Measuring the Air Quality Impacts of Energy Efficiency: Module 2

Presented by
Chris James and John Shenot

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Introducing RAP

- RAP is a non-advocacy, non-profit organization providing technical and educational assistance to government officials on energy and environmental issues – *usually for free*.
- RAP principals all have extensive utility or environmental regulatory experience.
- Focused programs in US, EU, China, and India.
- RAP is celebrating its 20th year.

Introducing Chris and John

- Chris James is a senior associate at RAP; he previously led Connecticut's climate and energy efforts at the CT DEP.

- John Shenot joined RAP in 2011 after serving as policy advisor to WI's PSC and as an air quality engineer for WI's DNR.

Topics for Today

- How are energy efficiency (EE) data processed? By whom?
  - Calculating energy and demand savings
  - Calculating emissions reductions

Calculating Energy and Demand Savings: Module 2A

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September 6, 2012 **The Regulatory Assistance Project** 50 State Street, Suite 3
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“Savings” Defined

Energy (or Demand) Savings =
Baseline – Actual

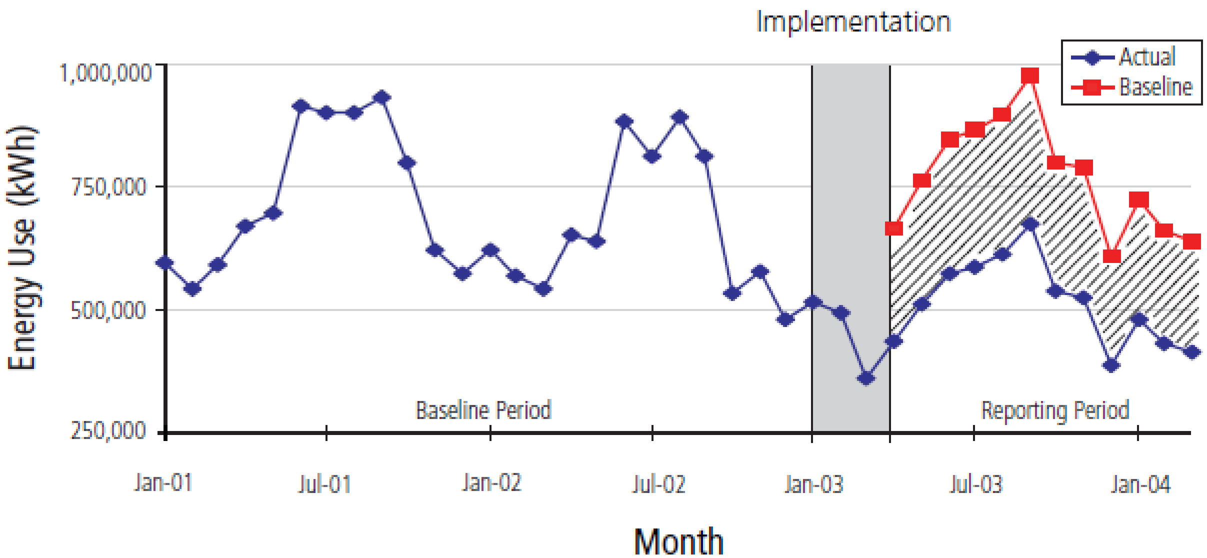
where

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

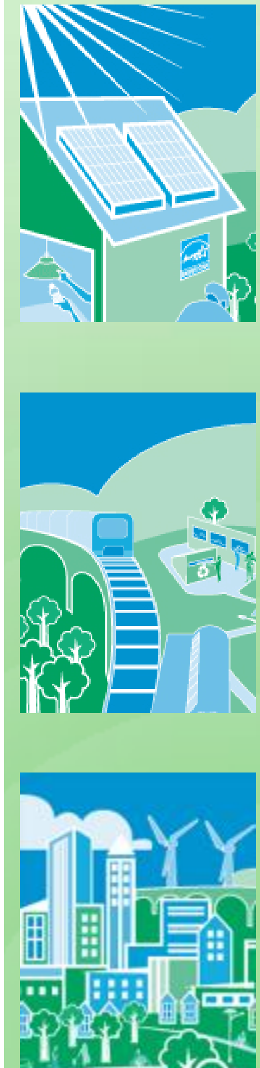


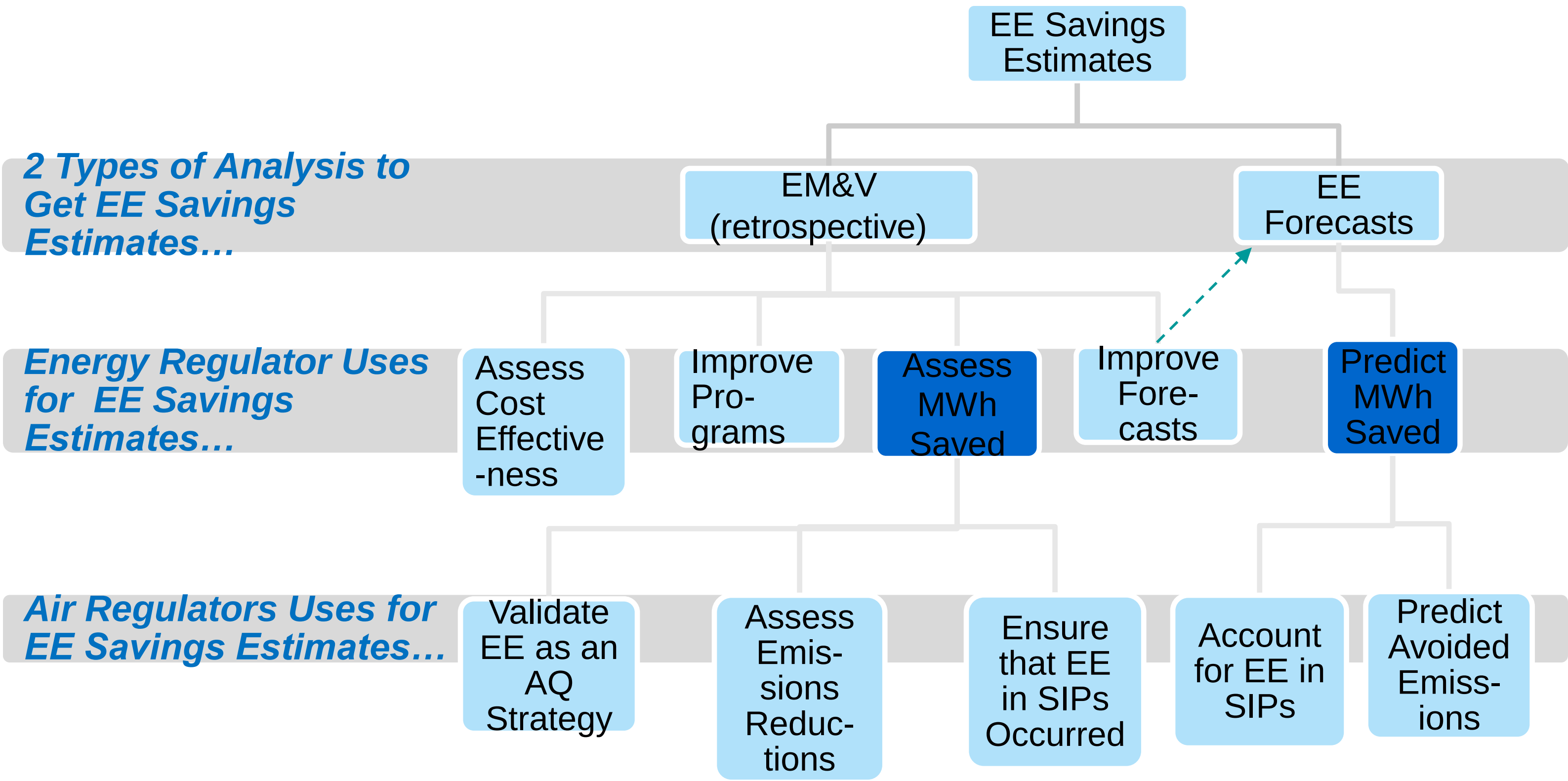
Source: National Action Plan for Energy Efficiency, *Model Energy Efficiency Program Impact Evaluation Guide*, November 2007.

Easy Example

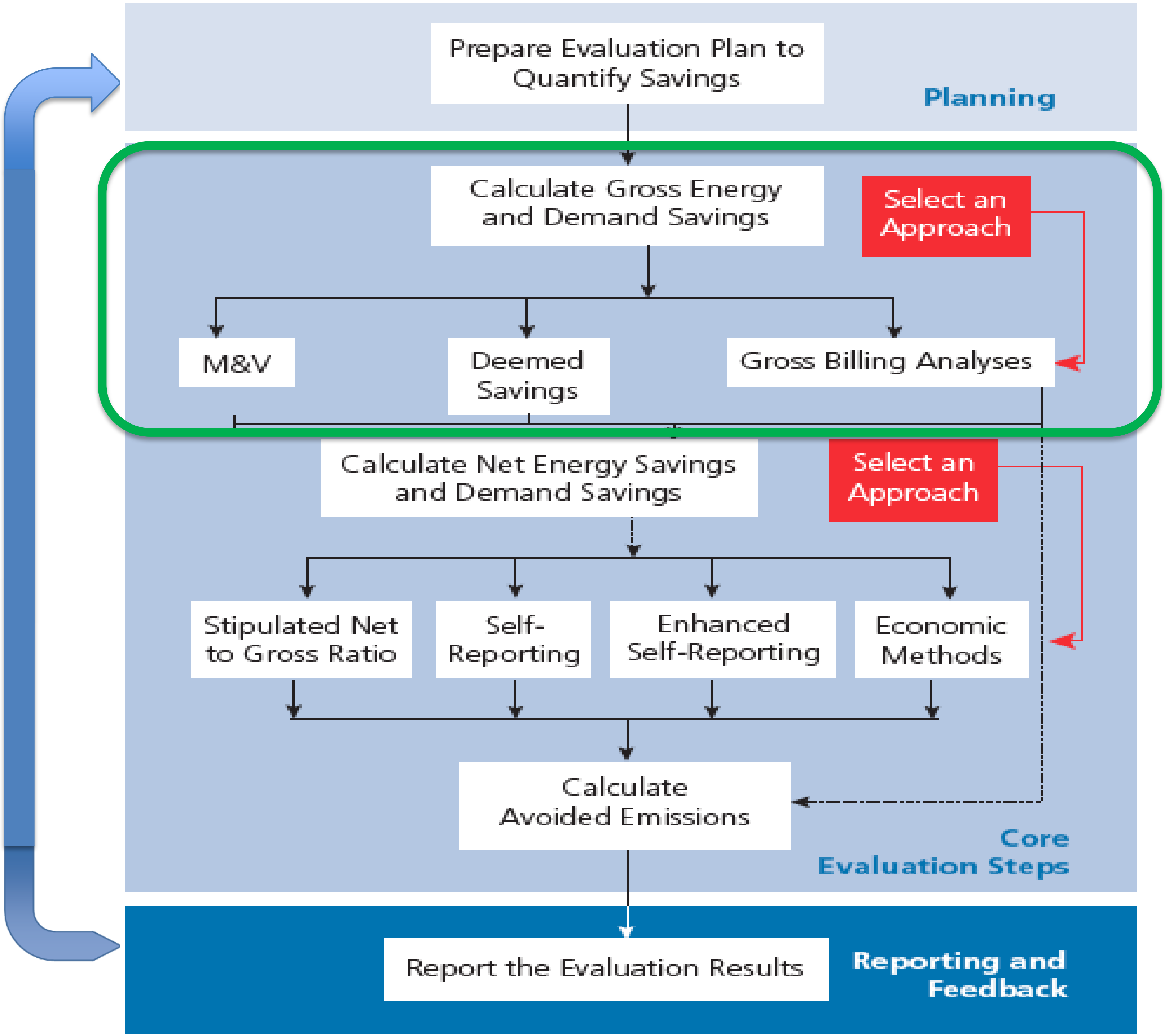
- Exit signs operate all day, every day
- Incandescent exit sign: 40 W, 350 kWh/yr
- LED exit sign: 5 W, 44 kWh/yr
- **Demand savings = 35 W/sign**
- **Energy savings = 306 kWh/yr/sign**

Uses for EE Savings Estimates





How Savings are Calculated in EE Program Evaluation Reports


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

Terminology

- You may find some variation in terminology across states and across evaluation reports
- A handy glossary is available from NEEP that covers most of the bases:
  - http://neep.org/emv-forum/forum-products-and-guidelines#glossary

Step 1: Estimate Gross Savings

- Gross Savings = the amount that results directly from EE program-related actions taken by participants, regardless of why they participated
- Involves a combination of methods:
  - Measured savings
  - Deemed savings
  - Gross billing analysis

Step 1: Estimating Gross Savings (cont.) Measured 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

Step 1: Estimating Gross Savings (cont.) Measured Savings Example (from CT)

- Custom weatherization programs:
  - Gross energy savings are "determined and documented on a case-by-case basis using commonly accepted engineering estimating techniques, approved energy simulation software, or through actual metering"

Step 1: Estimating Gross Savings (cont.) 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 savings for each project within a program
- Less accurate but also less expensive than measurement for each installation

Step 1: Estimating Gross Savings (cont.) Deemed Savings Example (CT)

- Residential Energy Star refrigerators:
  - Gross energy savings = 0.04405 * Federal Standard Energy Use (which depends on the style and volume of the refrigerator)
  - E.g., for a 25.6 ft^3 side-by-side refrigerator with through the door icemaker:
    - Federal Standard Energy Use = 665 kWh/yr
    - Deemed gross energy savings = 29 kWh/yr

Step 1: Estimating Gross Savings (cont.) Gross Billing Analysis

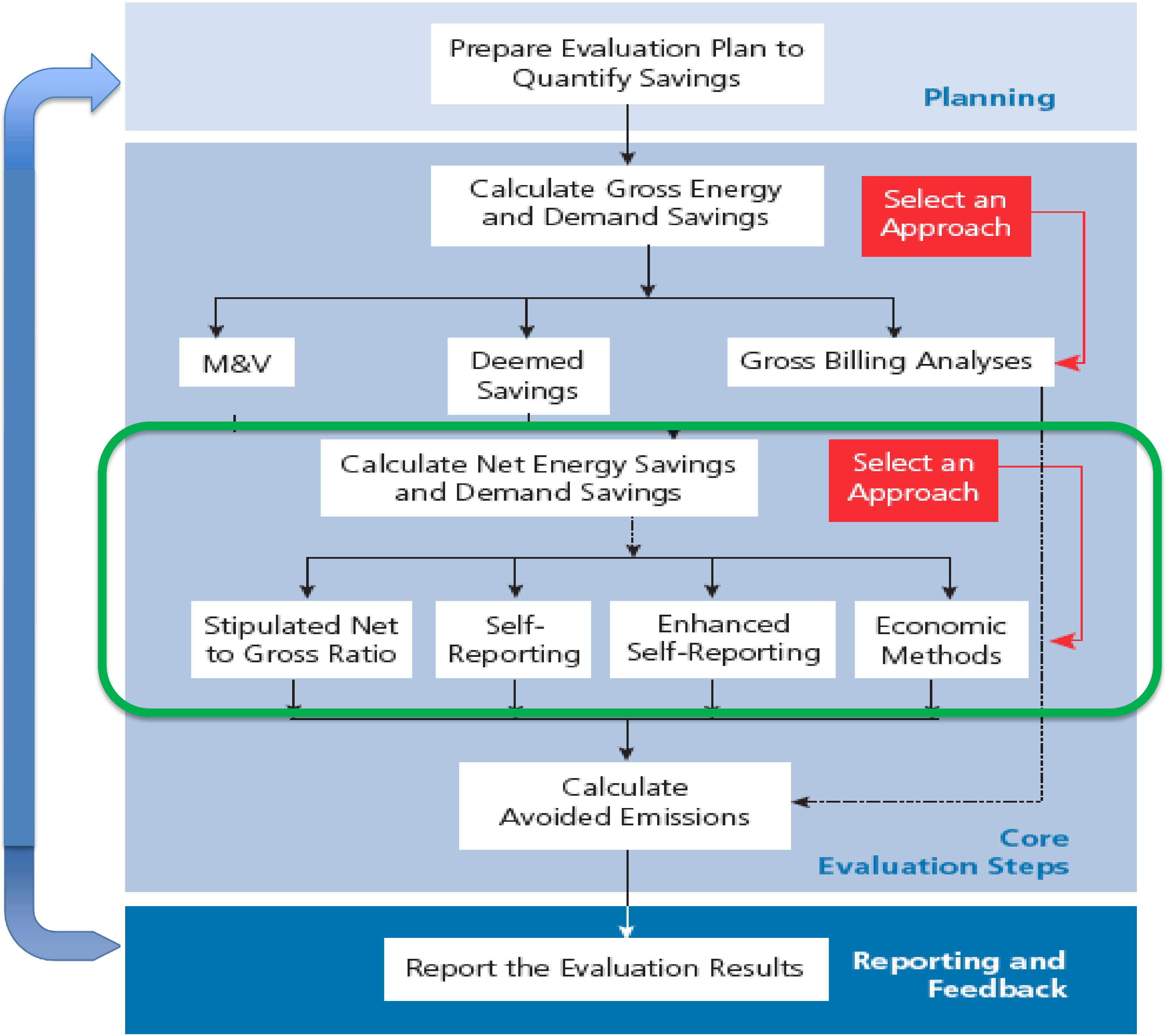
- Less common method
- Uses aggregated utility billing data and statistical methods, rather than project- or customer-specific measurements

Step 1: Estimating Gross Savings (cont.) Gross Billing Analysis Example (MA)

- Opinion Dynamics/Navigant Consulting evaluated behavior-based EE programs offered to National Grid customers in Massachusetts
- Survey methods combined with billing analyses indicated that the average participating household used 184 kWh/yr less than what would be expected in the absence of this program

Step 1: Estimating Gross Savings (cont.) Variations on Gross Savings

- *Adjusted* gross savings account for "installation rates" or other factors not reflected in deemed savings
- *Reported* savings are the amounts reported by the EE program administrator
- *Verified* savings are the amounts confirmed by the EE program evaluator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Core Evaluation Steps
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Step 2: Estimate Net Savings

- Net Savings = the amount of savings that can be *attributed to the EE program*, separating out other causes of changes in energy consumption or demand
- Why might net savings be different than gross savings?

Step 2: Estimating Net Savings (cont.) Why?

- **Free ridership**: some savings would occur even in the absence of the program
- **Spillover**: savings may be caused indirectly by the presence of the program
- **Installation rates:** some devices are purchased but not immediately installed
- **Rebound**: savings from installing an efficient device may be partially offset by greater use of the device

Step 2: Estimating Net Savings (cont.) How?

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 net-to-gross ratio (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:

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

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.

Step 2: Estimating Net Savings (cont.) Deemed NTGR Examples (CT)

Measure	Free Ridership	Spillover	Installation Rate	NTGR
General Service CFL Bulbs	9.2%	15.0%	76.6%	81.0%
Ceiling Fan & Lights	3.1%	6.0%	80%	82.3%
Torchieres	3.1%	6.0%	70%	72.0%

NTGR = (1- free ridership + spillover) * installation rate

Step 2: Estimating Net Savings (cont.) Variations on Net Savings

- Most EM&V reports show net savings at the customer's meter
- Vermont separately reports net savings at the customer's meter and at generation
  - *Net savings at generation* accounts for the amount of electricity lost in the transmission and distribution system
  - E.g., 100 kWh of savings at the meter might reduce generation by 110 kWh.

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?
- Measures have different expected lifetimes in terms of how long they save energy

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.

State	EE Program Evaluator(s)
CT	EE Board
DC	PSC, assisted by DDOE
DE	DNREC
MA	Utilities
MD	Utilities & PSC
ME	Efficiency Maine (3rd Party Admin.)
NH	PUC
NJ	Utilities & BPU
NY	Utilities & NYSERDA
PA	PUC
RI	Utilities
VA	SCC
VT	DPS

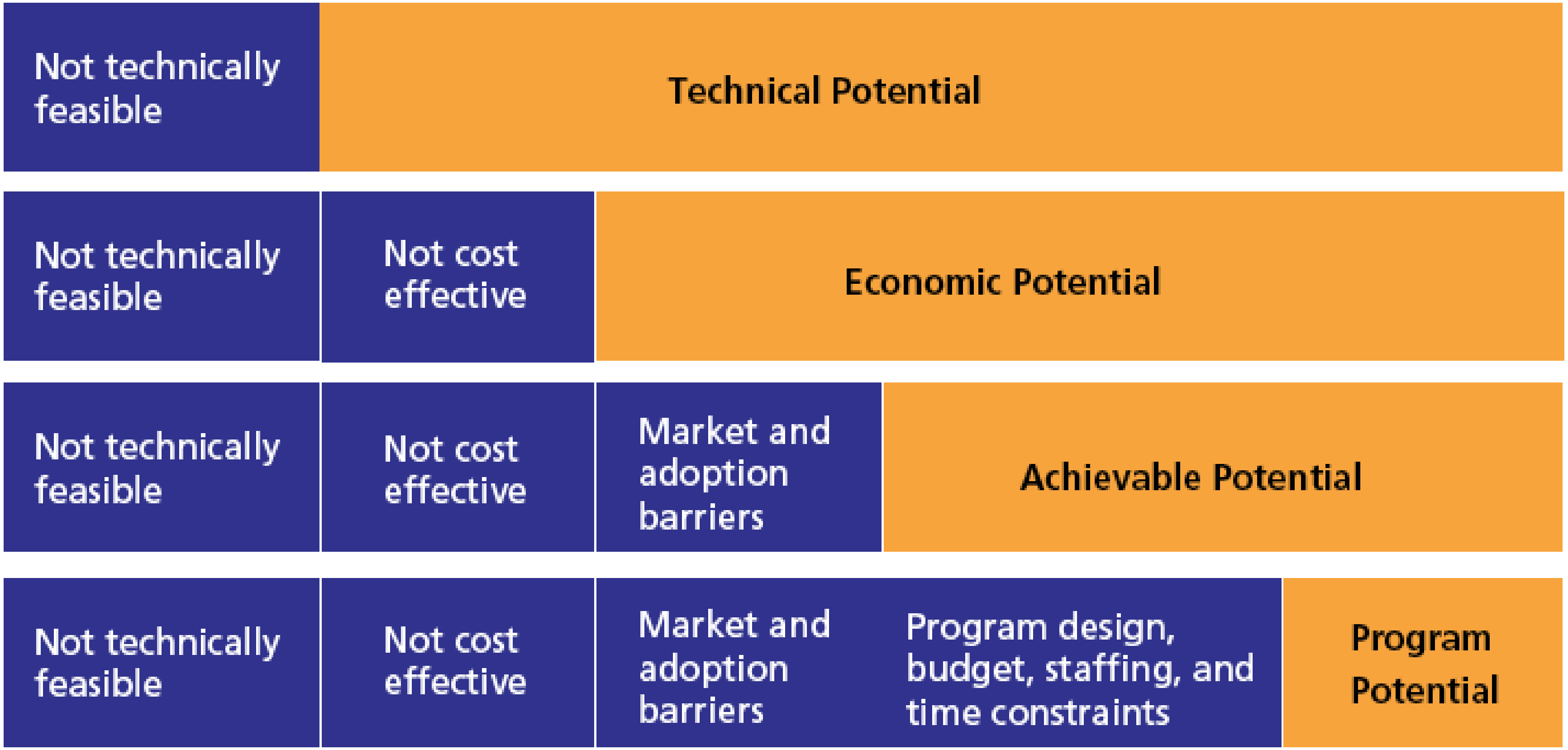
Source: *A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs* (ACEEE February 2012)

State	Savings Values Used
CT	Net
DC	(not yet determined)
DE	Both
MA	Both
MD	Gross
ME	Both
NH	Gross
NJ	Gross
NY	Net
PA	Gross
RI	Net
VA	Both
VT	Net

Source: *A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs* (ACEEE February 2012)

How Savings are Calculated in EE Potential Studies

Multiple Meanings of “Potential”



Typical Methodology for EE Potential Studies

- Step 1: Develop Initial Input Data
  - Develop list of EE measures to include in scope, based on analyst experience, expertise and feedback from stakeholders
  - Develop technical data (installation costs and energy savings) on each EE measure opportunity

Typical Methodology for EE Potential Studies (cont.)

- Step 1: Develop Initial Input Data (cont.)
  - Develop information on potential installations of each EE measure (based on building characteristics, number of households, market shares of key electric consuming equipment, initial market shares of EE measures, etc.)
  - Collect data on economic assumptions: avoided energy costs, electricity rates, discount rates, and inflation rate

Typical Methodology for EE Potential Studies (cont.)

- Step 2: Estimate Technical Potential
  - Match and integrate data on EE measures to data on existing building characteristics to produce estimates of technical potential

Typical Methodology for EE Potential Studies (cont.)

- Step 3: Estimate Economic Potential
  - Match and integrate EE measure and building data with economic assumptions to produce indicators of costs from different viewpoints (e.g., societal and consumer)
  - Estimate total economic potential using an industry standard cost-effectiveness test such as the total resource cost (TRC)

Typical Methodology for EE Potential Studies (cont.)

- Step 4: Estimate Achievable Potential
  - Identify market barriers (e.g. retailers don't carry efficient product)
  - Estimate customer adoption rates for EE measures based on assumed incentive levels, market barriers, etc.

Typical Methodology for EE Potential Studies (cont.)

- Step 5: Estimate Program Potential
  - Gather and develop estimates of program costs (e.g., for administration and marketing)
  - Identify any externally-imposed program budget or other constraints that will limit achievable potential
  - Apply limitations to estimate total program potential savings

Examples of Potential Studies

- *From Potential to Action: How New England Can Save Energy, Cut Costs, and Create a Brighter Future with Energy Efficiency* (Optimal Energy 2010)
- *Vermont Electric Energy Efficiency Potential Study* (GDS 2007)
- *Natural Gas Energy Efficiency Potential in Massachusetts* (GDS 2009)

Example of Results from the Optimal Energy 2010 Study

State	Annual Cumulative Savings Potential (GWh)								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Connecticut	872	1,744	2,616	3,488	4,360	5,232	6,104	6,976	7,849
Maine	311	622	932	1,243	1,554	1,865	2,175	2,486	2,797
Massachusetts	1,677	3,354	5,031	6,708	8,385	10,062	11,739	13,416	15,093
New Hampshire	329	659	988	1,318	1,647	1,977	2,306	2,636	2,965
Rhode Island	179	359	538	718	897	1,077	1,256	1,436	1,615
Vermont	164	328	492	656	820	985	1,149	1,313	1,477
New England	3,533	7,066	10,599	14,131	17,664	21,197	24,730	28,263	31,796

Importance of Timing and Location

- For some data uses, it doesn't matter what time of day/year or where energy is saved
- But for air quality planning, it does matter because it (partially) determines which power plant won't be dispatched, and thus the emissions avoided
  - Day, night, weekday or weekend, etc.?
  - Concentrated in one geographic area, or evenly dispersed across the state?

Promising Examples

- Con Edison published a first-of-its-kind paper in 2011 describing their method for forecasting the expected future demand reduction at each substation that will result from their EE programs
- Con Edison and a few others also offer good examples of attempts to discern hourly variations in savings

Which Data do I Use to Estimate Emissions Reductions?

It Depends…

- Are you estimating *potential* emissions reductions or *expected* reductions?
- What is actually required by state policy or Commission order?
- What are the utilities (or other EE program administrators) actually planning for in terms of acquiring EE?

One Final Complication

- What is the source for power sector data in your baseline forecast of emissions?
- To what extent are the expected impacts of EE policies and programs ***already embedded*** in your emissions baseline/forecast?

Supplemental slides, to be used only if questions arise on these topics

Example of an EE Supply Curve