

- Methods needs to work for prevailing TRM equations listed above even though many agree the equations are gross simplifications
- Measure is a core part of most EE portfolios but total savings as a percent of portfolio is generally small except for warmest climates
 - total savings limits EM&V budget available for impact evaluation, thus complexity/sophistication of methods
- Efficiency metrics changing to from EER/SEER to IEER but data collection/requirements lag

Major Points for Reconciliation(con't)

- Interaction with other related measures- demand controlled ventilation, sizing initiatives, EC motors, dual enthalpy economizers
- Measurement of cooling load is prohibitively expensive
- Simulation vs field measurements

Fundamental Assumptions-

- Some Measurement of a Large Random Sample of Building Types and Usage Patterns by Climate Zone and Size is Better Than Building Simulation
- kW/ton, EER, SEER, IEER rating data not always accurate reflection of actual performance but delta of those quantities between standard and known high efficiency is reasonable measure of savings
- Though ELFH developed using EER, method provides reasonable results using SEER and IEER in equation too

How Protocol Compares to Existing Industry Practices

- Protocol based on recent best practice study:
 - “Regional EM&V Methods and Savings Assumption Guidelines, Northeast Energy Efficiency Partnerships (NEEP) EM&V Forum, May 2010”
- and actual large scale metering study for Northeast:
 - KEMA. (August 2011). “C&I Unitary HVAC Load Shape Project.” Prepared for the Regional Evaluation, Measurement and Verification Forum facilitated by the Northeast Energy Efficiency Partnerships (NEEP)
- Optional more sophisticated method follows Navigant’s work in hot/dry climates

Questions/Comments?