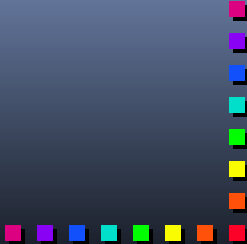


Overview of California Evaluator's Protocols

Presented at the Summer 2006 CEE
Meeting

by
Lori Megdal, Ph.D.
Megdal & Associates

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Associates*



Large Team, Much Assistance & Many Acknowledgements

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Pete Jacobs, BuildingMetrics, Inc.	Rick Ridge, Ph.D., Ridge & Associates
Ken Keating, Ph.D., Consultant	Francis Trottier, Francis Trottier Consulting
Steve Kromer, RCx Services	Ed Vine, Ph.D., Consultant

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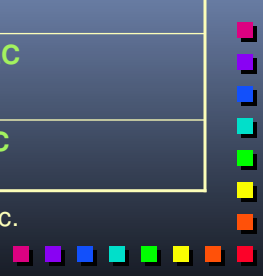


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Tim Drew, CPUC	Peter Lai, CPUC
Nora Gatchalian, CPUC	Nancy Jenkins, CEC
George Tagnipes, CPUC	Sylvia Bender, CEC

AND many reviews & useful comments by IOUs and public.

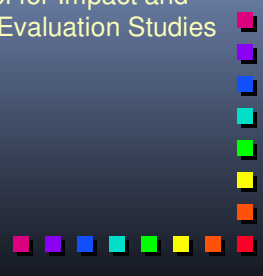
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“How to” Protocols Separate from Process Protocols

“How to” Protocols <ul style="list-style-type: none">■ Overall “how to”■ Impact Evaluation■ Measurement & Verification (M&V)■ Emerging Technologies■ Codes and Standards and Compliance Enhancement■ Effective Useful Life Evaluation (Degradation and Retention)■ Process Evaluation■ Market Effects Evaluation■ Evaluation Reporting	Process Protocols <ul style="list-style-type: none">■ Public Process Protocol for Impact Evaluation Scoping■ Performance Basis Protocol■ Study Review Protocol■ Review Protocol for Impact and Market Effects Evaluation Studies
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Focus Here is on “How to” Protocols

- TecMarket Works Team drafted & revised “How to” Protocols
- Joint Staff developed Process Protocols without consultant assistance
- “How to” Protocols adopted April 21, 2006 – entitled: *California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals* – a.k.a. Evaluator’s Protocols

<http://www.cpuc.ca.gov/static/energy/electric/energy+efficiency/rulemaking/eeevaluation.htm>

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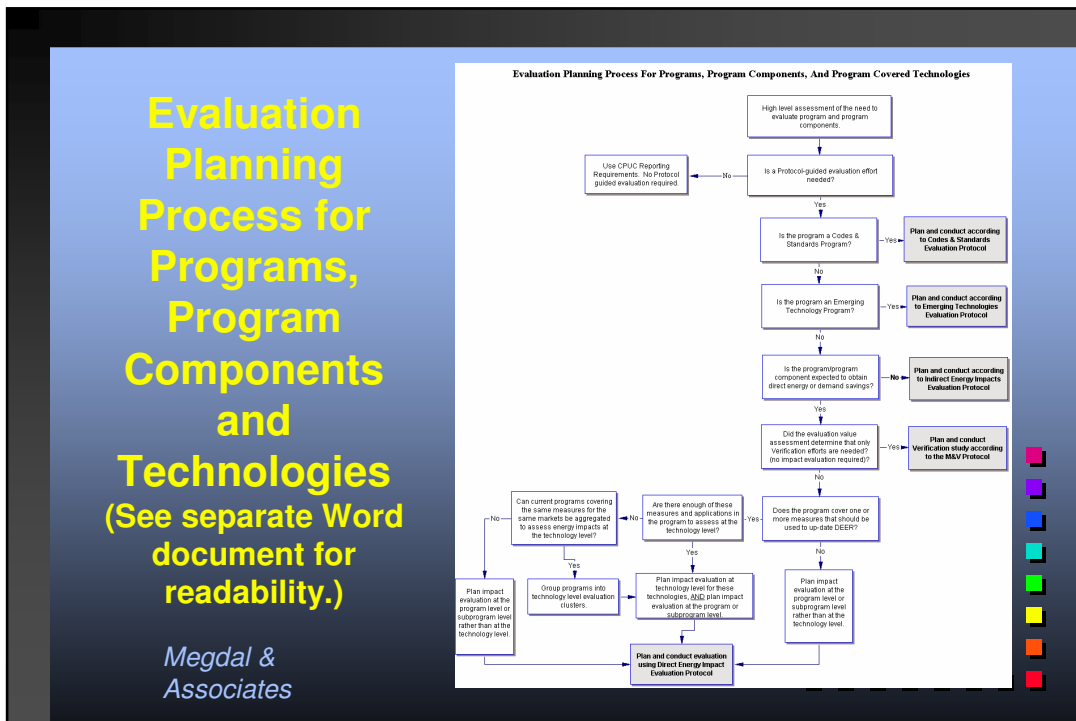
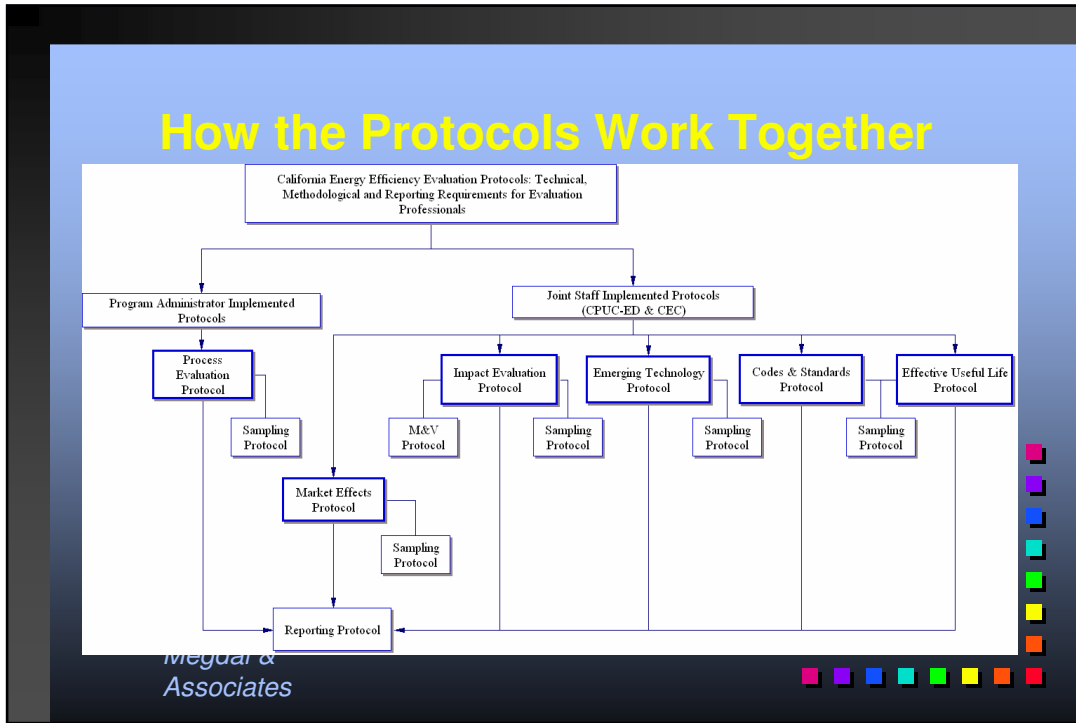


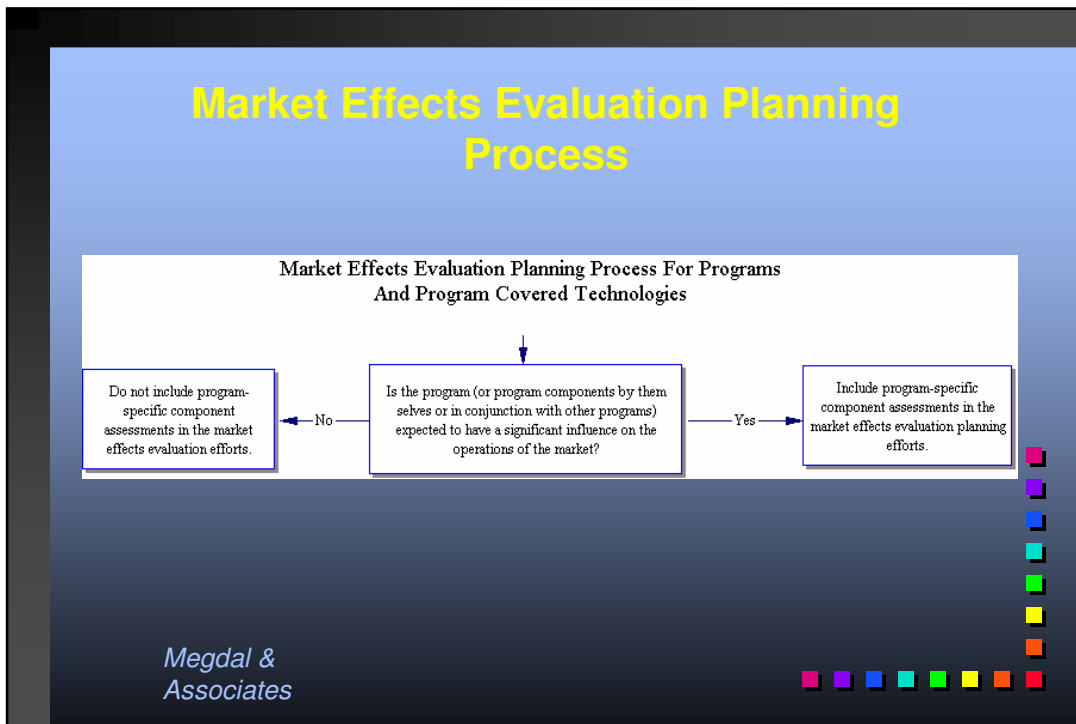
Evaluator’s Protocols

- 211 pages plus Appendices (including Glossary) = 276 pages
- Overall + Individual Protocol + Reporting can be viewed as set for direction on any one type of evaluation.
- BUT there are primary and supporting Protocols.

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- ## Detailed Evaluation Plan Required
- Specified info on Cover page
 - TOC
 - High level program theory
 - Evaluation goals & researchable issues (RI)
 - How evaluation addresses RI, evaluation priorities and rigor level requirements
 - Reliability assessment, threats to validity & how these will be mitigated/addressed
 - Task descriptions
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Detailed Evaluation Plan Required #2

- Description of analysis activities & approaches
 - Energy programs → kW, kWh & therm each year over EUL
 - Info & ed programs: Approach to est. actions/behaviors changes that lead to energy/demand savings
 - Process or operational assessment: Approach to measure potential changes to improve cost-effectiveness and/or participant satisfaction
- Description of M&V for Impact Evaluations
 - IPMVP option
 - Specific description of IPMVP option approach
 - Specify any deviations from IPMVP, if any
- Description of sampling rationale, methods and required sample sizes
- Specific Performance Basis Metrics that will be included

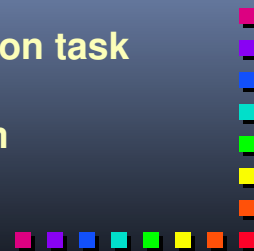
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Detailed Evaluation Plan Required #3

- Definition of the terms “participant” and “non-participant” in evaluation study to be conducted
- Specific data requirements from IOUs
- Evaluation activity timeline & deliverables for entire program cycle
- Program, evaluation and evaluation task budget
- Full contact info for lead program administrator & evaluator

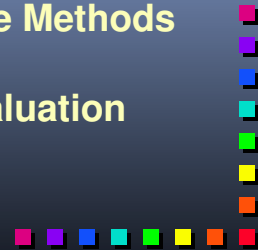
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General Components for Most "How To" Protocols

- Introduction
- Audience & Responsible Actors
- Protocol Types
- Rigor
- Key Metrics, Inputs and Outputs
- Protocols for Minimum Allowable Methods
- Guidance on Skills Required
- Summary of Protocol-Driven Evaluation Activities

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Use of Rigor Assignments & Levels of Rigor

- Rigor = Level of expected reliability
- Higher rigor = More confident results are accurate and precise.
- Sampling precision ≠ Accuracy (see Evaluation Framework)
- Rigor level set so minimum standard is reached that includes both precision & accuracy

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Many Advances in These Protocols to Better Recognize & Balance Precision versus Accuracy

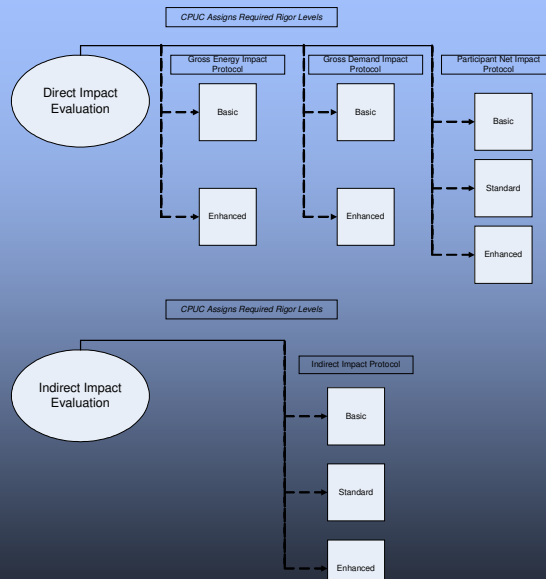
- Explicit recognition of two & potential trade-offs
- Explicit incorporation in Evaluation Plan and include mitigation methods and handling of potential bias w/i Evaluation Plan and activities (and budget)
- Required written assessment in evaluation reporting
- Required assessment of implications of potential issues

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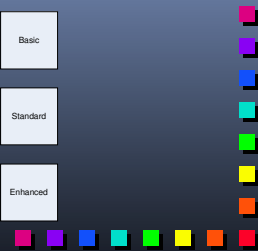


Impact Evaluation Protocol

Sub-protocols & Rigor Levels



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Summary of Gross Energy Impact Protocol

Rigor Level	Minimum Allowable Methods for Gross Energy Evaluation
Basic	<ol style="list-style-type: none"> 1. Simple Engineering Model (SEM) with M&V equal to IPMVP Option A . Meet M&V and Sampling req. 2. Normalized Annual Consumption (NAC) with Pre/Post, 12 and 12, normalized for weather and Sampling req.
Enhanced	<ol style="list-style-type: none"> 1. Regression analysis with inclusion/adjustment for changes and background variables over the time period of analysis that could potentially be correlated with the gross energy savings being measured. 12/12. Sampling – Power analysis. 2. Building energy simulation models that are calibrated as described in IPMVP Option D or Process model – M&V and Sampling req. 3. Retrofit Isolation engineering models as described in IPMVP Option B. M&V and Sampling req. 4. Experimental design established within the program implementation process, designed to obtain reliable net energy savings based upon differences between energy consumption between treatment and non-treatment groups from consumption data. Sampling req.

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Summary of Gross Demand Impact Protocol

Rigor Level	Minimum Allowable Methods for Gross Demand Evaluation
Basic	<p>Reliance upon secondary data for estimating demand impacts as a function of energy savings. End-use savings load shapes or end-use load shapes from one of the following will be used to estimate demand impacts:</p> <ol style="list-style-type: none"> 1. End-use savings load shapes, end-use load shapes or allocation factors from simulations conducted for DEER 2. Allocation factors from CEC forecasting models or utility forecasting models with approval through the evaluation plan review process 3. Allocation based on end-use savings load shapes or end-use load shapes from other studies for related programs/similar markets with approval through the evaluation plan review process
Enhanced	<p>Primary demand impact data must be collected during the peak hour during the peak month for each utility system peak. Estimation of demand impact estimates based on these data is required. If interval or time-of-use consumption data are available for participants through utility bills, these data can be used for regression analysis, accounting for weather, day type and other pertinent change variables, to determine demand impact estimates. Pre- and post-retrofit billing periods must contain peak periods.</p> <p>Spot or continuous metering/measurement of peak pre and post-retrofit during the peak hour of the peak month for the utility system peak to be used with full measurement Option B or calibrated engineering model Option D meeting all requirements as provided in the M&V Protocol. Pre-retrofit data must be adjusted for weather and other pertinent change variables.</p> <p>Experimental design w/ differences between energy consumption during peak demand periods between treatment and non-treatment groups from consumption data or spot or continuous metering.</p> <p>Sampling req. by program report by CEC's climate zone.</p>

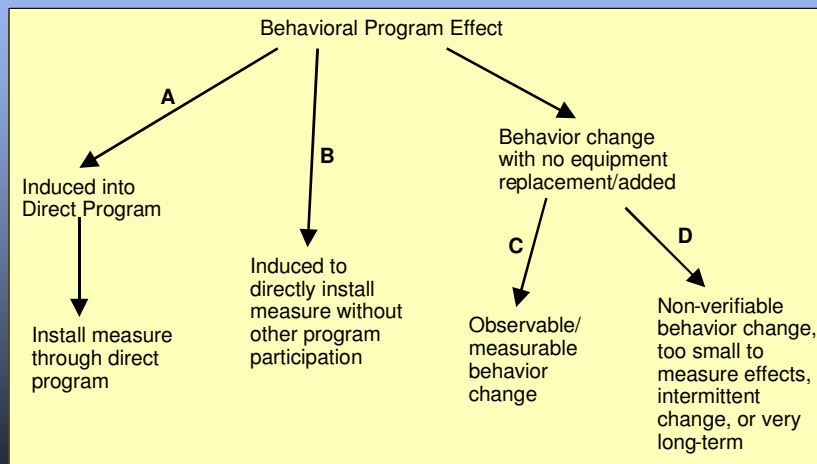
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Summary of Participant Net Impact Protocol

Rigor Level	Minimum Allowable Methods for Participant Net Impact Evaluation
Basic	1. Participant self-report.
Standard	1. Participant and non-participant analysis of utility consumption data that addresses the issue of self-selection. 2. Enhanced self-report method using other data sources relevant to the decision to install/adopt. These could include, for example, record/business policy and paper review, examination of other similar decisions, interviews with multiple actors at end-user, interviews with mid-stream and upstream market actors, Title 24 review of typically built buildings by builders and/or stocking practices. 3. Econometric or discrete choice with participant and non-participant comparison addressing the issue of self-selection.
Enhanced	1. "Triangulation" using more than one of the methods in the Standard Rigor Level. This must include analysis and justification for the method for deriving the triangulation estimate from the estimates obtained.

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Potential Behavioral Impacts

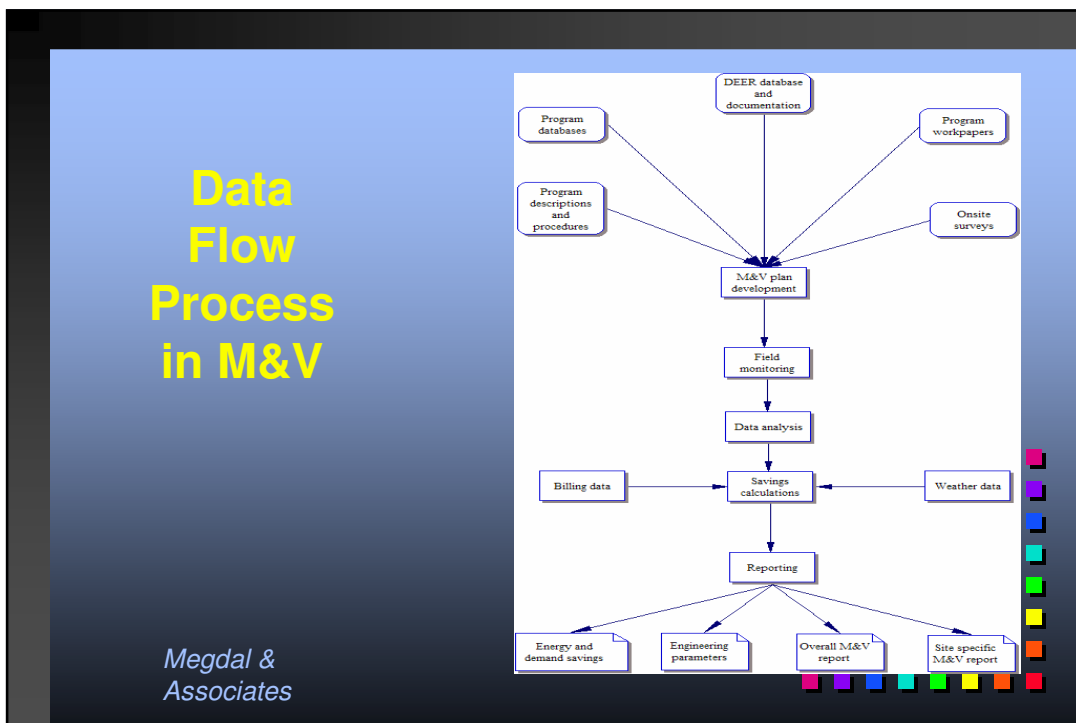


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Summary of Indirect Impact Protocol

Rigor Level	Minimum Allowable Methods for Indirect Impact Evaluation
Basic	An evaluation to estimate the program's net changes on the behavior of the participants is required; the impact of the program on participant behavior.
Standard	A two-stage analysis is required that will produce energy and demand savings. The first stage is to conduct an evaluation to estimate the program's net changes on the behavior of the participants/targeted-customers. The second is to link the behaviors identified to estimates of energy and demand savings based upon prior studies (as approved through the evaluation planning or evaluation review process).
Enhanced	A three-stage analysis is required that will produce energy and demand savings. The first stage is to conduct an evaluation to estimate the program's net impact on the behavior changes of the participants. The second stage is to link the behavioral changes to estimates of energy and demand savings based upon prior studies (as approved through the evaluation planning or evaluation review process). The third stage is to conduct field observation/testing to <i>verify</i> that the occurrence of the level of net behavioral changes.

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Summary of M&V Protocol

1. Specifications for site-specific M&V Plan

Provision	Basic Rigor Requirement
Verification	Physical inspection of installation to verify correct measure installation and installation quality
IPMVP Option	Option A (Some program types must follow Enhanced rigor req.)
Source of Stipulated Data	DEER assumptions, program work papers, engineering references, manufacturers catalog data, on-site survey data
Baseline Definition	Consistent with program baseline definition. May include federal or Title 20 appliance standards effective at date of equipment manufacture, Title 24 building standards in effect at time of building permit; existing equipment conditions or common replacement or design practices as defined by the program
Monitoring Strategy and Duration	Spot or short-term measurements depending on measure type
Weather Adjustments	Weather dependent measures: normalize to long-term average weather data as directed by the Impact Evaluation Protocol
Calibration Criteria	Not applicable
Additional Provisions	None

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Summary of M&V Protocol #2

Provision	Requirements for Enhanced Rigor Level
Verification	Physical inspection of installation to verify correct measure installation and installation quality. Review of commissioning reports or functional performance testing to verify correct operation
IPMVP Option	Option B or Option D
Source of Stipulated Data	DEER assumptions, program work papers, engineering references, manufacturers catalog data, on-site survey data
Baseline Definition	Consistent with program baseline definition. May include federal or Title 20 appliance standards effective at date of equipment manufacture, Title 24 building standards in effect at time of building permit; existing equipment conditions or common replacement or design practices as defined by the program
Monitoring Duration	Sufficient to capture all operational modes and seasons
Weather Adjustments	Weather dependent measures: normalize to long-term average weather data as directed by the Impact Evaluation Protocol
Calibration Criteria	Option D building energy simulation models calibrated to monthly billing or interval demand data. Optional calibration to end-use metered data
Additional Provisions	Hourly building energy simulation program compliant with ASHRAE Standard 140-2001

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Summary of M&V Protocol #3

Table 7. Model Calibration Targets

Data Interval	Maximum Root Mean Square (RMS) Error	Maximum Mean Bias Error
Monthly	± 15%	± 5%
Hourly	± 30%	± 10%

Table 8. Programs Compliant with ASHRAE Standard 140-2001 (Partial List)

Program	Sector(s)
Micropas	Residential
DOE-2	Residential and Commercial
EnergyPlus	Residential and Commercial

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Summary of Emerging Technologies

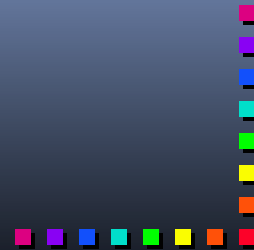
- 2 types of failure– techn. Perf. & utility selection
- Provided sample of ETP Evaluation Methods
- Required verification of basic achievements
- Program theory and logic model
- Aggregate level of analysis
- Implementation analysis
- Analysis of key performance indicators
- Peer review

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Summary of Codes and Standards and Compliance Enhancement Evaluation Protocols

- Technology-Specific Code and Standard Change Theory
- Identify evaluation-covered C&S
- Gross Market Level Energy Impact Assessment
- Estimate program's influence level
- Estimate net induced
- Estimate naturally-occurring market adoption
- Code non-compliance adjustment
- Normally occurring standards adoption
- Actual construction & retrofit true-up
- Multiple counting adjustment
- Measure life adjustment
- Utility service territory estimate
- Similar code compliance enhancement steps

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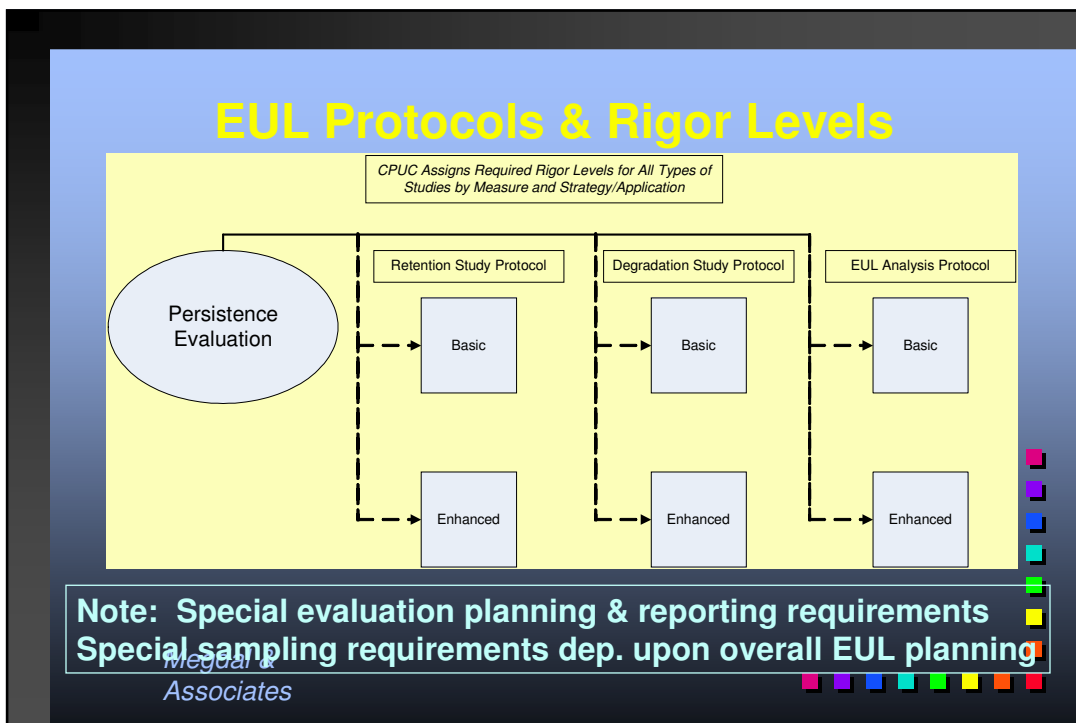
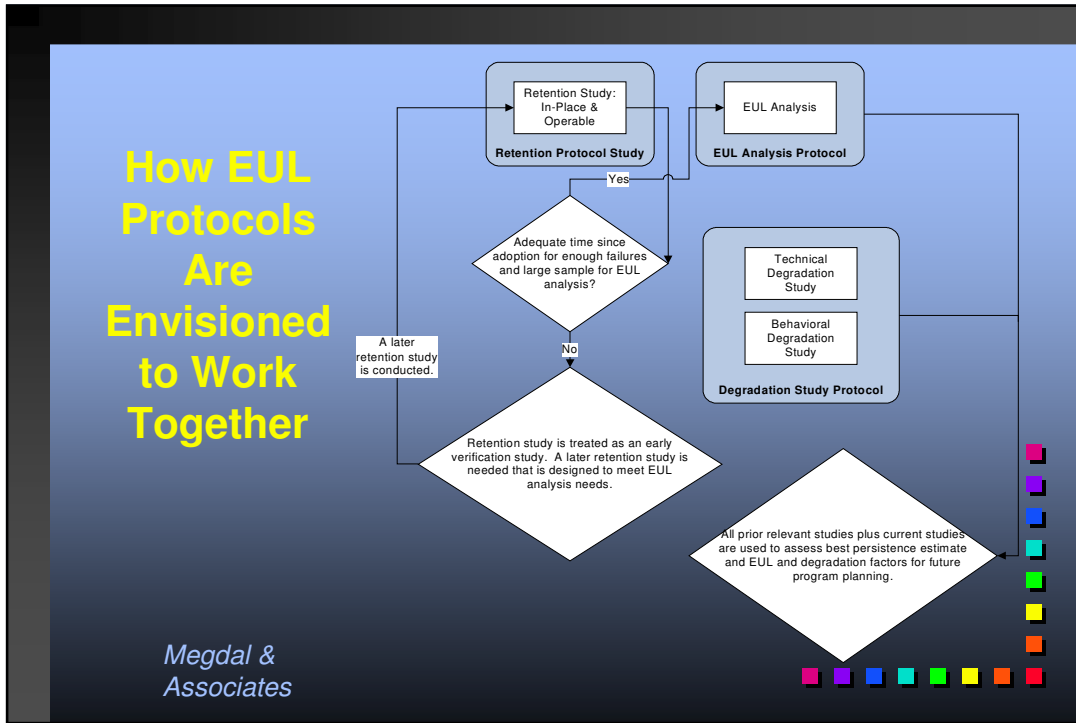


Definitions for Effective Useful Life (Degradation and Retention) Evaluation Protocol

- Persistence study measures net impacts of program-adopted measures over time.
- Retention = % of measures retained in place and are operable.
- EUL = Median # of years retained (in place and operable).
- Performance degradation includes:
 1. Technical operational charac. & cond.
 2. Human interaction comp. & behavioral

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Summary of Retention Study Protocol

Rigor Level	Retention Evaluation Allowable Methods
Basic	<ol style="list-style-type: none"> 1. In-place and operable status assessment based upon on-site inspections. Sampling must meet the Basic Rigor Level requirements discussed in this Protocol and must meet the requirements of the Sampling and Uncertainty Protocol. Special sampling req. issues 2. Non-site methods (such as telephone surveys/interviews, analysis of consumption data, or use of other data, e.g. from EMS systems) may be proposed but must be explicitly approved by Joint Staff through the evaluation planning process. Special sampling req. issues
Enhanced	<ol style="list-style-type: none"> 1. In-place and operable status assessment based upon on-site inspections. Sampling must meet the Enhanced Rigor Level requirements discussed in this Protocol and must meet Special sampling req. issues

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Summary of Degradation Study Protocol

Rigor Level	Allowable Methods for Degradation Studies
Basic	<ol style="list-style-type: none"> 1. Literature review required for technical degradation studies across a range of engineering-based literature, to include but not limited to manufacturer's studies, ASHRAE studies, and laboratory studies. Review of technology assessments. Assessments using simple engineering models for technology components and which examine key input variables and uncertainty factors affecting technical degradation. 2. Telephone surveys/interviews with a research design that meets accepted social science behavioral research expectations for behavioral degradation.
Enhanced	<ol style="list-style-type: none"> 1. For technical degradation: field measurement testing. 2. For behavioral degradation: field observations and measurement.

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Summary of EUL Analysis Protocol

Rigor Level	Allowable Methods for EUL Analysis Studies
Basic	<p>1. Classic survival analysis or other analysis methods that specifically control for right-censored data must be attempted. For methods not accounting for right-censored data, the functional form of the model used to estimate EUL ("model functional form") must be justified and theoretically supported. Sample size requirements determined through the use of power analysis, results from prior studies on similar programs, and professional judgment. Power analysis used to determine the required sample size must be calculated by setting power to at least at 0.7 to determine the sample size required at a 90% confidence level (alpha set at 0.10). Where other analyses or combined functional forms are used, power analysis should be set at these parameters to determine required sample sizes for regression-based approaches and a 90% confidence level with <u>30% precision</u> is to be used for non-regression components.</p>
Enhanced	<p>1. As above with: Power analysis used will set power to at least to 0.8 to determine the sample size required at a 90% confidence level (alpha set at 0.10). Other analyses as above and a 90% confidence level with <u>10% precision</u> is to be used for non-regression components.</p>

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- ## Summary of Process Evaluation Protocol
- Annual process evaluation planning meeting
 - Recommendations for changes
 - Key issues & information covered
 - Program-specific process evaluation plans
 - Data collection & assessment
 - Conducting investigatory efforts
 - Independence
 - Selection of contractors
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Market Effects Evaluation Protocol

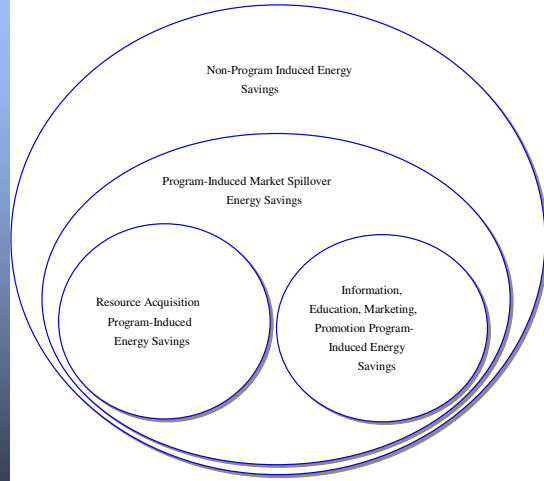


Figure 11. Sources of Energy Efficiency Changes in the Market

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Summary of Market Effects Evaluation Protocol #1

Level of Rigor	Scoping Study Requirements
Basic	Define the market by its location, the utilities involved, the equipment, behaviors, sector and the program years of interest. Develop market theory. Identify available secondary data and potential sources for primary data. Outline data collection and analysis approaches
Enhanced	Define the market by its location, the utilities involved, the equipment, behaviors, sector and the program years of interest. Develop market theory and logic model. Detail indicators. Identify available secondary data and primary data that can be used to track changes in indicators. Outline data collection approach. Recommend hypotheses to test in the market effects study. Recommend the analysis approach most likely to be effective.

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Summary of Market Effects Evaluation Protocol #2

Level of Rigor	Market Theory and Logic Model Requirements
Basic	Identification of assumptions about anticipated changes in the market and associated research questions. Market theory should include market operations and conditions, external influences, and assumptions about changes in the market (which could include market operational theory, market structure and function studies, and product and communication flows). Program theory and logic model specific to program, use interviews to generate, programmatic influences vs. other.
Enhanced	As above plus develop graphical model of market theory. Develop multiple program theory and logic models for those programs intervening in the market. Integrate the market theory and program theory/logic models to examine external and programmatic influences, assumptions about changes in the market and associated research questions. PT/LM through workshops & interviews. Use a literature review and other studies of these markets and iteration with program staff to ensure thoroughness in measuring the critical parameters for both market development from external influences and market effects.

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Summary of Market Effects Evaluation Protocol #3

Level of Rigor	Indicator Study Requirements
Basic	Select appropriate market actor group for each indicator, survey representative samples of market actors able to report on each indicator from market experience. A baseline study must be conducted as early as possible. On-going tracking provides the basis for comparisons.
Enhanced	Select appropriate market actor group for each indicator. Conduct longitudinal study of representative samples of market actors able to report on each indicator from market experience. Samples weighted to represent known parameters in the population of interest. A baseline study must be conducted as early as possible, on-going tracking provides the basis for comparisons.

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Summary of Market Effects Evaluation Protocol #4

Level of Rigor	Preponderance of Evidence Approach Requirements for Causality Assessment
Basic	A representative sample of market actors surveyed or interviewed to provide self-reports on perceived changes in the market, attribution and the sustainability of those changes.
Enhanced	Quasi-experimental or experimental design with comparison groups using a representative sample of market actors surveyed or interviewed to provide self-reports on perceived changes in the market, attribution and the sustainability of those changes.

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- ### Summary of Market Effects Evaluation Protocol #5
- Net market effects modeling for causality
 - Assessing/estimating sustainability
 - Considerations for conducting market effects evaluation
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Summary of Sampling and Uncertainty Protocol

- Provides summary tables for sampling requirements by Protocol/sub-protocol
- Requirements for statistical reporting to support system learning
- Sample size and precision
- Validity and research design
- Requirements of issues/methods to address accuracy within:
 - Regression analysis
 - Engineering-based methods

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Summary of Evaluation Reporting Protocol

- Common evaluation reporting requirements (format, minimum content, timing)
- Requirements for each specific type of evaluation
- Required reporting tables for impact evaluations results

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What is Provided in the Appendices

- Appendix A: Measure Level M&V Results Reporting Requirements
- Appendix B: Glossary of Terms (pages 217-245)
- Appendix C: Performance Basis Metrics
- Appendix D: A Primer for Using Power Analysis for Determining Sample Size
- Appendix E: Summary Table for All Protocols

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Questions



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