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Module 4
Estimating the Benefits of Energy Efficiency/Renewable Energy

Electric Energy Training
for Air Regulatory & Planning Staff
US EPA OAQPS

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Topics Covered by this Module

- What do we mean by “energy savings?”
- What is EM&V?
  - Why do it?
  - Who does it?
  - What methods are used?
  - Can we rely on the answers?
- What is a Market Potential Study?

“Energy Savings” Defined

Energy Savings = Baseline – Actual

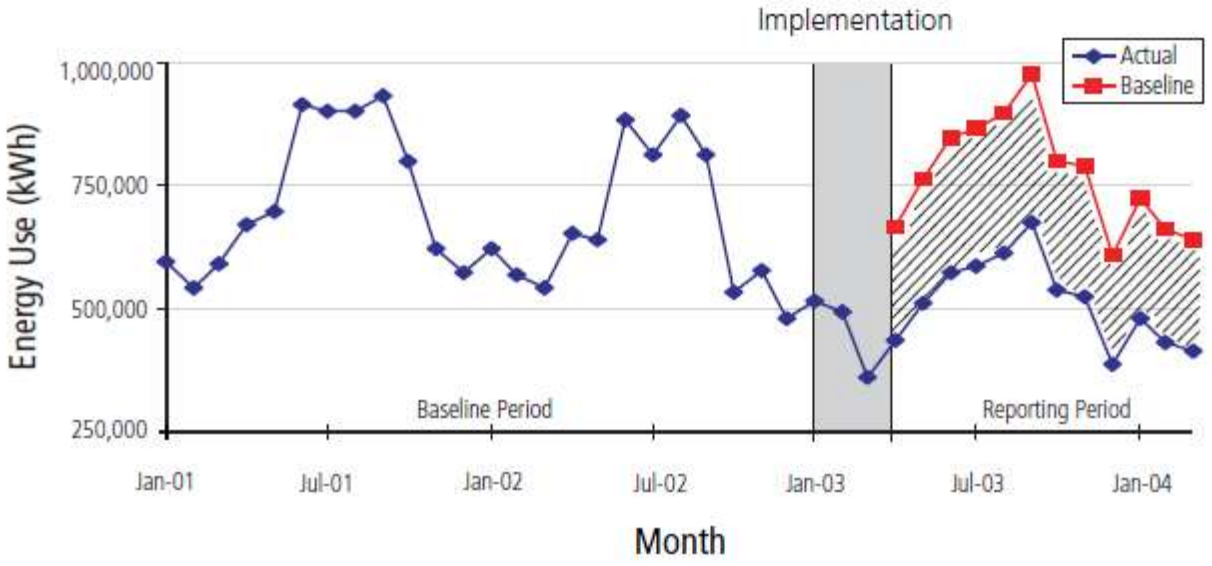
where

Actual is the amount of energy used during a given period; and,

Baseline is the amount of energy that would have been used during the same period had the efficiency measure(s) not happened

Energy Savings Visualized

Figure 4-1. Comparison of Energy Use Before and After a Program Is Implemented



Source: National Action Plan for Energy Efficiency, *Model Energy Efficiency Program Impact Evaluation Guide*, November 2007.

EM&V Definition and Background

Source: EPA State and Local Climate and Energy Program

- "Evaluation, measurement, and verification" is the process of estimating energy, peak demand, and emissions impacts from energy efficiency (EE) policies, programs, or projects
  - EM&V for EE programs is a mature field with well-developed methods
  - Conducted for several decades in nearly all states/municipalities with significant public investment in EE
- With renewable energy, EM&V is used to determine emissions impacts
  - RE generation is directly metered
- EM&V refers to retrospective analysis
  - It does not include forecasting the impacts of future policies, programs, or projects (although EM&V data are used to inform and improve forecasting)
- EM&V issues that air regulators should be aware of include: net vs. gross savings, rebound effect, persistence of savings

The Need for EM&V

Source: State Energy Efficiency Action Network, www.seeaction.energy.gov

- Most EM&V activities have originated from the need for state regulators to assess the success of programs funded by utility customers.
- Regulators support evaluation activities because of their interest in documenting total savings, assessing the cost-effectiveness of efficiency compared to generation alternatives, assessing the relative contribution of program administrators in achieving savings, determining market baselines and market program effects, and using the feedback to improve current and future portfolio offerings.
- Increasingly, other stakeholders have interest in the outcomes of EM&V including load forecasters, RTOs/ISOs, state and federal governments, utility customers, etc.
- Entities with multiple facilities (e.g., school districts, universities, chain store companies, industrial companies) can be interested in evaluations of their efficiency programs in terms of benchmarking and assessing lessons learned. This would be in addition to the more typical private sector transaction need for project specific M&V.

State Uses for EM&V

Source: EPA State and Local Climate and Energy Program

- States use EM&V data to help inform and address the following needs:
  - **PUCs** need retrospective, timely information to ensure ratepayer value and cost-effectiveness
  - **Energy system planners** need to know how EE policy is likely to affect the energy system (consistent with resource plans)
  - **Governors** need talking points on the multiple benefits achieved with recent EE/RE investments
  - **DEPs** need to know when and where EE/RE is likely to affect air emissions, and the magnitude of these impacts

Air Regulator Uses for EM&V

Source: EPA State and Local Climate and Energy Program

- Ensuring that EE is a reliable energy resource on par with generation
  - Criteria of interest include measurable, real, permanent
- Confirming that EE/RE policies have achieved forecasted energy and peak demand impacts
- Quantifying the magnitude of air emissions impacts from past EE/RE activities
- Determining when and where these air emissions impacts occurred, consistent with policy goals
  - e.g., State implementation plans (SIP), high electric demand days (HEDD)

EM&V Audiences, Needs, and Concerns

Source: State Energy Efficiency Action Network, www.seeaction.energy.gov

Audience	Needs and Concerns: What decisions must be made?
Planners and System Operators	• Prove energy efficiency is a viable resource. • Need data accurate and complete enough to analyze energy efficiency for resource planning and system operation (could include hourly impacts and load shape).
Program Administrators	• Run programs effectively/improve programs; compare programs. • Demonstrate that programs achieved expected savings. • Pass program cost-benefit tests.
Commissions	• Need credibility so that planning authorities will incorporate energy efficiency into load forecasts and resource planning. • Prove energy efficiency programs and portfolios are cost effective. Determine attribution and/or appropriate incentive payments. Compare programs.
State and Federal Government	• Measure and verify savings. Know that targets are met and energy efficiency benefits ratepayers. Compare savings across various programs and potential program activities. • Improve grant management by improving best practices. • Use energy efficiency data to determine green house gas (GHG) and other environmental impacts.
Finance Community	• Need data sufficient to show that efficiency is a viable investment.
Host Customers	• Need feedback justifying their participation (current EM&V uses hosts solely as data sources). Could benefit from individualized results from M&V activities.
(EM&V Practioners)	• Need better access to tools and data, support for capacity building, more people.

EM&V Audience Data Needs

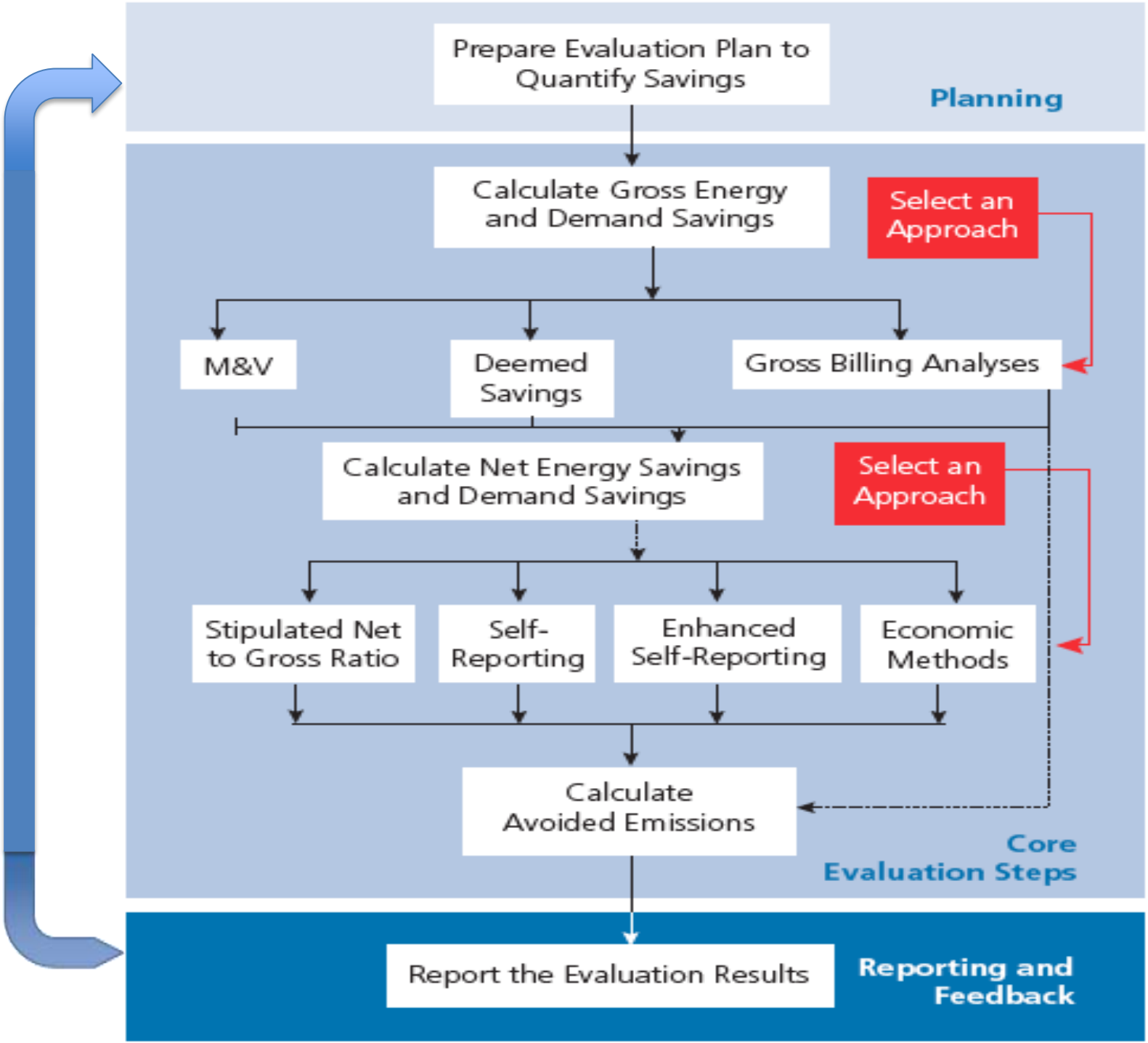
Source: State Energy Efficiency Action Network, www.seeaction.energy.gov

AUDIENCE	DATA NEEDS							
Key: ● Almost Always ○ Sometimes NA Rarely	First Year Gross Energy Saved (annual, monthly, hourly)	Net Energy Saved	Cost-Effectiveness (perspectives vary)	Savings Persistence	Lessons Learned (process evaluation)	Market Impacts	Participation Levels (e.g. customers served)	Environmental Benefits
Planners and System Operators	●	○	○	●	○	○	●	○
Program Administrators	●	○	●	●	●	○	○	○
Commissions	●	○	●	●	●	○	○	○
State and Federal Government	●	○	○	○	●	○	○	○
Finance Community	●	NA	●	○	○	NA	NA	○
Host Customers	●	NA	●	○	○	NA	NA	○
EM&V Practitioners	●	○	○	○	○	○	○	○

Roles with EM&V

Source: EPA State and Local Climate and Energy Program

- DEPs are not typically responsible for evaluating (or forecasting) energy or demand impacts
  - This is the responsibility of PUCs or other state agencies
- DEPs are responsible for identifying the needed EM&V data, documenting EM&V procedures to be applied, and quantifying the resulting air impacts
- EPA Regions determine whether the methods specified for documenting energy/emissions impacts are appropriate to the pathway selected
- ISOs, EIA, PUCs, and EPA are data sources
- Non-profit partners are key to information sharing, training, facilitation, etc.


Prepare Evaluation Plan to Quantify Savings
Planning
Calculate Gross Energy and Demand Savings
Select an Approach
M&V
Deemed Savings
Gross Billing Analyses
Calculate Net Energy Savings and Demand Savings
Select an Approach
Stipulated Net to Gross Ratio
Self-Reporting
Enhanced Self-Reporting
Economic Methods
Calculate Avoided Emissions
Core Evaluation Steps
Report the Evaluation Results
Reporting and Feedback

Step 1: Estimate Gross Energy Savings

- Gross Savings = the amount that results directly from actions promoted by the EE program, regardless of the extent to which the program actually prompted the change
- Involves a combination of methods:
  - Measured and verified savings
  - Deemed savings
  - Gross billing analysis

Measured &Verified Savings

- Used for large, complex, or "risky" projects or for programs in which a variety of factors determine savings
  - **Project savings** determined by metering, modeling, or engineering calculations
  - **Program savings** determined by selecting a representative sample of projects, measuring the savings from those selected projects, and extrapolating the results to the entire program

Deemed Savings

- Used for simple projects with well-understood savings that don't significantly vary from project to project
- Stakeholders stipulate that they will use deemed values to estimate energy savings for each project within a program
- Less accurate but also less expensive than M&V

Gross Billing Analysis

- Less common method
- Uses aggregated utility billing data and statistical methods, rather than project- or customer-specific measurements

Step 2: Estimate Net Energy Savings

- Net Savings = the portion of gross savings that can be attributed to the EE program, separating out other factors that influence behavior and consumption
- Why might net savings be different than gross savings?

Estimating Net Energy Savings: Why?

- **Free riders**: participants who would have acted even in the absence of the program
- **Spillover**: changes in energy use caused indirectly by the presence of the program
- **Rebound**: savings from installing an efficient device that are offset by greater use of the device

Estimating Net Energy Savings: How?

- Net-to-Gross Ratio (NTGR): 4 approaches
  1. Self-reported survey responses from program participants
  2. Self-reported survey responses enhanced with interviews or other documentation
  3. Statistical/economic models that compare behavior of participants & non-participants
  4. Deemed/stipulated NTGR based on past use of the other methods

National Grid Net Savings Example

In 2006, National Grid undertook a study of free ridership and spillover in its commercial and industrial energy efficiency programs. That study identified a free ridership rate of 10 percent and a spillover rate of 14 percent for custom installations as determined using the Design 2000*plus* software program. The net-to-gross ratio for custom installations is equal to:

$$NTGR = (1 - \text{free ridership} + \text{spillover})$$
$$= (1 - 0.10 + 0.14)$$
$$= 1.04$$

In this case, net savings for custom installations in National Grid's Design 2000*plus* Program are 4 percent higher than gross savings.

Provided by National Grid based on a report from PA Consulting Group, 2006.

Temporal Aspects of Measurement

- Future net and gross savings caused by past actions can be forecasted
- Persistence is a key factor: will the efficiency of a project degrade over time?
- Need to understand if you are looking at:
  - First year savings
  - Lifetime savings
  - Lifecycle savings

Energy Savings Visualized

Table G-1. The Timing of Energy Savings from a Hypothetical Program

Program Year	Quantity	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FY01	100	6,000	6,000	6,000	6,000	6,000	6,000									
FY02	100		6,000	6,000	6,000	6,000	6,000	6,000								
FY03	100			6,000	6,000	6,000	6,000	6,000	6,000							
FY04	100				6,000	6,000	6,000	6,000	6,000	6,000						
FY05	100					6,000	6,000	6,000	6,000	6,000	6,000					
FY06	100						6,000	6,000	6,000	6,000	6,000	6,000				
FY07	100							6,000	6,000	6,000	6,000	6,000	6,000			
18MCP	100								6,000	6,000	6,000	6,000	6,000	6,000		
CY09	100									6,000	6,000	6,000	6,000	6,000	6,000	
CY10	100										6,000	6,000	6,000	6,000	6,000	6,000

Source: Public Service Commission of Wisconsin, *Focus on Energy Evaluation: Annual Report (2010)*, April 2011.

Current State of EM&V

Source: State Energy Efficiency Action Network, www.seeaction.energy.gov

Current Market Activity

- In 2009, rate-payer funded programs budgeted ~$100 million on EM&V activities; ESCOs spent ~$60 - $80 million; DOE spent ~$1 million (and ~$37 million on ARRA EM&V).
- Level of funding for EM&V is related to the regulatory expectations or requirements.
- Rate-payer funded programs with at-risk incentives for administrators (utilities) have the most thorough EM&V procedures. Range of rate-payer funded program EM&V spending is from 0.5% to 5% of program funding with mean of 2.8% (CEE, 2010)

Key Programs and Policies in Place

- National Action Plan guidelines on EM&V methods being used by large portion of EM&V practitioner audience .
- ESCOs conduct M&V to assure hosts' savings (but still often rely on stipulated savings values).
- Many states establishing their own EM&V policies and requirements. On a regional basis, the mid-Atlantic/Northeast EM&V Forum is developing standard reporting forms and EM&V protocols. The Pacific Northwest Regional Technical Forum has developed EM&V tools and databases.

Two-Year Forecast Without SEE Action

- Incremental progress in adopting best practices and common use of terms will be achieved; more 'up and coming' states will establish EM&V infrastructures, and more state/regional databases will be established of stipulated savings values and deemed calculated values.
- Limited advances will be made in having comparable results between states/regions, number of experienced/trained EM&V practitioners, use of the large quantities of data being collected from EM&V efforts and smart meters, developing results which are directly usable by resource and transmission planners, increasing the ability to cost-effectively report results with more certainty, and in the development of top down evaluation methods.

Technical Reference Manuals

- A common basis for evaluating savings
  - By program
  - Differentiated by climate zone as needed
  - Defining baselines
- Slick on-line versions in Pacific Northwest and California
  - http://www.nwcouncil.org/energy/rtf/reports.htm#ptcs
  - http://www.deeresources.com/
  - http://www.energy.ca.gov/deer/

Going Forward

Source: EPA State and Local Climate and Energy Program

- Getting the right EM&V information requires ongoing collaboration and information sharing with the PUC, ISO, and other appropriate entities
  - PUC/ISO staff, EM&V experts, and web resources are available to help
  - Important coordination and facilitation role for non-profit partners (e.g., NESCAUM, NEEP EM&V Forum)
  - Numerous case studies exist
    - Many years of EE program investment and EM&V in nearly all N.E. states, many mid-Atlantic states
    - Several examples of including EE/RE in past SIPS
    - ISO-NE Forward Capacity Market captures impacts of future EE activity based on an agreed-upon EM&V approach
- More discussion is needed between EPA HQ, EPA regions, states, and supporting organizations to identify and resolve key EM&V issues

EM&V Challenges (1)

Source: State Energy Efficiency Action Network, www.seeaction.energy.gov

- EM&V is sometimes seen as expensive, not credible, not timely, not transparent, and as a burden, not a benefit.
- Jurisdictions calculate and define savings differently, utilize different deemed savings values and baseline assumptions, tend to not report uncertainty in results, and apply different levels of independent review. This can both make meaningful comparisons difficult and hurt the credibility of energy efficiency when savings values for the same measures, even when justifiable, vary from one state to another.
- Jurisdictions have difficulty reliably determining savings directly attributable to their programs and also use different methods and apply different net savings factors (e.g., free riders, spillover, snap back) when estimating net savings. This makes it difficult to determine program attribution, define and set standards for rigor and accuracy for net savings given different policy objectives, and assess broader "net" market effects of energy efficiency programs.

EM&V Challenges (2)

Source: State Energy Efficiency Action Network, www.seeaction.energy.gov

- While most EM&V focuses on first-year savings, there is a lack of support for analyses of savings persistence. Similarly, comparative analysis of alternative program designs, estimates of market changes, and mechanisms for prompt and regular program feedback are not emphasized.
- EM&V practices have yet to evolve to take advantage of the Smart Grid infrastructure that allows for increased data collection.

Key Solutions & Actions to Achieve the Goal

Source: State Energy Efficiency Action Network, www.seeaction.energy.gov

GOAL: Transform EM&V to yield more accurate, credible, and timely results that accelerate successful energy efficiency deployment and management

Three Major Work Areas

Priority Solution Areas

Develop a foundation for improving credibility and cross-jurisdiction comparability

1. Consistent savings estimates and consistent and comparable reporting
Resource for calculations, uniform definitions and common forms

2. Review and update EM&V resource guides
Impact evaluation techniques explained

3. Uniform methods and/or standards
Set of voluntary methods/protocols

Explore new methods to address emerging issues and technologies

4. Explore new technology solutions
Use Smart Grid and AMI to measure and verify savings

5. Innovative analysis techniques
New methods provide more efficient EM&V and maintain rigor

Build capacity and increase adoption of best practices

6. Resource accessibility and tool development
National or regional databases of reports, plans, and stipulated savings values

7. Training
Increase the number of EM&V practitioners and their level of expertise and experience

What is a Market Potential Study?

- Prospective, quantitative assessment of market potential for deploying EE and/or RE (but usually just EE)
- Most often conducted by a third party under contract with a utility, state utility commission, or state energy office

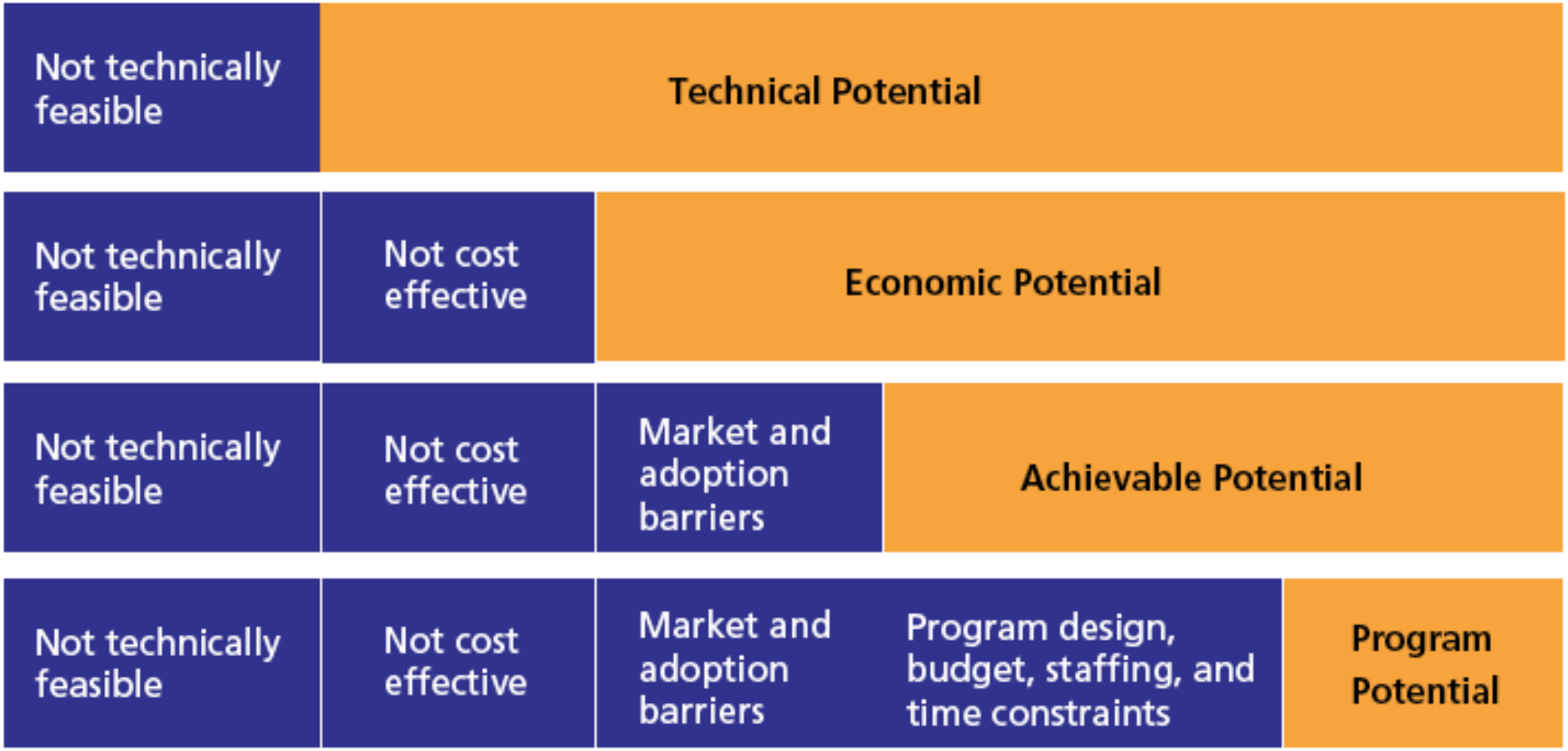
Scope of Potential Studies

- Can cover a single neighborhood, a utility service territory, an entire state, or a region
- May be limited to electricity, or a fuel like natural gas, or all sources of energy
- Might cover all sectors of the economy, or just a subset (e.g. residential customers)

Possible Purposes of a Potential Study

- Build support for developing new policies
- Identify alternatives to new generation, transmission and distribution assets
- Design policies
- Set realistic targets and/or budgets
- Select measures to include in programs
- Forecast energy savings and/or renewable generation

Multiple Meanings of "Potential"



Overview of Methodology for EE Potential Studies

- Identify technically feasible EE measures
- Determine costs of each measure
- Calculate benefits of each measure over time, relative to baseline assumptions
- Screen measures for cost effectiveness
- Adjust for barriers to adoption, expected market penetration, etc.

Recent Energy Efficiency Potential Studies

Study* (Date)	Technical Potential (aMW)	Achievable Potential (aMW)	Achievable as % of Baseline Sales**	Levelized Cost ($/kWh)
PacifiCorp: Wyoming (2007)	158	82	5%	$0.03
NWPCC: 4 PNW states (2009)	--	5,800	21%	$0.03
Northeast EE Partnerships: NE ISO area (2004)	--	3,924	23%	$0.03

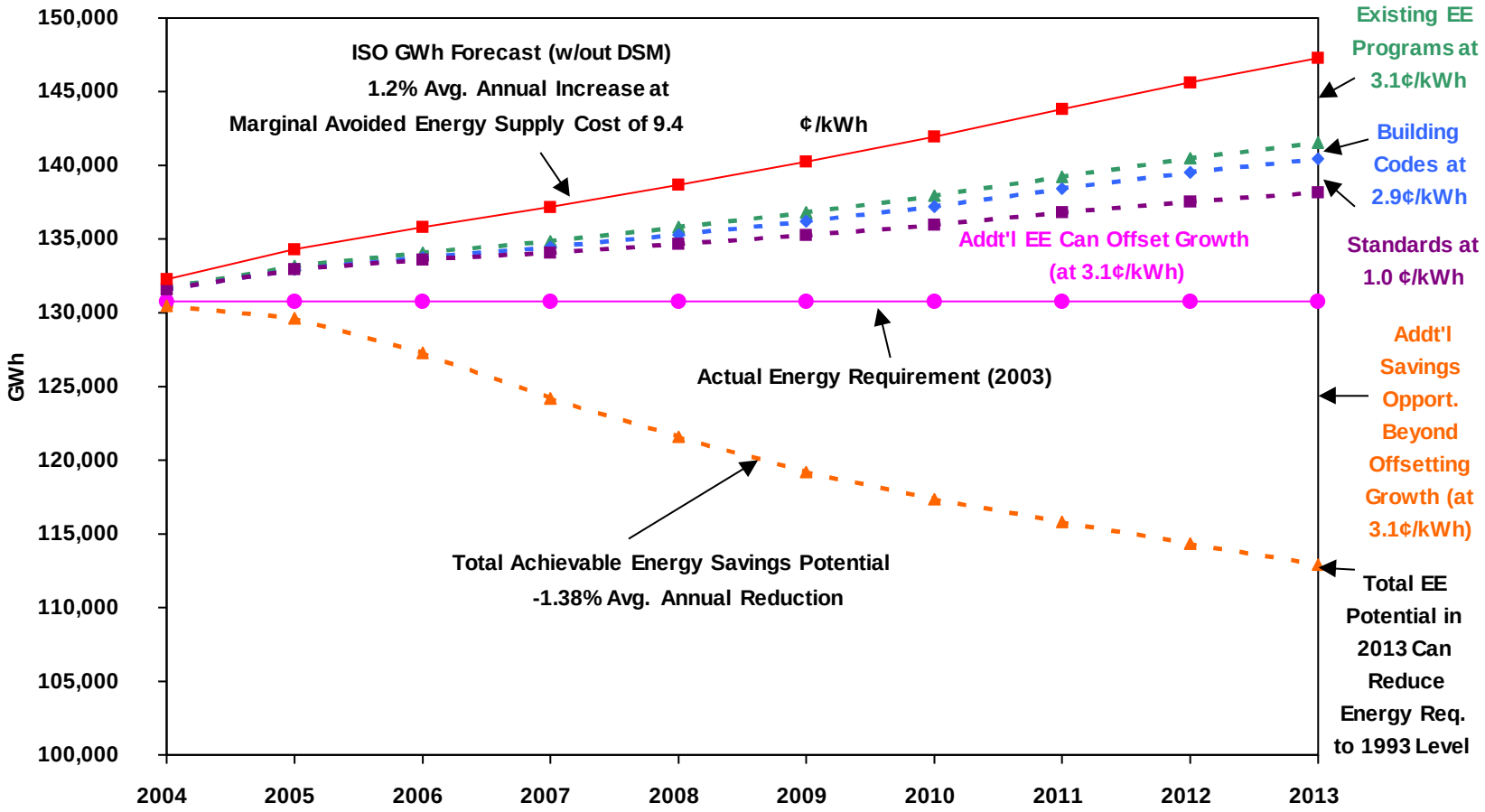
*20-year study period for PacifiCorp and NWPCC; 10 years for NEEP

**Percent of baseline sales forecasted for last year of the study period

NWPCC Study in Context

- Achievable, cost-effective energy efficiency could meet 85 percent of forecasted load *growth* in the four-state region over 20-year study period

NEEP Study in Context



Question and Answer Period

- Thank you!

About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

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