Energy Technologies Area Lawrence Berkeley National Laboratory

Demand Side Efficiency EM&V and the Clean Power Plan

Presentation #1: Basics of EE, EM&V and the CPP

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Introduction

LBNL is supported by the U.S. Department of Energy to conduct non-classified research, operated by the University of California

- Provides technical assistance to states—primarily state energy offices and utility regulatory commissions
- Assistance is independent and unbiased

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Topics

- This Webinar
  - Basics of EE and EE EM&V
  - High level overview of how EE fits into CPP pathways
  - EE, EM&V and CPP Resources
- Next Webinar—December 15th
  - EM&V in CPP mass and rate plans, and the CEIP
  - Discussion of EM&V topics in CPP documents out for review
  - More detail on selected topics selected from today's webinar?

Energy Efficiency Basics

What is Efficiency?

- **Energy Conservation**: Doing with less of a service in order to save energy:
  - *Using less energy and probably getting less output/service quality*
  - *Example: Turning up the thermostat to get less cooling*
- **Energy Efficiency**: The use of less energy to provide the same or an improved level of output or service to the energy consumer in an economically efficient way:
  - *Using less energy to perform the same function*
  - *Example: A more efficient air conditioner*
- Turning street lights off versus installing efficient street light lamps and controls

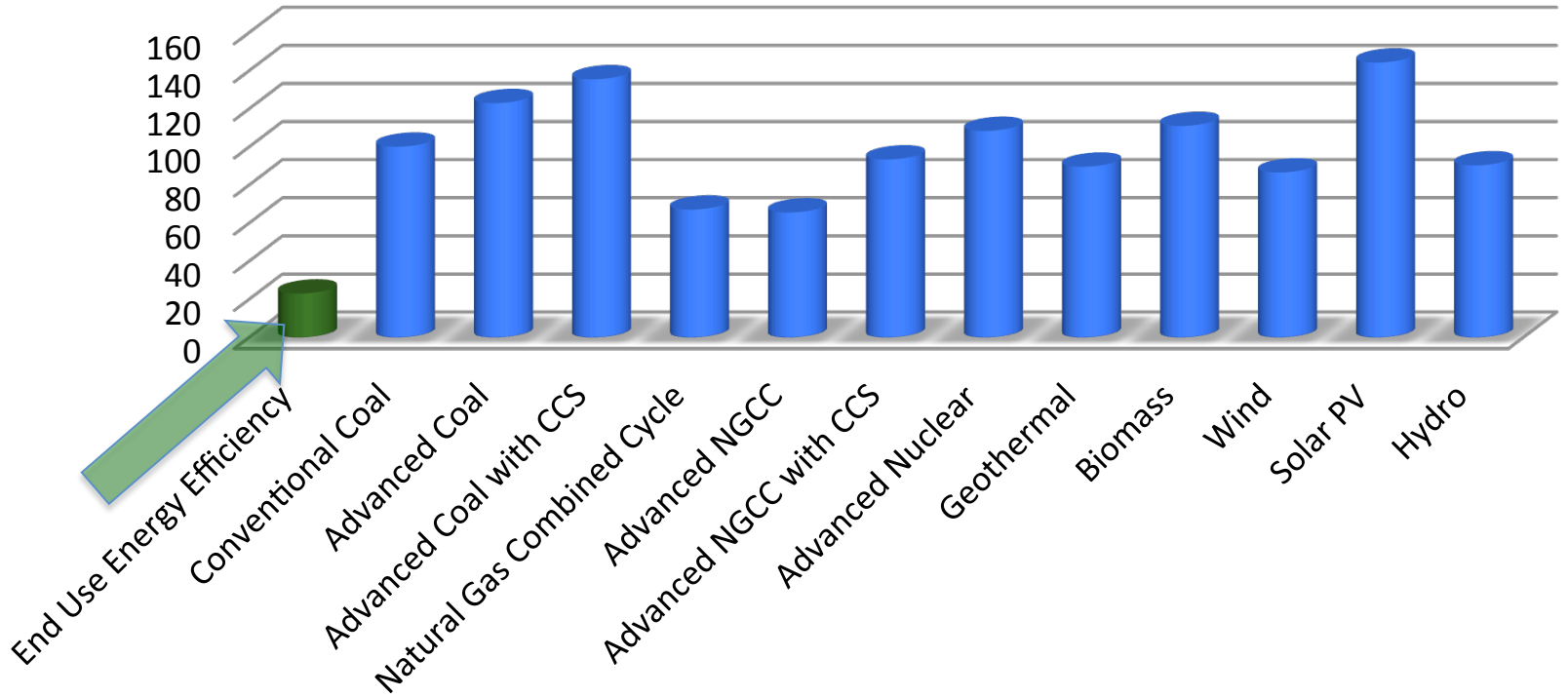
Why is Efficiency Important?

- Cost savings
- Reliability improvement
- Environmental impact mitigation

Why Efficiency: Its Relatively Cheap

Levelized Cost of New Electricity Resources in $/MWh

From a Utility Investment Perspective



Why Efficiency: Increases Reliability

- Less demand = less generation, transmission and distribution required and less fuel
- Can be targeted, modular, and quickly implemented
- Capacity & electricity reliability benefits, and supports renewable integration

- Bottom line—if your boat sank, would you rather swim 1 mile or ½ mile to shore

Why Energy Efficiency: Multi-Pollutant Reductions

- Demand-side efficiency reduces emissions by avoiding the need to generate electricity in the first place
- Efficiency is included as a top measure to meet the reduction goals of state GHG mitigation plans
  - Of the approximately 30 state-level climate change action plans that have been completed since 2000, efficiency programs were in the "top 10" GHG reduction measures and in many cases were among the top five measures
- Of course *all* types of power plant-related emissions are reduced

Health and Welfare Impacts of Air Pollutants and Energy Efficiency Reduction Potential

Pollutant	Climate Forcer	Acidifying Substance	Eutrophying Substance	Ozone Precursor	Particulate Matter or Precursor	Can Be Reduced Through Energy Efficiency
Ammonia (NH_3)		X	X		X	X
Carbon Dioxide (CO_2)	X	X				X
Carbon Monoxide (CO)	X			X		X
Heavy Metals (HM)					X	X
Methane (CH_4)	X			X		X
Nitrogen Oxides (NO_x)	X	X	X	X	X	X
Non-Methane Volatile Organic Compounds (NMVOC)	X			X	X	X
Primary Particulate Matter (PM)	X				X	X
Polycyclic Aromatic Hydrocarbons (PAH)					X	X
Sulfur Dioxide (SO_2)	X	X			X	X

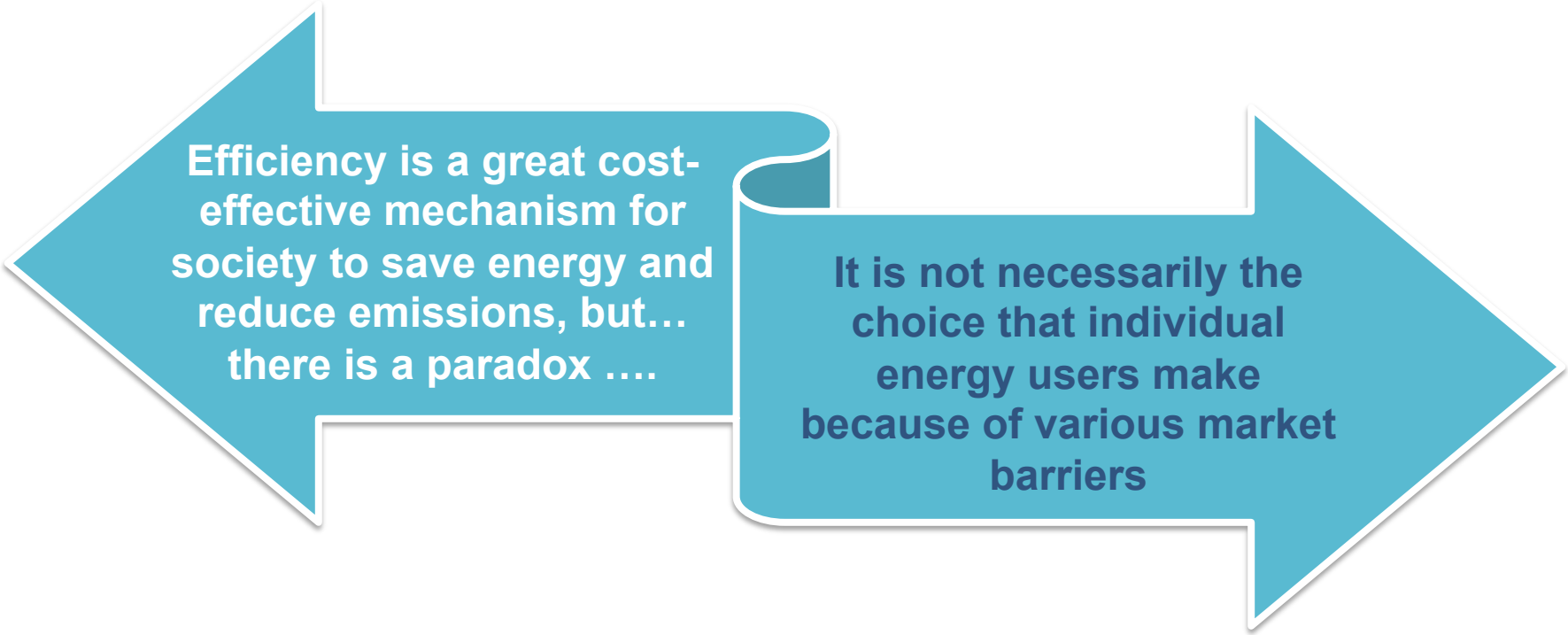
Table Source: SEE Action Guide for States: Energy Efficiency as a Least-Cost Strategy to Reduce Greenhouse Gas Emissions and Meet Energy Needs in the Power Sector (forthcoming)

So What Is The Problem?

Challenges to Energy Efficiency

Or – How many people does it take to screw in a LED?

Efficiency's Version of the Tragedy of the Commons



Thus, intervention is required to meet full potential of efficiency

Challenges and Opportunities

Challenges

- Front-end investment requirements
- Principal agent problem (property owner/tenant)
- Lack of information
- Transaction costs
- Lack of knowledgeable contractors, suppliers, etc.
- Uncertainty in documenting benefits

Opportunities

- Utility programs
- Codes and Standards
- Performance contracting
- Distribution efficiency
- Etc.
- Etc.

Efficiency is an Established Resource

- Efficiency programs have been in place in the U.S. for several decades, and every state has programs in place
- Many utilities include demand-side efficiency in the resource plans they develop to guide investment decisions and operational plans
- Nevertheless, there is significant (and 'renewing') untapped efficiency potential

There are a lot of options for new construction and retrofit efficiency savings

Broad Categories of Efficiency Program
"Utility" programs
Codes and standards
Performance contracting
Distribution system improvements
Water conservation/ energy efficiency combination projects
Financing programs
Low income/at-risk/ disadvantaged community programs

Strategies		
Funding	**Lead Entity**	**Time Frame**
▪ Utility customers ▪ Public/General funds ▪ Cap and Trade Auction Funds ▪ Consumers ▪ Industry	• Local and state agencies • Federal Entities • Utilities • Non-profits • Industry collaboratives	• Short Term – Quick Start • Medium term • Long Term
Market Segments/ Sectors	**Objectives**	**Implementation Strategies**

• Market Segments
  • Upstream
  • Mid-stream
  • Down stream
• Market Sectors
  • Commercial
  • Residential and Multi-Family
  • Low Income
  • Agricultural
	• Market transformation
	• Resource Acquisition
	• Pilots
	• Infrastructure development
		• Voluntary
		  • Direct Install
		  • Incentives
		  • Financing
		• Mandatory
		  • Codes
		  • Standards

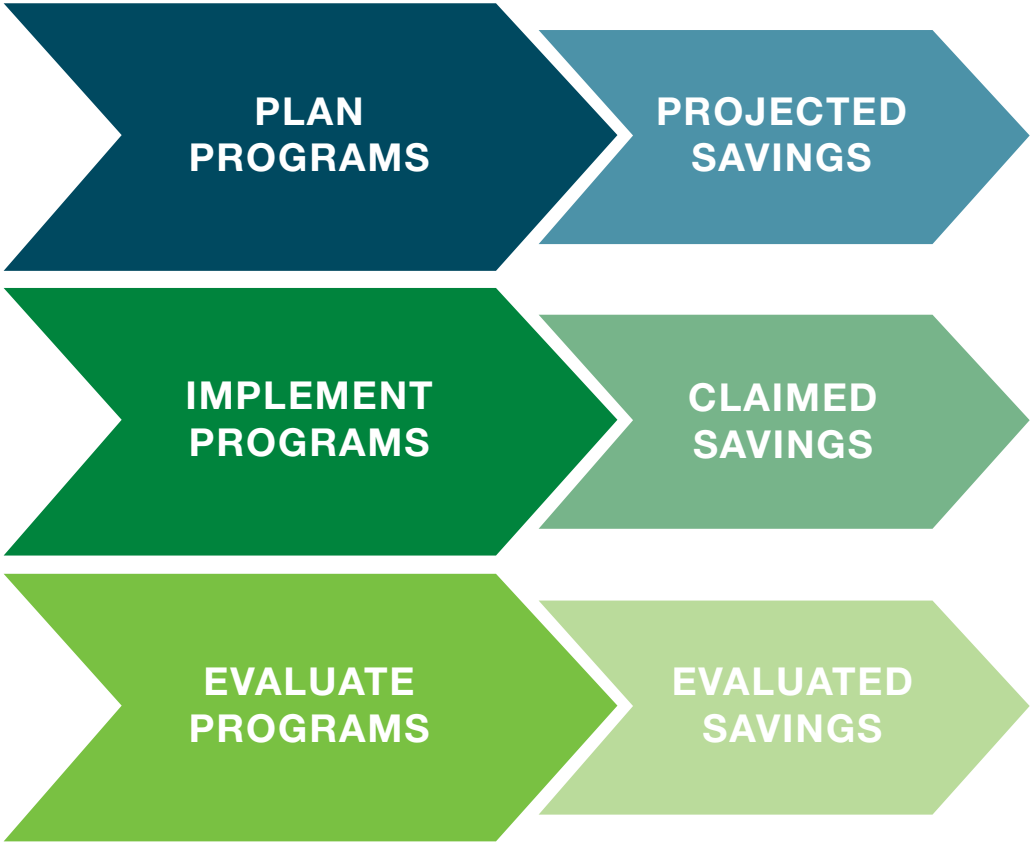
High level sense of efficiency's potential

It depends on so many factors, but:

- **Codes and Standards**
  - Savings from Codes and Standards have each grown from essentially zero to about 1% of national electricity sales in 2012 and growing
- **Utility efficiency programs**
  - Grown from very small impacts in the 1980s to about 0.5% annual decreases in electricity consumption nationally
  - Based on current state policies, savings from these programs could reach 0.8% to 1.1% per year of national electricity sales by 2025
- **Using broad generalization—efficiency can probably save, cost-effectively, at least 1% to 2% (some say 3%) of electricity sales each year**
- **For comparison,** EIA's 2012 reference case projects that U.S. electric retail sales will grow by 0.58% annually through 2025

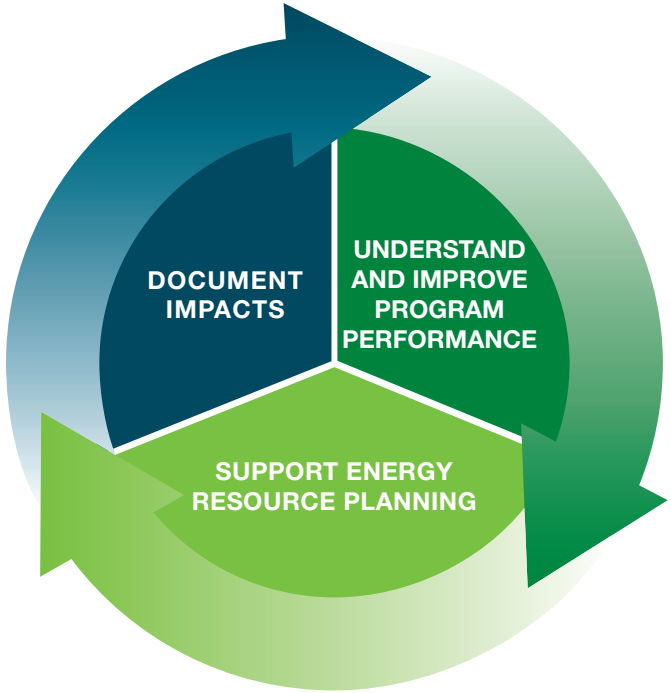
EM&V Basics

Planning, Implementing, and Evaluating Efficiency Programs



Why Evaluate?

- **Document impacts**: Document the energy savings of projects and programs in order to determine how well they have met their goals; e.g., has there been a good use of the invested money and time? Provide PROOF of the effectiveness of energy management.
- **Resource Planning:** To support energy resource planning by understanding the historical and future resource contributions of energy efficiency as compared to other energy resources. Provide data to support efficiency as a reliable resource.
- **Understand why the effects occurred:** Identify ways to improve current and future projects and programs as well as select future projects. "You can't manage what you don't measure" and "Things that are measured tend to improve".



EVALUATION SUPPORTS SUCCESSFUL EFFICIENCY PROGRAMS

Evaluation Types – Real Time or Ex-Post

Evaluation Type	Description	Example Uses
Impact Evaluation	Quantifies direct and indirect changes associated with the subject program(s).	Determines the amount of energy and demand saved.
Process Evaluation	Indicates how the procedures associated with program design and implementation are performing from both the administrator's and the participants' perspectives.	Identifies how program designs and processes can be improved.
Market Effects Evaluation	Analyzes how the overall supply chain and market for energy efficiency products have been affected by the program. Market baselines and Potential Studies.	Characterizes changes that have occurred in efficiency markets and whether they are attributable to and sustainable with or without the program.
Cost-Effectiveness Evaluation	Quantifies the costs of program implementation and compares them with program benefits.	Determines whether an energy efficiency program is a cost-effective investment compared with other programs and energy supply resources.

FOCUS OF THIS PRESENTATION IS IMPACT EVALUATION – BUT THE FOLLOWING FEW SLIDES INTRODUCE THE OTHER STUDY TYPES

Process Evaluations

- Recommend ways to improve a program's efficacy and effectiveness
- Frequency:
  - For a new program
  - Whenever there are major changes in the program
  - Or after 2-3 years

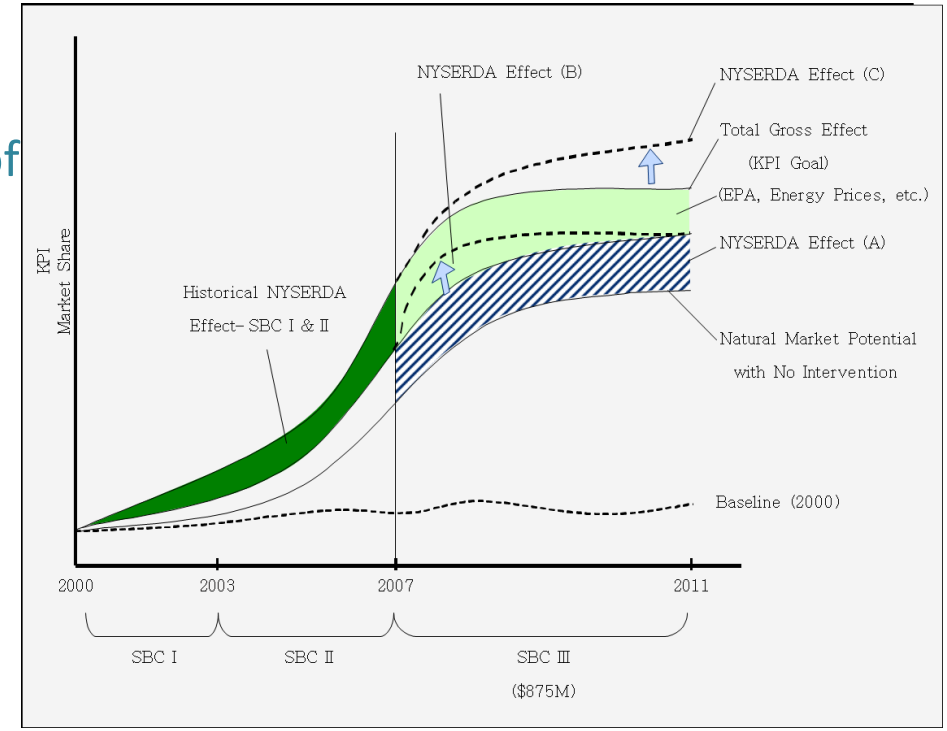
Process evaluations are particularly valuable when:

- The program is new or has many changes
- Benefits are being achieved more slowly than expected
- There is limited program participation or stakeholders are slow to begin participating
- The program has a slow startup
- Participants are reporting problems
- The program appears not to be cost-effective

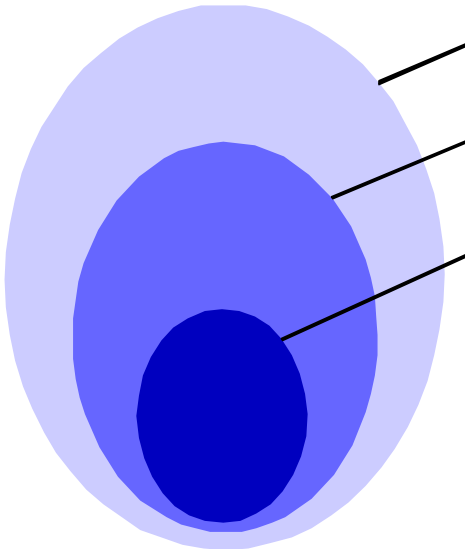
Market Studies

- **Market Baseline -** studies look at the broader market for EE products and services and establishes existing levels of efficiency—done before program

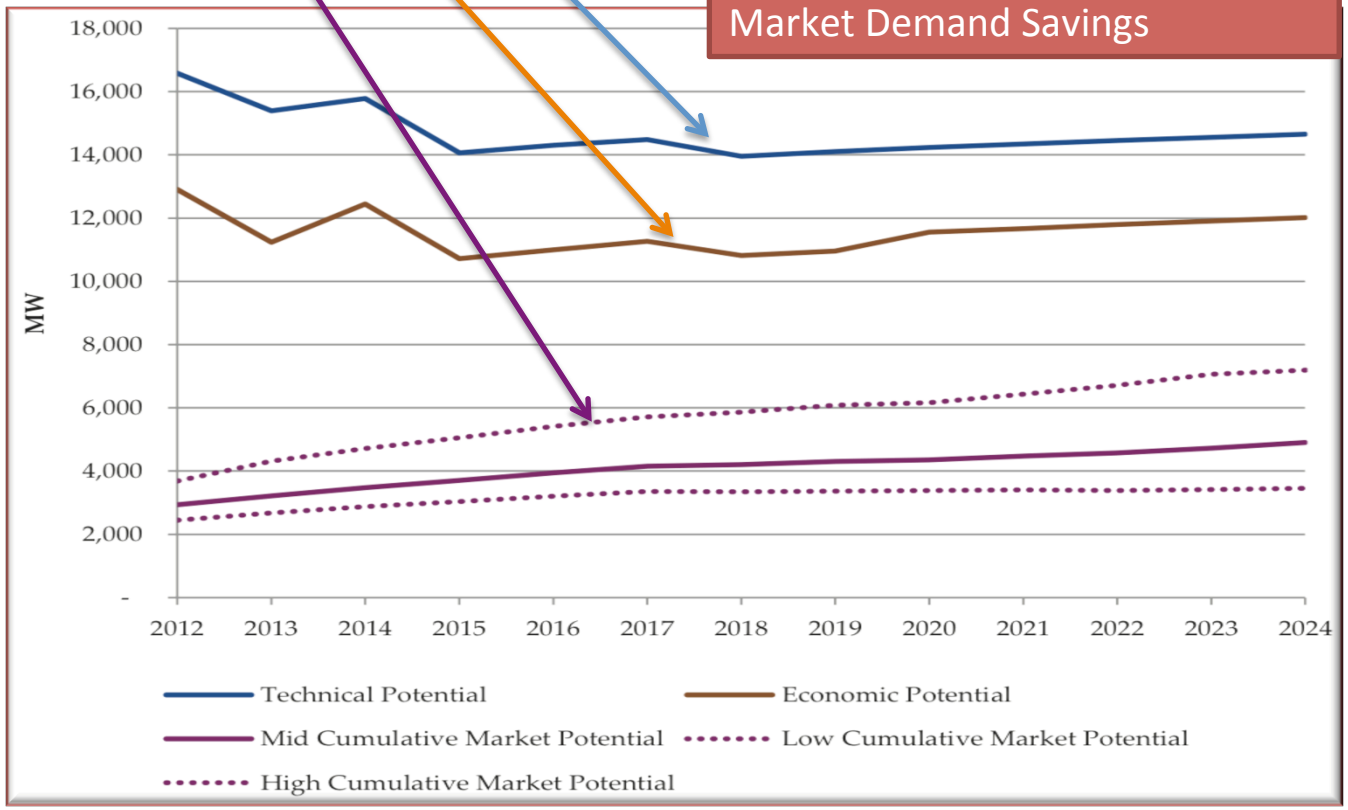
- **Market Effects -** look at the broader market effects of EE programs (e.g., sometimes rebate programs may increase product availability and drive product prices down, resulting in…)



Potential Studies
Ex-Ante Estimates



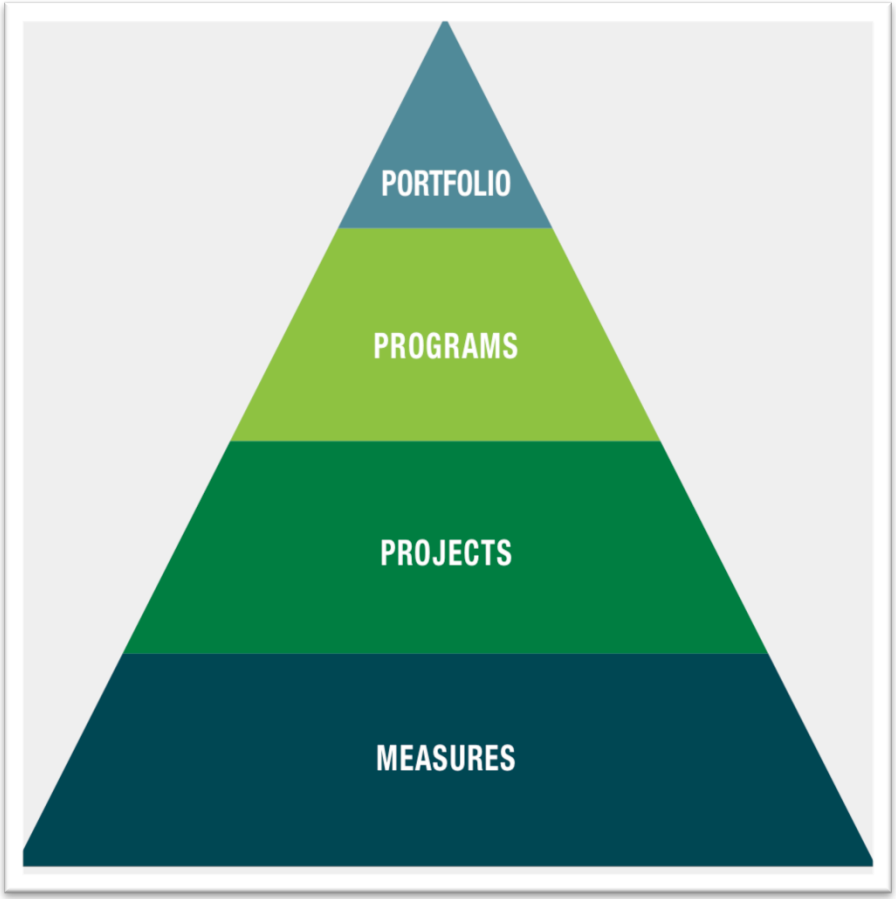
Example: Gross Technical, Economic, and Cumulative Market Demand Savings



IMPACT EVALUATIONS

EM&V Definitions
– Impact Evaluations Perspective

- Evaluation - Performance of studies and activities aimed at determining the effects of a program or portfolio.
- Measurement and Verification - Data collection, monitoring, and analysis associated with the calculation of gross energy savings from individual sites or projects. M&V can be a subset of program evaluation.
- EM&V - The term "evaluation, measurement, and verification" is frequently seen in efficiency evaluation literature. EM&V is a catchall acronym for determining both program and project impacts.



Two Components to Impact Evaluation:

1. Verify potential to generate savings
2. Determine savings

Example: Lighting Retrofit

Potential to Save:

Before: 60 Watts/fixture

After: 13 Watts/fixture

Savings:

Savings determined based on operating hours and lifetime of lamps

Example: New Car

Potential to Save:

Before: 10 MPG

After: 50 MPG

Savings:

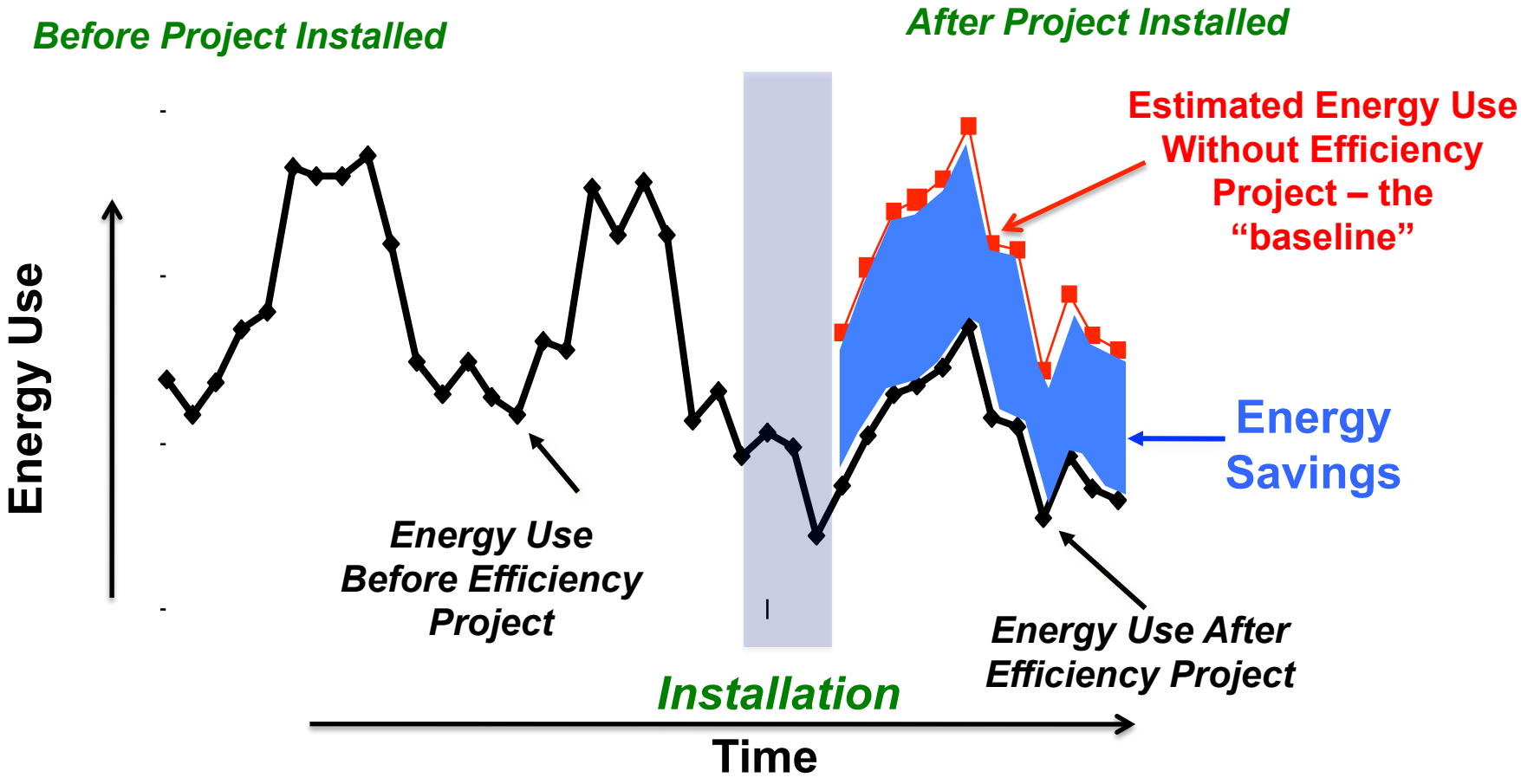
Savings determined based on how many miles driven and for how many years

Verification

- Usually some physical assessment of at least a sample of the individual projects is done
- Ensures that the measures installed are to specification and thus have the potential to save
- Potential to generate savings can be verified through observation, inspections, and spot or short-term metering conducted immediately before and after installation
- Sometimes, all you may need is verification and the use of a deemed savings value

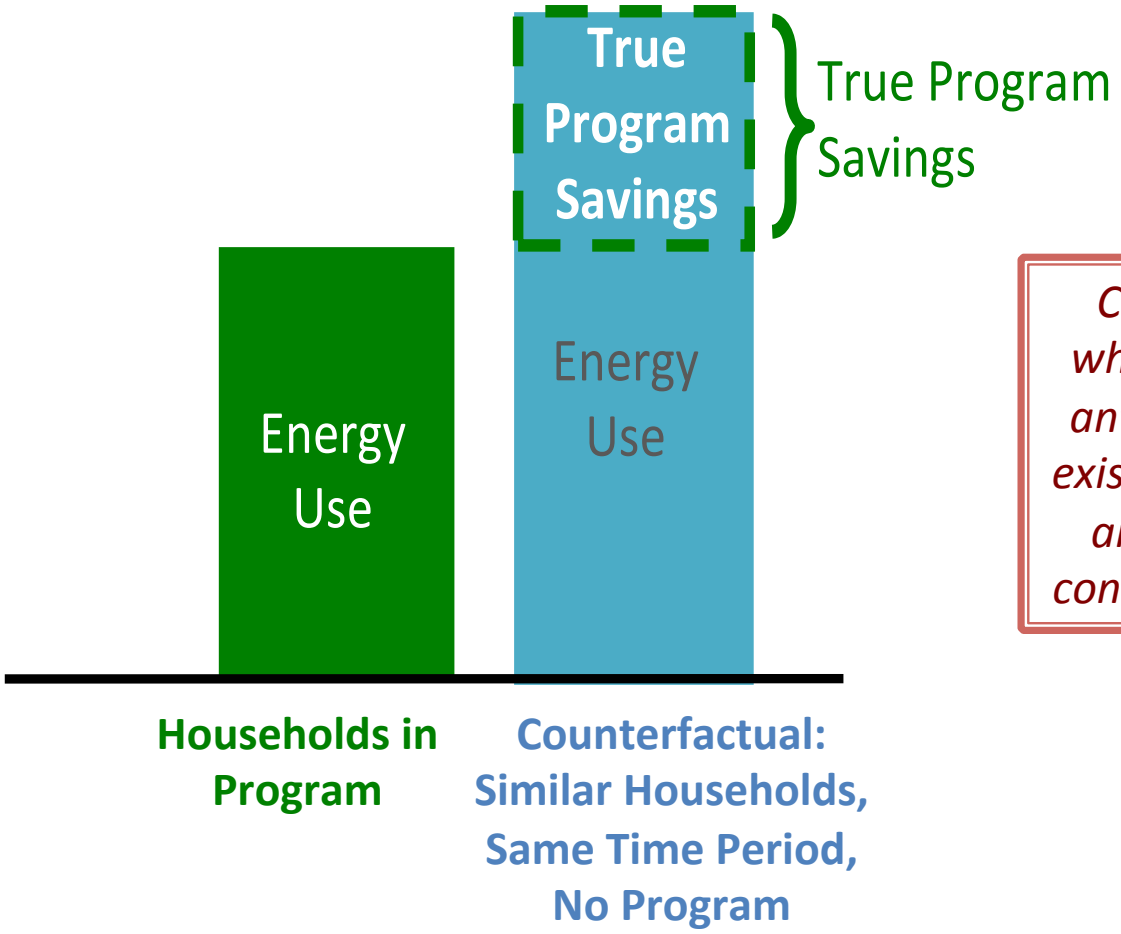
Savings Cannot Be Measured -

They Are Estimated



Graph of Energy Consumption Before, During And After Project Is Installed

Savings are Determined with a Counterfactual



Counterfactual analysis occurs when a person modifies a factual antecedent (a thing or event that existed before or logically precedes another) and then assesses the consequences of that modification.

Savings Baselines and Adjustments

- **Savings = (energy use without program, i.e. the baseline) – (energy use with program) +/- "adjustments"**
- **Baseline:**
  - Baseline definition: conditions (including energy consumption) that would have existed without implementation of the EE activity.
  - The key challenge with quantifying EE savings is the identification of an accurate baseline from which to determine energy savings.
- **Adjustments for non-project related influences:**
  - Individual building changes: Renovations, home occupants (e.g., new baby), business activities (e.g., number of employees, operating hours), plug loads
  - Broader changes: weather, economy, energy prices, other programs

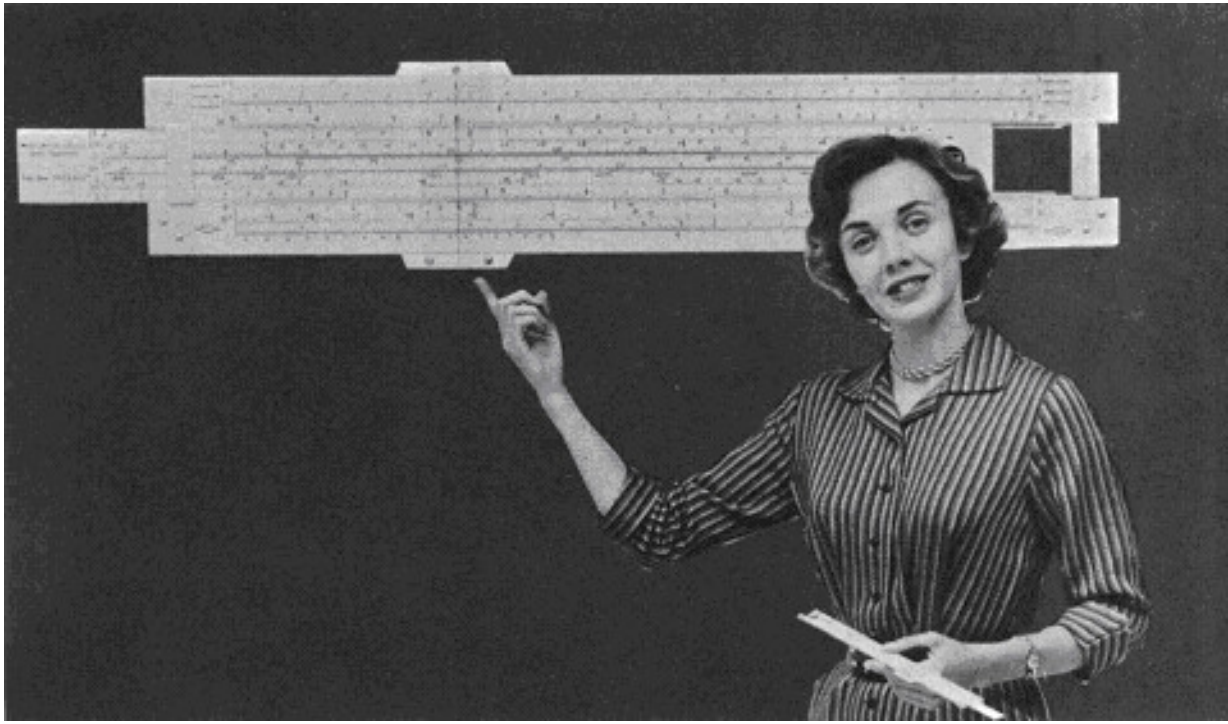
Savings Baseline Options for Efficiency Programs – Typical Applications

Program Category for Purposes of Baseline Determination	Existing Conditions Baseline	Codes and Standards Baseline	Common Practice Baseline
Early replacement or retrofit of functional equipment still within its current useful life; Process improvements	X - Existing conditions baseline for the remaining life of what is replaced	X - C&S baseline for the time period after the remaining life of the replaced equipment	X - Common practice baseline for the time period after the remaining life of the equipment
Replacement of functional equipment beyond useful life		X	X
Unplanned replacement for (of) failed equipment		X	X
New construction		X	X
Non-equipment based programs (e.g., behavior-based and training programs)			X – What control group would be doing in the absence of the program

Impact Evaluation Metrics

- **Gross Savings:** The change in energy consumption and/or demand that results directly from program-promoted actions taken by program participants regardless of the extent or nature of program influence on their actions.
- **Net Savings:** Refers to the portion of gross savings that is attributable to the program. Attributing changes to one cause (i.e., a particular program) or another can be quite complex.
- **Non-Energy Impacts:** Impacts associated with program implementation or participation. Can be positive or negative. Some examples include: avoided emissions and environmental benefits, productivity improvements, jobs created and local economic development, reduced utility customer disconnects, higher comfort and convenience.

Impact Evaluation Methods



Approaches for Determining Gross Energy Savings

- Deemed (stipulated, default) values or calculations
  - Use historical and verified data to projects and/or measures with correct applicability conditions
  - Typically applied to "prescriptive" or "standard" measures
  - Widely used and potentially very cost-effective to apply
- Comparison group EM&V methods
  - Conduct Statistical analyses of large volumes of metered energy usage data.
  - Typically applied to "mass market" and "residential" programs and with a control group versus a participant group
- Project-based measurement and verification (M&V)
  - Determine savings from a sample of projects.
  - These savings are then applied to all of the projects in the program.
  - Typically applied to "calculated" or "custom" measures

All of these approaches can take and are taking advantages of advances in "big data," load monitoring technology and analytical tools – "EM&V 2.0"

Deemed Savings

- **Deemed Savings Value**: (*Stipulated Savings Value, Unit Energy Savings).* Estimate of energy or demand savings for installed EE measure 'per unit':
  - Used for well understood and documented EE measures
    - For example: energy-efficient appliances such as washing machines, computer equipment and refrigerators, and lighting retrofit projects with well-understood operating hours
  - Has been developed from reliable data sources and analytical methods
  - Is applicable to the situation being evaluated

- **Deemed Savings Calculation**: An agreed-to (stipulated) engineering algorithm(s) used to calculate the energy and/or demand savings associated with an installed EE measure(s)

- Common sources of deemed savings values are previous evaluations and studies that involved actual measurements and analyses
- With deemed savings, the per-unit MWh values are determined and agreed to by parties prior to EE implementation
- When deemed savings are used to quantify MWh savings, a separate verification process is needed to confirm the quantity of units installed

Deemed Savings and Algorithm Resource Databases – AKA "TRMs"

- TRM is a resource (document, database, website) that includes information used in program planning, reporting and evaluating of EE programs which can include:
  - Energy efficiency measures metrics or characteristics (e.g. ,savings)
  - Engineering algorithms to calculate savings
  - Specific parameters needed to calculate savings
  - Factors for applying to calculated savings (e.g., net-to-gross ratios)
- Typically include documentation of:
  - Assumptions (e.g., baselines) used to prepare values
  - Calculations of values
  - When (what appropriate applications) to apply values and algorithms
- Provide a common reference for utility program managers, implementers, evaluators, and regulators

Examples:
- California DEER Database
- Northwest Regional Technical Forum

Deemed Savings - risk and rewards

They are used a lot for gross and net savings—they provide certainty!

But, Must Be Used With Caution

- Have to be applied where appropriate—only!
- The use of deemed values in a savings calculation is an agreement to accept a stipulated value, irrespective of what actually "happens."
- When using deemed values, it is important to realize that technologies alone do not save energy—it is how they are used that saves energy.

Comparison Group EM&V - Statistical Data Analysis

- Large-scale data analysis applies a variety of statistical methods to measured facility energy consumption meter data (almost always whole-facility utility meter billing data) and independent variable data (e.g., weather) to estimate savings
- These methods are generally used to estimate program-level savings, not facility- or project-level savings
- Specifically, comparison group EM&V methods determine program savings based on the differences in electricity consumption patterns between a comparison group and the program participants
- Comparison group approaches may involve:
  - Randomized control trials (RCTs) using non-participants as control group
  - Quasi-experimental methods using non-participants or participants (time series) as control group; the time series is most common
- Usually net savings, sort of….
- Because the effects of implemented measures is reflected in the observed participant-comparison differences, separate verification is not required

Project–Based Measurement and Verification (M&V)

- M&V is determining gross savings for individual projects or measures
- To obtain *program savings* using M&V, either:
  - Determine the savings of each project in a program—for example, for a program with a limited number of large industrial or commercial projects
  - Select a representative sample of projects and apply the sample projects' savings to the entire population, i.e., the program

M&V methods are defined in the International Performance Measurement and Verification Protocol (IPMVP); the leading international energy efficiency *M&V protocol*:

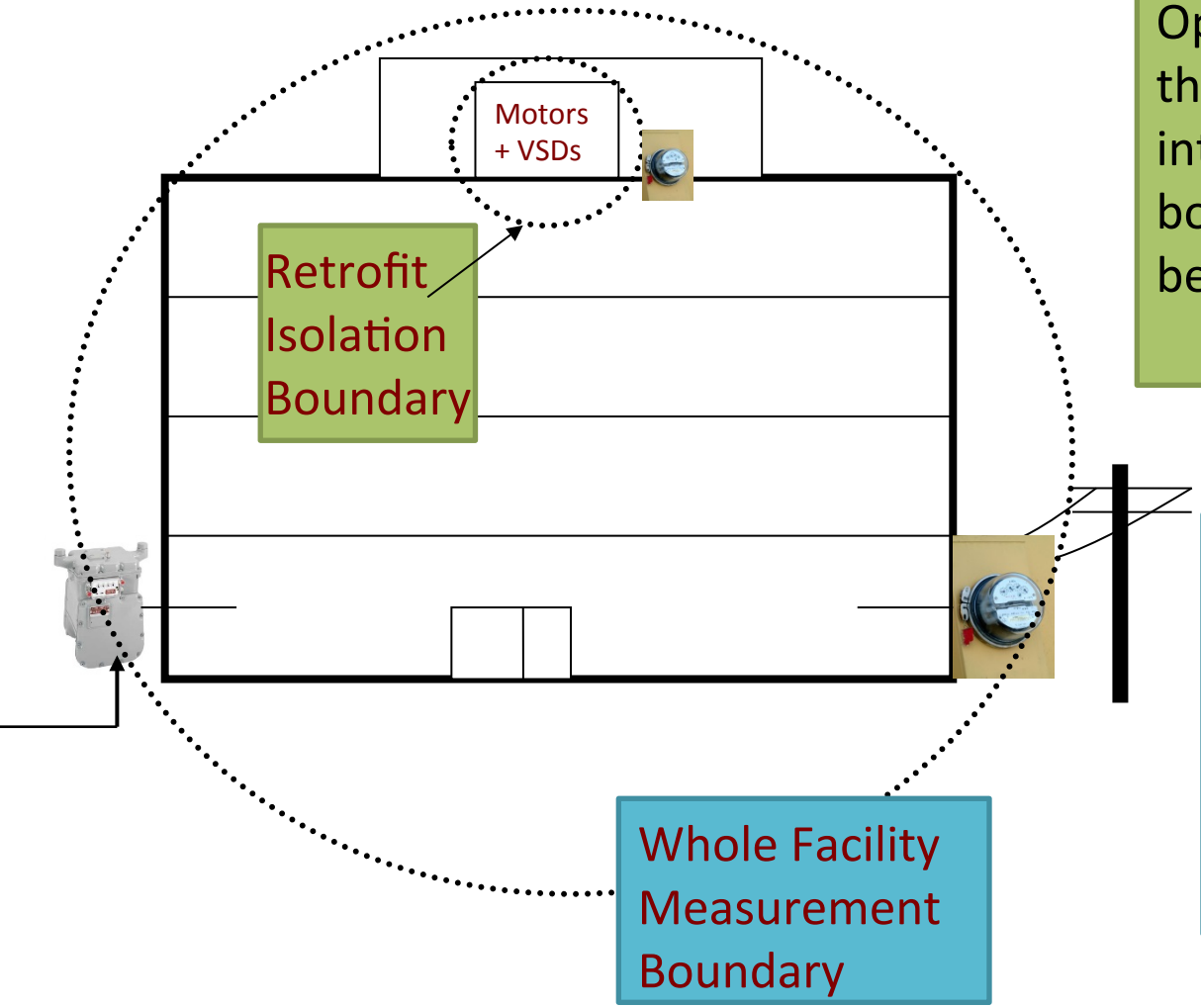
- Owned by "EVO" —non-profit organization—with document drafting and peer review technical committees
- IPMVP translated into 10 languages and is used in more than 40 countries
- Since going online, there have been more than 25,000 downloads of the IPMVP

More information can be found at www.evo-world.org

Summary of IPMVP Options

- The IPMVP has four M&V options: Options A, B, C, and D
  - *Retrofit isolation*—assessing savings from each EE measure individually (IPMVP Options A & B).
  - *Whole facility*—analyzing savings from each EE measure in a project/ facility collectively (IPMVP Option C, review of energy bills or Option D, calibrated simulation)
  - Some combination of the above
- The options are generic M&V approaches for determining energy savings from projects—one is not better than another, just have different pros and cons
- Four options provide a range of approaches to determining energy cost avoidance, depending on the characteristics of the efficiency projects being implemented, and balancing accuracy in reporting with the cost of conducting M&V

IPMVP: Retrofit Isolation and Whole Facility



The Retrofit Isolation Options: Option A or B - Addresses only the retrofitted system—ignores interactive effects beyond the boundary (although these may be independently addressed)

The Whole Facility Options: Option C or D - Addresses all effects in the facility—retrofits AND other changes (intended and **un**intended)

A "Typical" Combination for Determining Gross Savings for a Portfolio of Efficiency Programs

- Set of prescriptive programs use deemed savings values for savings (e.g., residential CFLs, commercial ventilation motors, commercial building lighting)
- Set of custom programs use calculated ex-ante savings estimates and 100% site verification with spot measurements to confirm assumptions (e.g., commercial HVAC measures)
- Another set of custom programs use M&V savings analyses (Options A, B, C and/or D), defined in a guideline, on a census of projects (e.g., industrial process measures)
- Residential weatherization program uses large scale billing data analyses with comparison groups

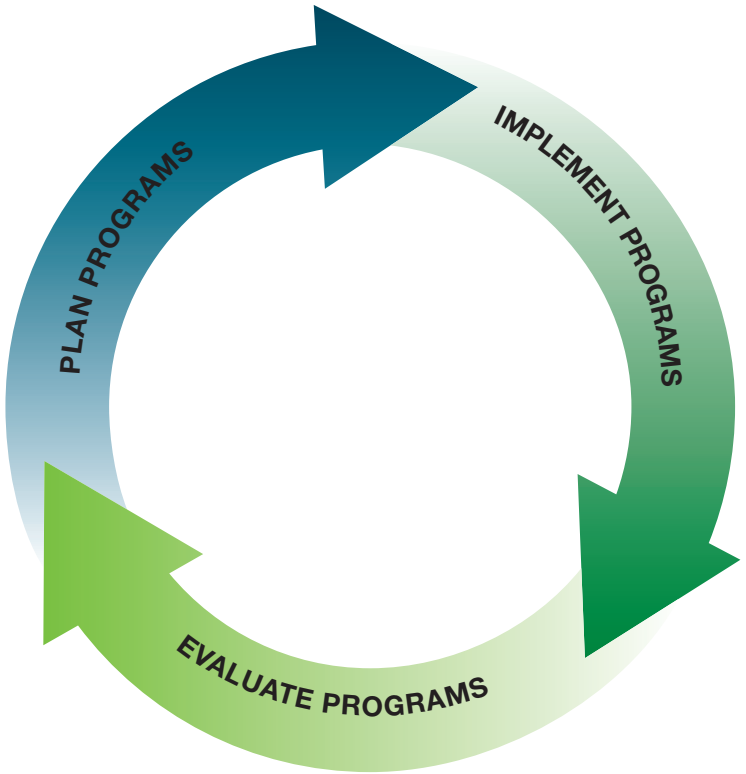
Getting from Energy Savings to Avoided Emissions

The basic approaches:

- Applying emission factors (e.g., pounds of CO_2 per MWh) to energy savings
- Using emissions scenario analyses, e.g., using computer models to estimate the difference in emissions from power plants with and without the reduced energy use:
  - Average emissions approaches
  - Marginal emissions approaches
  - Dispatch modeling approaches

EM&V Planning

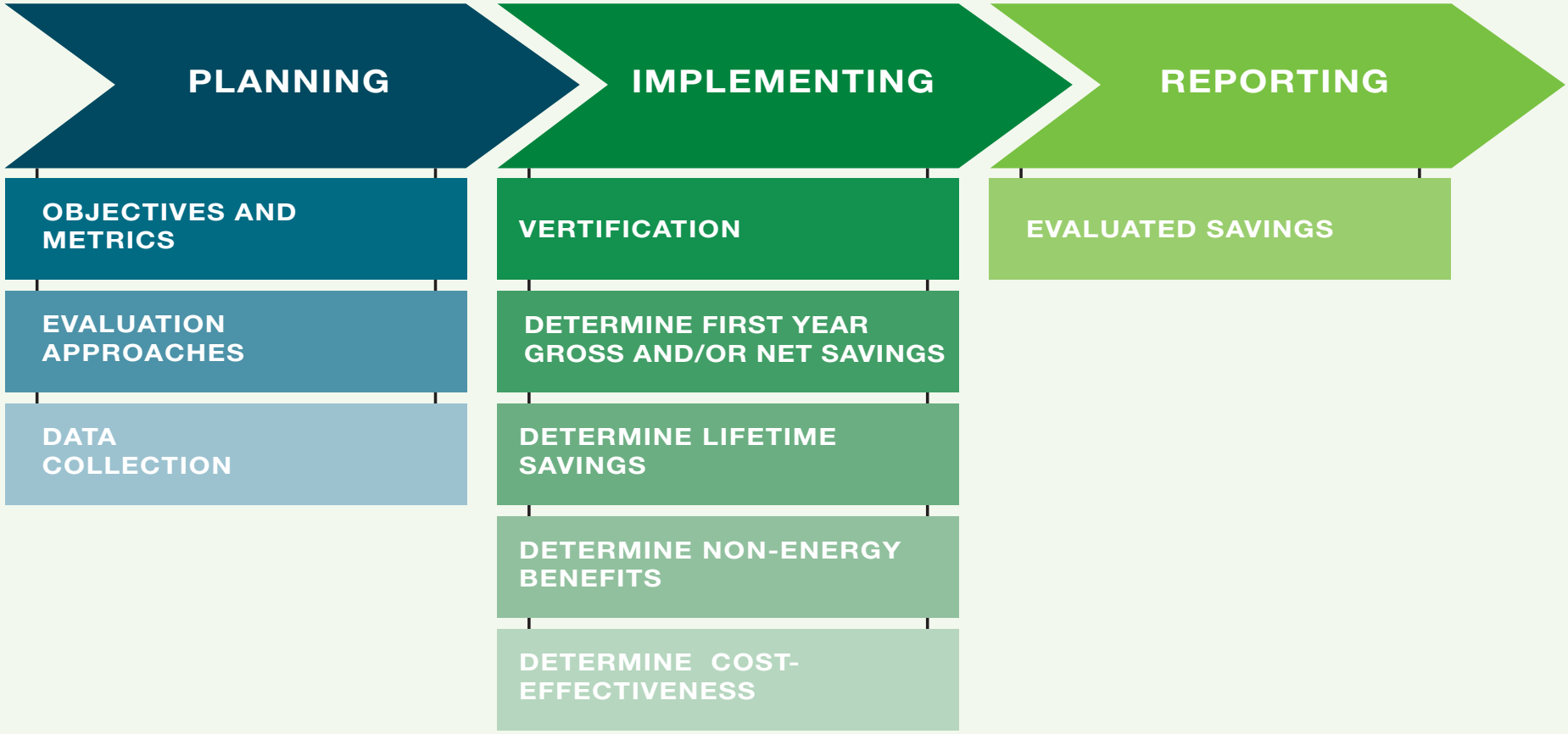
Evaluation is Integral to Planning—Implementation-Evaluation Process



When to Evaluate:

- Evaluations should be produced within a portfolio cycle or very soon after the completion of a cycle
- In a timely manner and provide feedback for:
  - Ongoing program improvement
  - Supporting portfolio assessments
  - Support the planning of future portfolio cycles, load forecasts, and energy resource plans
- Can also be used to inform future evaluations, in particular through updating deemed savings values

EM&V Workflow



EM&V Issues and Frameworks

The Big Issues of EM&V

How good is good enough?

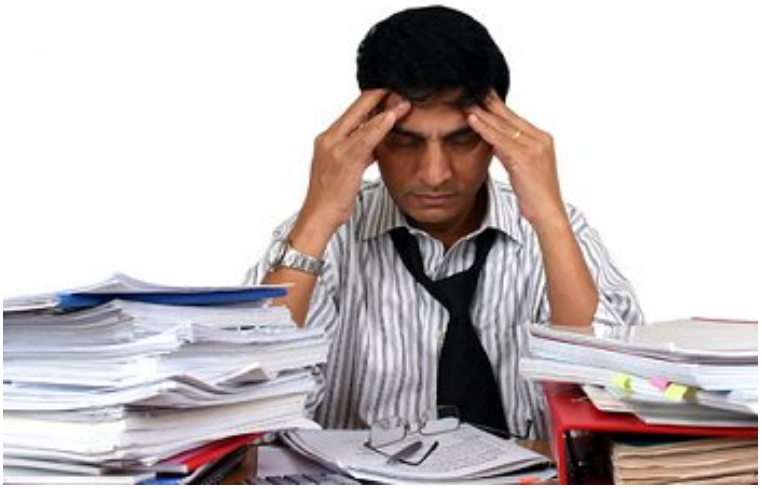
- Fundamental issue of EM&V
- How certain does one have to be of savings estimates and is that certainty balanced against the amount of effort utilized to obtain that level of certainty?
- EM&V investments should consider risk management principles—balance the costs and value of information derived from EM&V (i.e., EM&V should be cost-effective).

As compared to what?

- First – Defining a baseline against which efficiency actions are compared for determining energy savings and whether attribution should be considered—the counterfactual
- Second – Establishing level of performance confidence and risk for efficiency relative to other options meeting energy use, cost, reliability, etc. goals

EM&V is About Risk Management

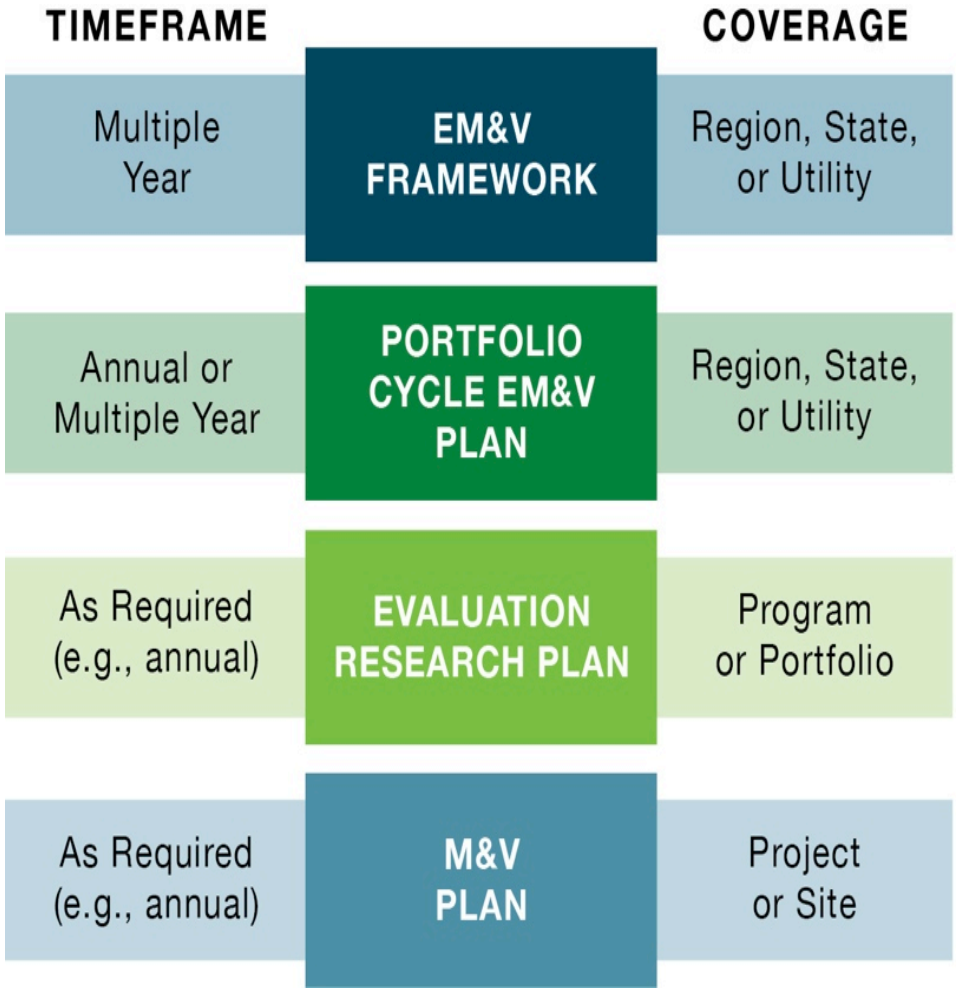
Energy Savings – Regulator vs. Consumer Perspective
Energy Avoidance



- Regulators/utilities/resource planners focus on how much energy would have been consumed if the consumers had not taken the energy efficiency action. They want to know how much energy is avoided. To do so they make adjustments.
- Energy consumers often use the word 'savings' to describe 'cost reductions.' They might make 'technical' adjustments but certainly not 'resource' adjustments.
- Result – savings for consumers might be different than savings determined from a resource/regulatory perspective

Structure for Defining Evaluation Activities

- EM&V Framework – Primary document that lays out top level structure. *This is perhaps the principal document that all stakeholders can focus on and provide high level input.*
- Annual Plans – Indicates major activities that will be conducted during the evaluation cycle
- Evaluation Research Plans – Created for the major EM&V activities
- Site Specific M&V Plans – For custom project sites that are analyzed and inspected



EM&V Framework

- Primary document that lays out key aspects of evaluation such as:
  - Definitions
  - Evaluation principles
  - Allowable approaches
  - Metrics for determination of gross and/or net savings
  - Reporting requirements
  - Schedules
  - Roles and responsibilities of various entities
- Tends to be "fixed" for several years, but can be updated periodically
- Sets expectations for the content and scope of subordinate evaluation documents, such as a portfolio cycle EM&V plan
  - Whereas the subordinate EM&V documents contain a higher level of detail and apply to narrower time frames, the EM&V framework is the principle document on which all stakeholders can focus and provide input

Who Does What EM&V Activities

Common factors for deciding:

- Realities and perceptions of conflict of interest
- Resources and capability to manage and timely implement
- Resources to conduct (major issue in industry is lack of human EM&V capacity)

Examples of Who Does What in Utility Programs:

Impact

- Administrator (utility) conducts EM&V with internal staff
- Administrator (utility) conducts EM&V with third-party consultants
- Commission (or Commission surrogate) conducts EM&V with third-party consultants
- Administrator (utility) conducts EM&V and Commission (or Commission surrogate) conducts review/audit

Process

- Almost always done by administrator (utility)—with internal staff or more often third-party consultants

Market

- Almost always done by administrator (utility)—with internal staff or more often third-party consultants—but can be initiated by others particularly if looking at statewide or regional market analyses (good to combine resources)

Planning

- EE potential studies—can be done as part of utility or regional resource planning

Demand-Side Energy Efficiency in the Clean Power Plan

Disclaimers

The information presented herein does not represent and is not suggestive of any U.S. Department of Energy (DOE) or Lawrence Berkeley National Laboratory (LBNL) positions with respect to the Clean Power Plan (CPP), CPP documents, or strategies/actions that states, electricity generating units (EGUs), or others should, can or may take with respect to CPP compliance.

In addition, some of the information and concepts referenced herein are based, at least in part, on these proposed EPA documents:
Federal Plan Requirements for Greenhouse Gas Emissions from Electric Utility Generating Units Constructed on or Before January 8, 2014; Model Trading Rules; Amendments to Framework Regulations, and
Evaluation Measurement and Verification (EM&V) Guidance for Demand-Side Energy Efficiency (EE).

These documents are in proposed and draft form, respectively, for public input; as such they are subject to change. DOE and LBNL are not taking positions on the proposed documents.

State, EGUs, or other parties should contact their U.S. EPA regional office if they have questions concerning the CPP. Further information on the CPP can be found at the U.S. EPA CPP website: http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants

State Plan Types and Overall Approaches

- States pick a **mass-** or **rate-based goal approach**
- States submit a "State Plan" for affected EGUs to implement interim and final goals (or federal plan is implemented)
- Federal enforcement is on the EGUs
- Two State Plan types:
  - **Emission standards plan** – EGU source-specific requirements ensuring all affected EGUs meet their goals
  - **State measures plan** – mixture of measures implemented by the state, such as renewable energy standards and efficiency programs

Plan Type	Goal
Emissions Standard Plan	Rate or mass-based goal
State Measures Plan	Mass-based goal only

Many CO_2 Reduction Opportunities

- Heat rate improvements
- Fuel switching to a lower carbon content fuel
- Combined heat and power
- Qualified biomass co-firing and repowering
- Renewable energy (new & capacity uprates) – wind, solar, hydro
- Nuclear generation (new & capacity uprates)
- Electricity transmission and distribution improvements
- Carbon capture and utilization/sequestration for existing sources
- ***Demand-side energy efficiency measures, programs and policies***

Energy efficiency improvements are expected to be an important part of state compliance across the country and under all state plan types, providing energy savings that reduce emissions, lower electric bills, and lead to positive investments and job creation

Energy Efficiency Supported in CPP

CPP encourages states to select efficiency as a compliance path:

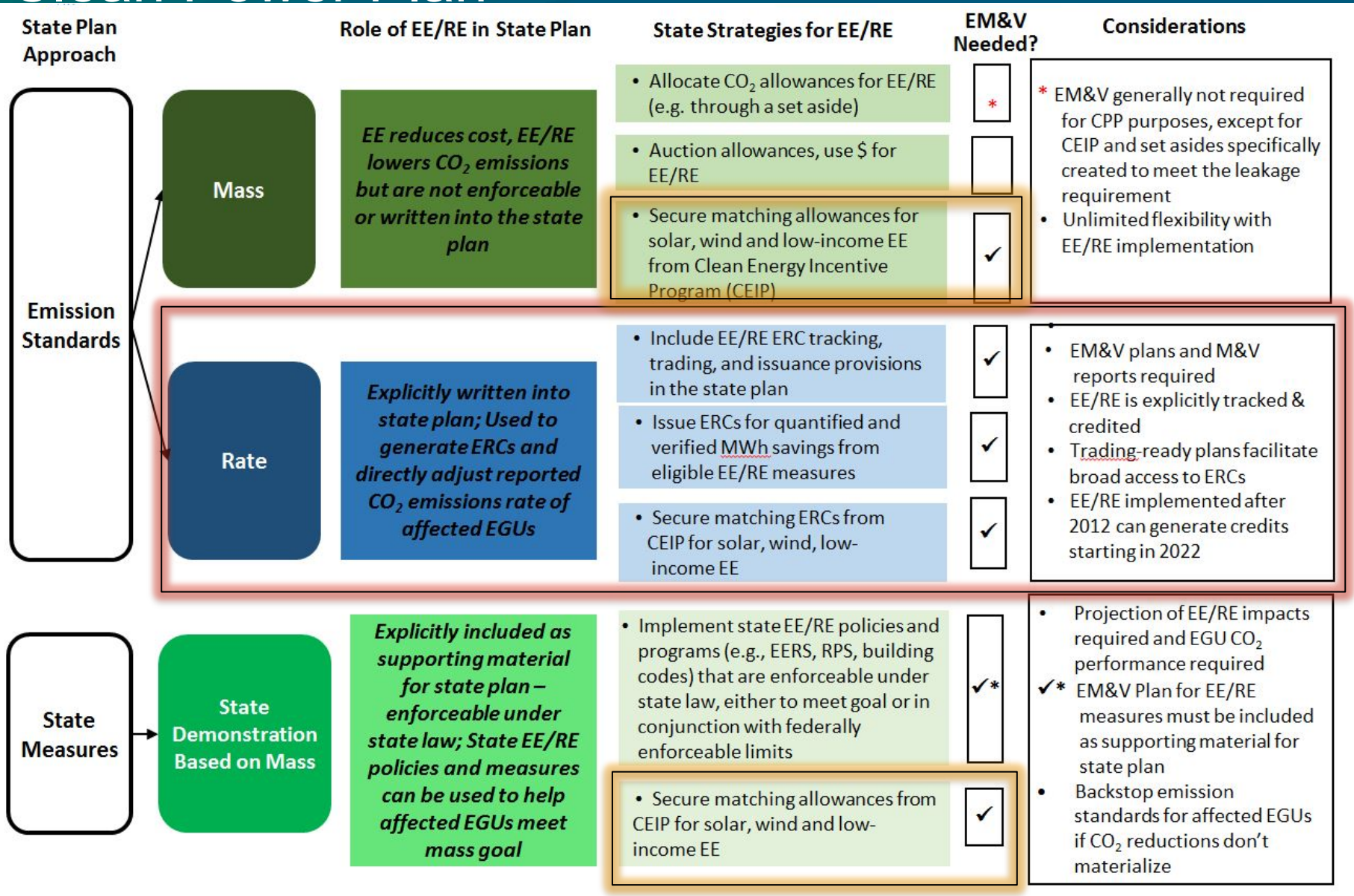
- Under a mass-based approach, energy efficiency automatically "counts" toward compliance and states can use an unlimited amount to help achieve their state goals
- Under a rate-based approach, CPP enables states to get credit for all eligible energy efficiency projects whose electricity savings are documented via EM&V
- The Clean Energy Incentive Program (CEIP) provides additional incentives for early investment in demand-side energy efficiency in low-income communities

Eligible Efficiency

- Demand-side energy efficiency may include a range of eligible measures that are zero-emitting and avoid, rather than simply shift, the use of electricity. Very wide range of programs, projects and measures could be eligible
- Primary requirement is that the measures can be quantified and verified in accordance with the EM&V requirements in the CPP Emission Guidelines
- Savings from projects installed today (since 2012) that are still achieving quantifiable and verifiable energy savings in 2022 may be applied during the compliance period

How EE/RE Fits in the Clean Power Plan

- slide from U.S. EPA



CPP EE EM&V In One Slide

Do I need to do EM&V for CPP?

- Mass –
  - EGU Emission Standards Plan – Not really
  - State Measures Plan – Yes, but not fundamental to compliance calculations
- Rate –
  - EGU Emission Standards Plan - Yes, fundamental to compliance calculations
- CEIP –
  - Mass or rate plans - Yes

EM&V Requirements

- Prepare an EM&V plan that provides for quantified and verified savings by applying industry best-practice protocols and guidelines
- Provide regular interval EM&V and periodic reports
- Use a baseline that represents what would have happened in the absence of the demand-side EE activity—common practice baseline
- Address savings persistence
- Have independent verification
- No double counting

For the CPP, EM&V is primarily associated with successfully quantifying and verifying savings for generating emission rate credits (ERCs) and adjusting an emission rate

Efficiency EM&V Coverage in the CPP

	Type of EM&V Information	Summary
CPP Emissions Guidelines	Requirements	Must do for CPP compliance to quantify and verify savings
Proposed Model Trading Rule ***Proposed for Comment***	EM&V provisions that will be presumptively approvable if included in state regulations governing how EE is to be quantified by EE providers and verified by independent entities acting on behalf of the state.	Strongly recommended characteristics of EM&V for approvable State Plans. Any alternative EM&V approaches proposed by a state would have to "… demonstrate to the EPA's satisfaction that its alternative provisions are as stringent as the presumptively approvable approach…."
Proposed EM&V Guidance for Demand Side EE ***Proposed for Comment***	Applicable guidance	Further information and recommendations covered in this companion document

Energy Efficiency in the CPP – Rate-Based Approach

- **EE can be used to generate Emission Rate Credits (ERCs) that are used to help meet the rate target**
- **Rate based approaches are where there are significant CPP EM&V and tracking requirements for EE**

CPP Emissions Rate =

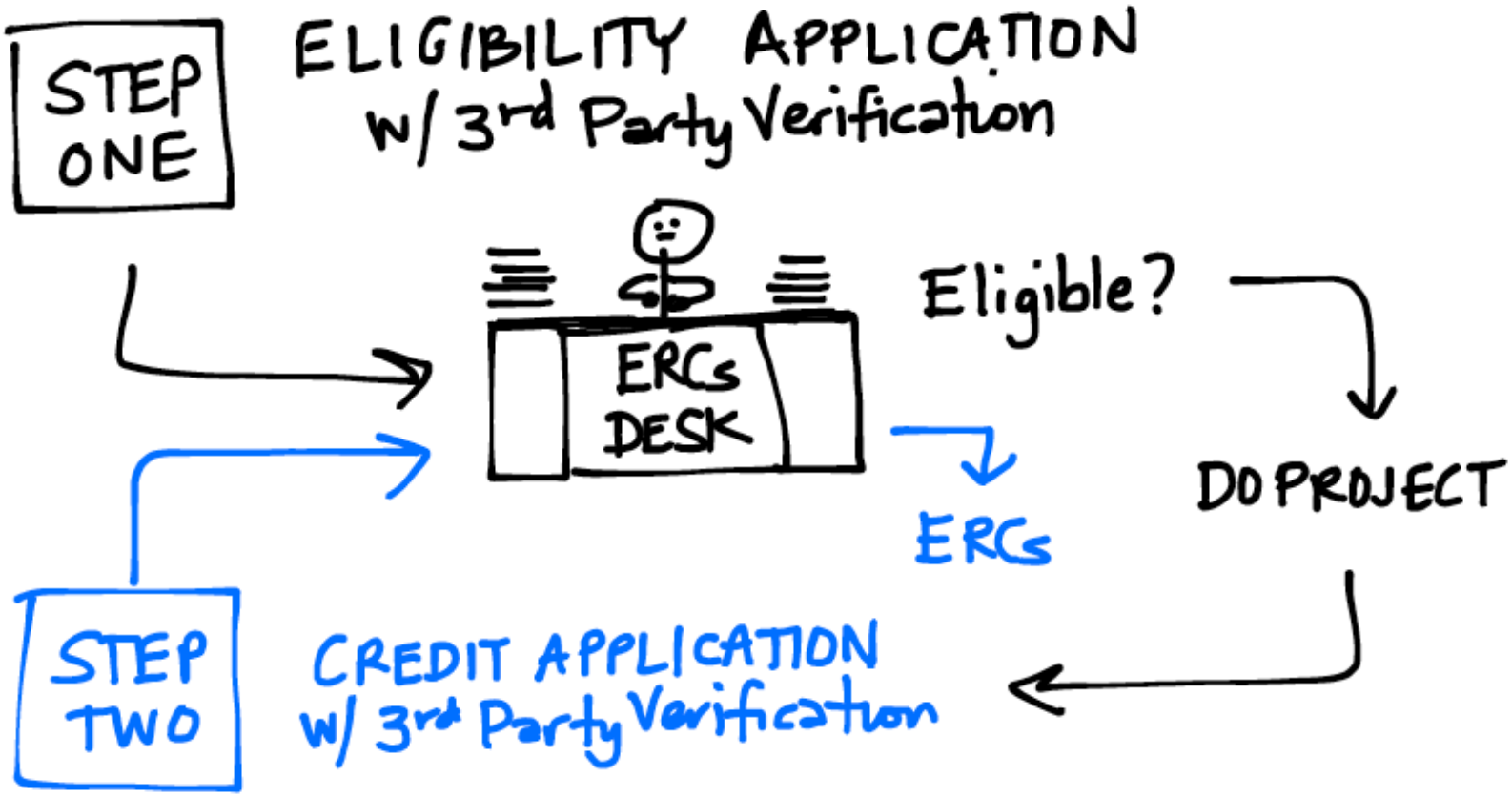
$$\frac{\text{(Affected EGU Emissions, lbs/year)}}{\text{(Affected EGU Generation, MWh/year)} + \text{(ERCs, MWh/year)}}$$

Example:

- Emission = 1,000,000 lbs/year
- Generation = 1,000 MWh/year
- Emission rate = 1,000 lbs/MWh
- Target = 800 lbs/MWh
- ERCs required = 250 MWh/yr ➡ CPP Rate = 800 lbs/MWh

Metric is Annual MWh

The ERC Process – slide from Franz Litz, Program Consultant, Great Plains Institute



! Liability for improperly issued ERCs lies with the affected EGU who uses them for compliance !

Energy Efficiency in the CPP – Mass-Based Approach

EE reduces emissions mass "indirectly":

- **Complimentary programs – e.g., energy codes, EERS, public buildings programs**
- **Could be funded with allowance auction funds**

- Emission Standards plan – EE does not have to be defined and thus EM&V does not have to be defined in plans (probably)
- State measures plan – EE measures do need to be defined and thus EM&V Plan is required
- EE EM&V is less of an issue with mass-based approach, because it is not fundamental to compliance calculations but:
  - EE is implemented with complementary programs, which should have their own EM&V plans
  - California's and RGGI's approaches can be examples

EM&V Requirements

Emissions Guidelines (EG) requirements are general and relatively limited, including (see EG for complete description):

- State plan would include EM&V plan for quantifying and verifying electricity savings on a retrospective (ex-post) basis using industry best-practice EM&V protocols and methods that yield accurate and reliable measurements of electricity savings.
- Assessment of the independent factors that influence the electricity savings and the expected life of the savings
- Baseline that represents what would have happened in the absence of the demand-side EE activity
- Periodic M&V reports
- Independent verification
- Skill certification is also discussed

EM&V Guidance and Model Trading Rule

Cover wide range of EM&V topics, including the following list from CPP EM&V Guidance document:

- EM&V Methods
- Electricity savings metrics and baselines
- Reporting timeframes and considerations
- Deemed savings
- Independent factors
- Accuracy and reliability
- Avoiding double counting
- Persistence of savings
- Savings quantification/verification cycles
- T&D savings adders
- Interactive effects
- EE EM&V Protocols and Guidelines

Also Covered in Guidance and/or Model Rule:

- Tracking and compliance systems
- Independent verification and review
- Additional EM&V guidance for several common EE program and project types
  - Programs implemented using utility customer funds ("utility EE programs")
  - Individual or aggregated EE projects, such as those implemented by ESCOs or at industrial facilities
  - Building energy codes
  - Appliance energy standards
- Glossary of key terms
- Templates for program and project EM&V plans
- Examples for several common measure types

Trading and Tracking – quick notes

- Trading is allowed, encouraged in the Rule –
  - emission rate credits (for a rate-based standard) or
  - allowances (for a mass-based standard)
- Trading of ERCs, including EE ERCs under Rate Based Approach, can support CPP compliance:
  - Intra-state and Inter-state
  - Final Plan does not require complex air quality modeling to identify location of emission impacts from efficiency nor adjustment or discounting of efficiency impacts that cross state lines.
- This requires implementing "systematic tracking and accounting procedures, including the use of well-structured and well-maintained tracking and reporting systems such as those already being used by many states and EE providers."

Resources

Resources - CPP

- Clean Power Plan website: http://www2.epa.gov/carbon-pollution-standards

- Specific Documents:
  - CPP Emission Guidelines: http://www.epa.gov/airquality/cpp/cpp-final-rule.pdf
  - Federal Model Plan: http://www.epa.gov/airquality/cpp/cpp-proposed-federal-plan.pdf
  - EM&V Guideline: http://www2.epa.gov/cleanpowerplantoolbox/draft-evaluation-measurement-and-verification-guidance-demand-side-energy

- For additional resources to help states develop plans, visit the CPP Toolbox for States: http://www2.epa.gov/cleanpowerplantoolbox

- EPA Overview and energy efficiency presentations:

  http://www2.epa.gov/cleanpowerplan/clean-power-plan-overview-webinar

  http://www2.epa.gov/cleanpowerplan/fact-sheet-energy-efficiency-clean-power-plan

Efficiency Resources

- ACEEE – American Council for Energy Efficiency Economy – non-profit efficiency organization http://www.aceee.org
- Utility and other program administrator websites (e.g. Northwest Energy Efficiency Alliance – htpp://www.neaa.org)
- U.S. DOE Energy Efficiency Office — http://energy.gov/eere/efficiency
- EPA/DOE State and Local Energy Efficiency Action Network (SEE Action)–
  - focuses on providing assistance states need to advance policies and practices that bring energy efficiency to scale. http://www.epa.gov/cleanenergy/energy-programs/seeaction/

EM&V Resources

- EPA/DOE State and Local Energy Efficiency Action Network (SEE Action)–
  - focuses on providing assistance states need to advance policies and practices that bring energy efficiency to scale. http://www.epa.gov/cleanenergy/energy-programs/seeaction/index.html
- The Northwest Regional Technical Forum –
  - an advisory committee established to develop standards to verify and evaluate conservation savings. http://www.nwcouncil.org/rtf/about.htm
- Regional EM&V Forum (Northeast and Mid-Atlantic) –
  - supports the development and use of common and/or consistent protocols to evaluate, measure, verify, and report the savings, costs, and emission impacts of energy efficiency. Covers 11 states. http://www.neep.org/emv-forum
- EVO –
  - capacity building for M&V best practices www.evo-world.org

EM&V Resources and Support

About 40 years of experience with EE EM&V

- An EM&V industry of professionals exists – for example see: www.evo-world.org and www.iepec.org
- Numerous state, national and international guidance documents and protocols exist

State and Local Energy Efficiency Action Network (SEE Action), facilitated by the U.S. Department of Energy/U.S. Environmental Protection Agency, as well as DOE and EPA on their own have and are continuing to sponsor a number of EM&V projects, for example:

- Uniform Methods Project
- Data Warehouse Project
- Model Impact Evaluation Guide
- Guidance for Evaluating Behavior Programs
- EM&V webinar series (with recordings)

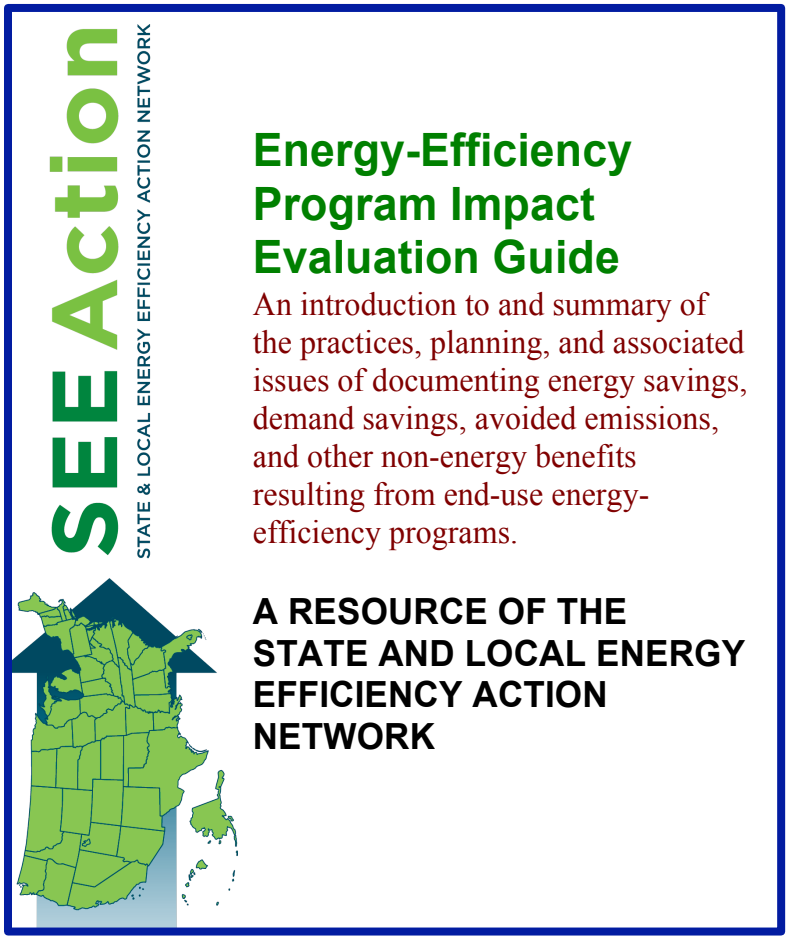
http://www1.eere.energy.gov/seeaction/evaluation.html

SEE Action

STATE & LOCAL ENERGY EFFICIENCY ACTION NETWORK

2012 SEE Action Impact Evaluation Guide

- Describes common terminology, structures, and approaches used for determining (evaluating):
  - energy and demand savings
  - avoided emissions
  - other non-energy benefits
- Does not recommend specific approaches—it provides:
  - context
  - planning guidance
  - discussion of issues
- Audience:
  - Public and private energy efficiency portfolio administrators
  - Program implementers
  - Evaluators



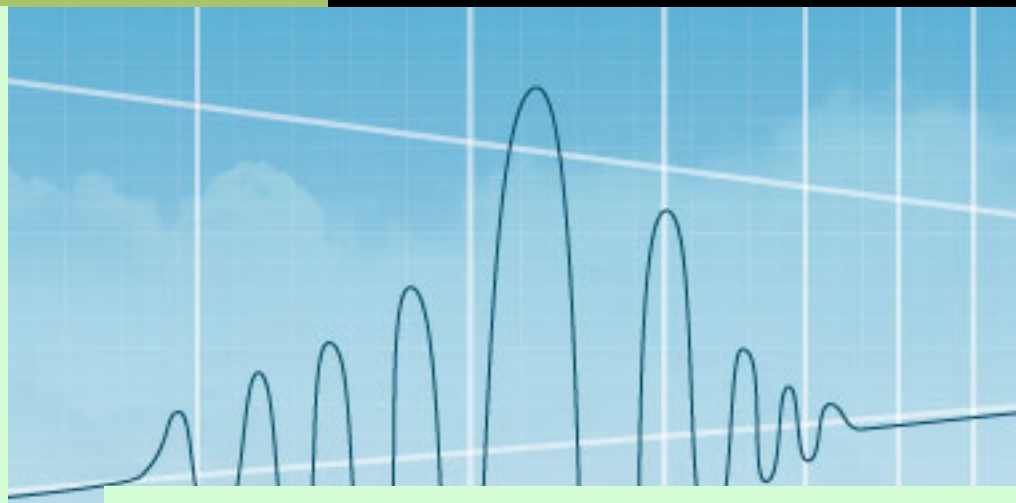
http://www1.eere.energy.gov/seeaction/

2012 SEE Action Impact Evaluation Guide Contents

Part	Chapters	Intended Audience
Part 1	Executive Summary	Readers interested in a brief summary and introduction to impact evaluation
Part 2	Chapter 1: Introduction Chapter 2: Energy Efficiency Program Evaluation Overview Chapter 3: Impact Evaluation Basics	Readers who want an overview of evaluation and the key aspects of impact evaluation
Part 3	Chapter 4: Calculating Energy Savings Chapter 5: Determining Net Energy Savings Chapter 6: Calculating Avoided Air Emissions	Readers who want additional detail on impact evaluation approaches—**deemed savings, M&V, large-scale consumption data analysis**
Part 4	Chapter 7: Impact Evaluation Considerations Chapter 8: Impact Evaluation Planning	Program implementers, evaluators, and managers/regulators of evaluations looking for guidance on key evaluation issues and planning of evaluations as well as readers with a background in evaluation may want to go directly to these chapters
Part 5	Appendix A: Glossary Appendix B: Other Evaluation Categories and Approaches—Market, Process, Cost-Effectiveness Appendix C: Resources References	Readers interested in standard energy efficiency evaluation **definitions** and **reference materials** as well as summaries of **process, market evaluations, cost-effectiveness analyses and top-down evaluation**

U.S. DEPARTMENT OF ENERGY

- Addresses common residential and commercial efficiency measures
- Step-by-step calculations for determining gross, first-year savings using M&V approach
- Also cross cutting chapters on some EM&V topics (net savings, sampling, metering, persistence, peak savings)
- Adoption is voluntary
- http://energy.gov/eere/about-us/ump-home



DOE Goals

Strengthen credibility EE savings calculations

Provide clear, accessible, step-by-step protocols

Support consistency and transparency

Reduce costs of EM&V

Allow for comparison of savings

UNIFORM METHODS PROJECT

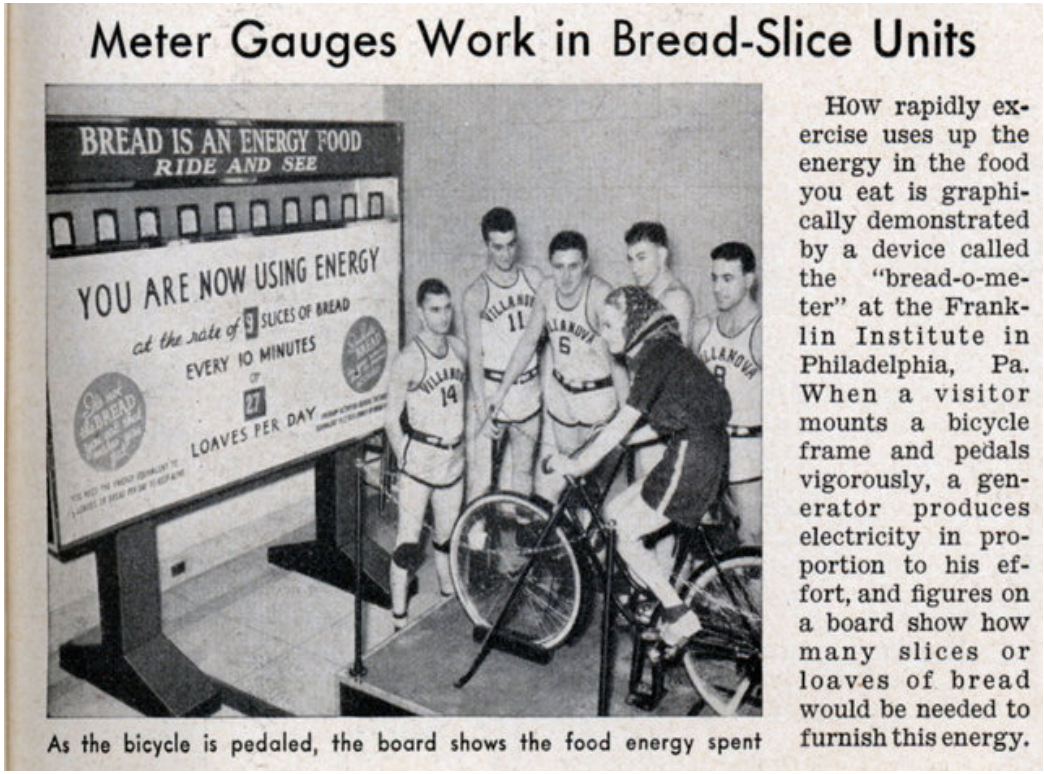
Jointly managed by the DOE Office of Electricity Delivery and Energy Reliability and the Office of Energy Efficiency and Renewable Energy

Discussion/Questions

From Albert Einstein:

"Everything should be as simple as it is, but not simpler"

"Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted"



Meter Gauges Work in Bread-Slice Units

As the bicycle is pedaled, the board shows the food energy spent

How rapidly exercise uses up the energy in the food you eat is graphically demonstrated by a device called the "bread-o-meter" at the Franklin Institute in Philadelphia, Pa. When a visitor mounts a bicycle frame and pedals vigorously, a generator produces electricity in proportion to his effort, and figures on a board show how many slices or loaves of bread would be needed to furnish this energy.

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