Introduction to Measurement & Verification in Federal ESPCs

What you don't measure, you can't manage.

What is M&V, and why do you need it?

- **M&V refers to any activities aimed at determining whether the savings guarantee is being met**
  - The guarantee and annual M&V are legally and contractually required
- **When M&V is done well, it will:**
  - Reduce uncertainty of the savings estimates to a reasonable level
  - Allocate risks appropriately
  - Potentially identify operations & maintenance issues

Basic M&V Concepts

- **M&V methods should balance savings assurance against added cost**
- **The degree of M&V should be proportional to**
  1) the ECM's savings; and
  2) the ECM's performance risk
- **Good M&V plans require ESCOs to measure the key performance parameters of ECMs**
- **If the M&V plan is weak, the guarantee may be met only on paper**

FEMP Guidance on M&V
(items 2, 6, 8, and 9 in the "Resources" section of FEMP's ESPC Web site)

- **FEMP M&V Guidelines v. 3.0**
  - M&V specifically for federal energy projects
  - Application of the International Performance Measurement and Verification Protocol (IPMVP)
- **Introduction to M&V for FEMP ESPC Projects**
- **Guidance on government witnessing of M&V**
- **Guidance on reviewing M&V reports**

M&V in the ESPC Process (more on this in Phases 4 & 5)

Baselines	• Defined in IGA and Proposal
M&V Plan	• Developed as part of Proposal
Post-Installation M&V Report	• Verification of ECMs' ability to perform
Annual M&V	• Activities per M&V Plan • Findings documented in M&V reports

Baselines

- Typically proposed for each ECM by ESCO as part of investment grade audit; agency reviews/approves
- Baselines are compared to post-installation energy use to determine savings
- Once project is installed, it's difficult or impossible to revisit baselines, so properly defining them is important
- Baselines may vary with changes in weather (or other factors, potentially)
  - e.g., gas usage = 2500 MMBtu + 46 × (Heating Degree Days)

Savings Guarantee

- Savings must exceed payments
  - This is cardinal rule of federal ESPC
  - DOE has interpreted this to mean that savings must exceed payments in each year
- Savings that may be used to pay the ESCO:
  - Energy and water cost savings
  - Energy/water-related cost savings

Energy and Water Cost Savings

- Reductions in system use
- Efficiency improvements
- Reductions in peak demand
- Reductions in energy rates
- Shifting time of use to lower-cost periods
- Switching to less expensive fuels
- Self-generation (including cogeneration/CHP)
- Reduced water and sewer use
- Reduced sewer charges (e.g., due to irrigation)

Energy/Water-*Related* Cost Savings

- **Most commonly reduced O&M expenses**
  - Parts and repair costs
  - Equipment replacement costs
  - O&M contracts and other labor
- **Cost savings must be *real***
  - If labor savings are claimed, agency must demonstrate contract or staff reductions
  - Reducing tasks of existing staff does not count

Other Sources of Savings (and thus payments)

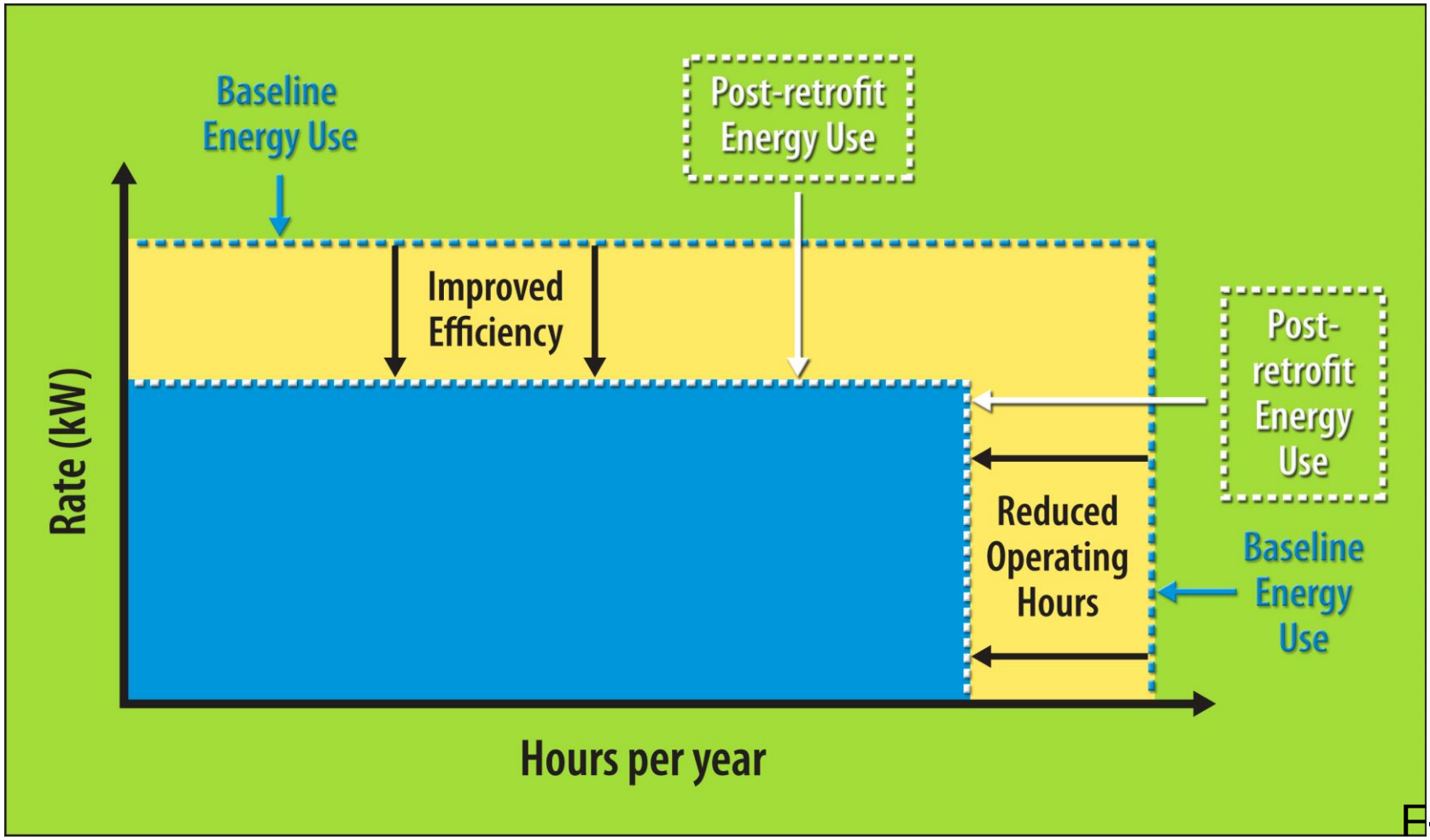
- **Cost avoidance provided by the project**
  - Example: Including chiller replacement funds in project where funds were planned to be paid out of repair & replacement budget in early year of project
- **Construction period energy savings**
  - Savings accrued from ECMs that are installed and performing in advance of project acceptance
- **More info on acceptable sources of savings:**
  - *Practical Guide to Savings and Payments in Federal ESPC Projects*, in "Resources" section of ESPC Web site

Calculating Savings

- **There are two components to energy use**
  - Rate of energy use (e.g., watts of lamp)
  - Usage (hours of use)
- **Energy use is the product of the two**
  - Example: 4 kW × 2 hours = 8 kWh

Reducing the rate of energy use *or* the usage (hours) reduces the total energy use

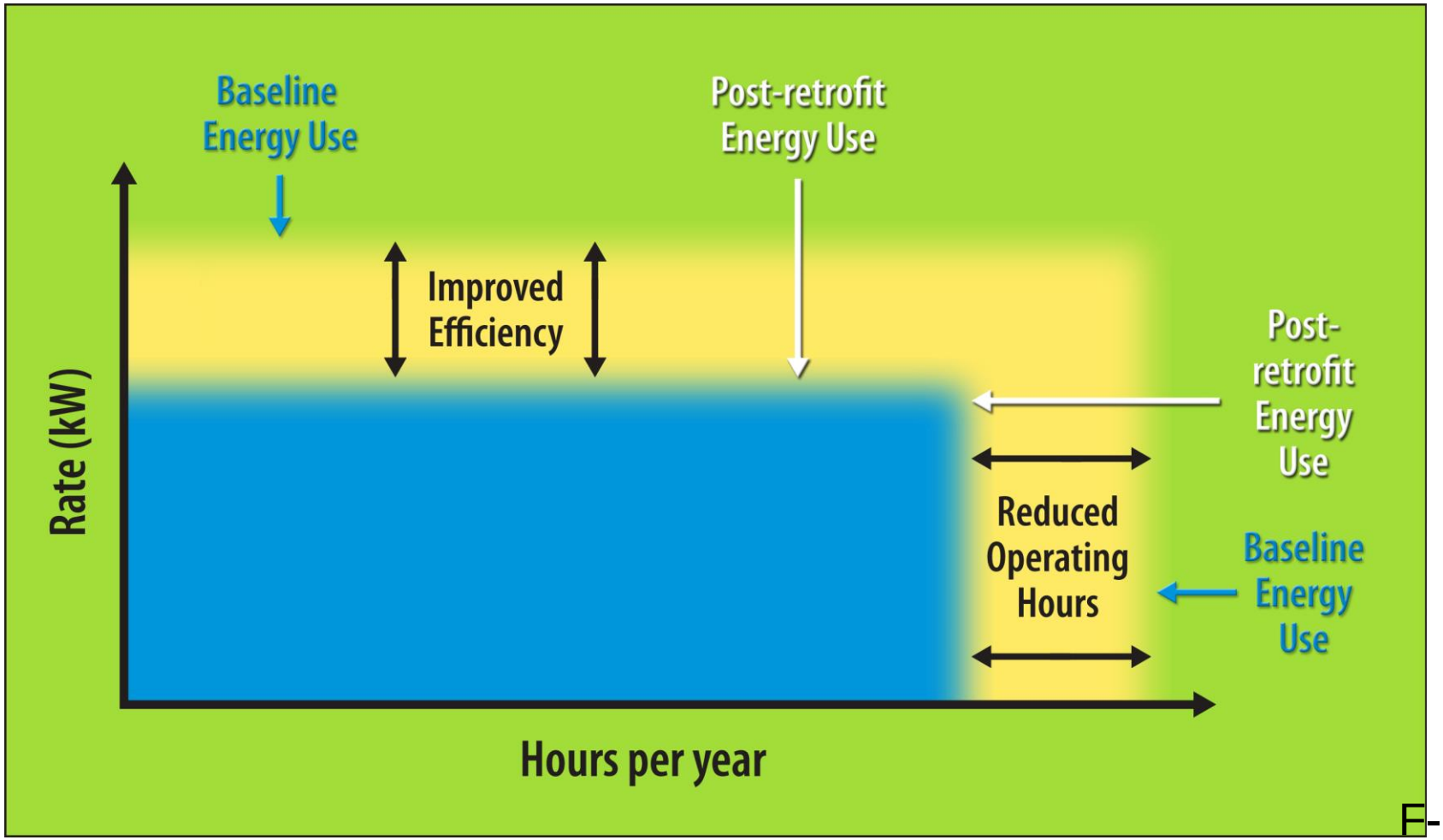
Achieving Energy Savings



Savings Uncertainty

- **We can't measure savings directly**
  - Because it's the absence of something – i.e., it's energy use that's not there any more!
- **We measure energy use before and after the ECM – the savings is the difference (roughly)**
- **We usually don't know the *exact* energy use before and after**
  - there is almost always some uncertainty in each
- **And even when we do, we can't know for sure what's responsible for all the change**

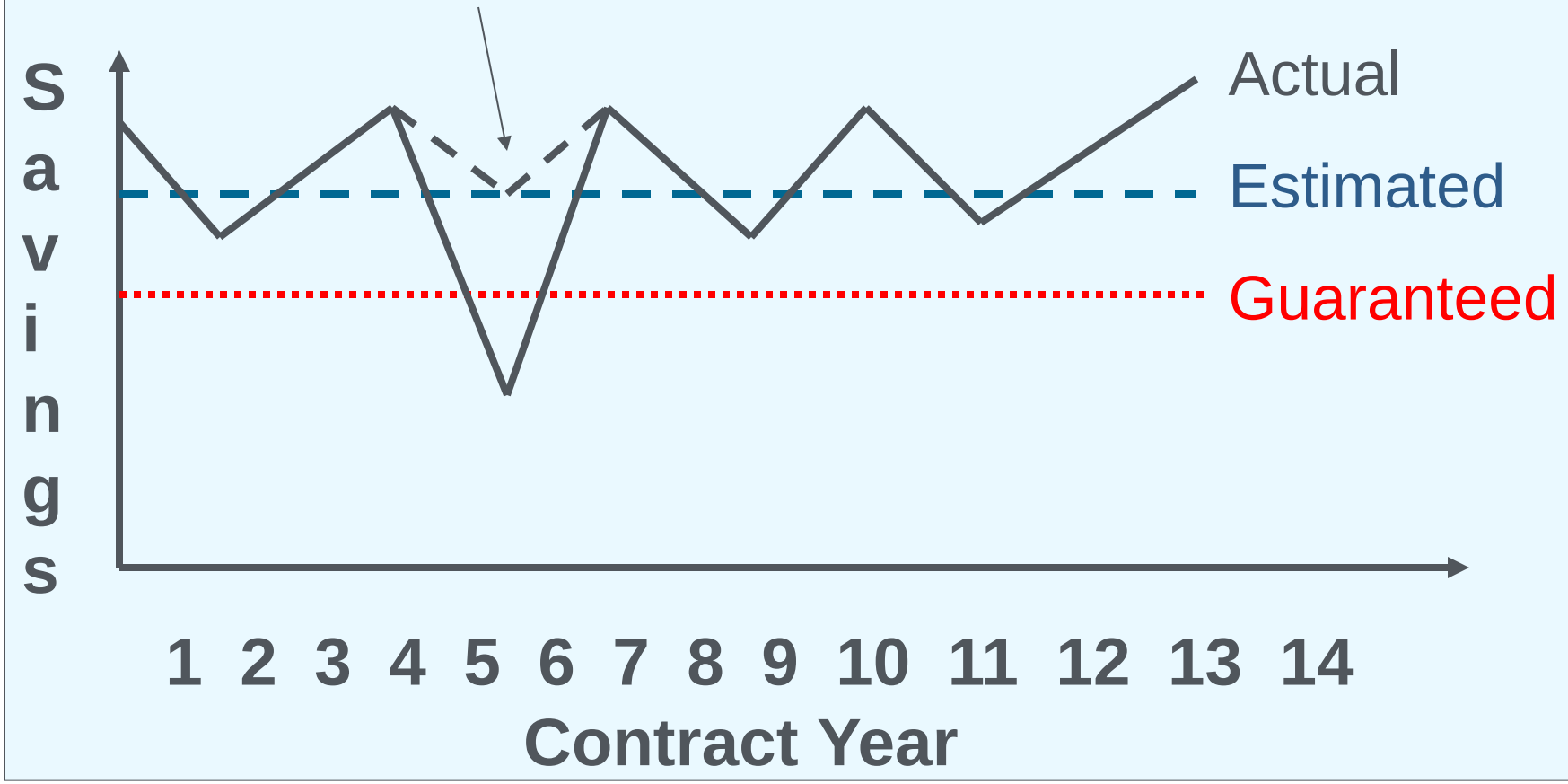
Achieving Energy Savings: The Real Picture



Uncertainty can be reduced, but never eliminated

- **Claimed savings are always estimates because savings cannot be measured directly**
- **Uncertainty is introduced through:**
  - Measurement and modeling error
  - Sampling error
  - Simplifying assumptions
  - Other changes at facility
- **These factors are inherent in M&V**

Savings can be normalized to account for mild or severe weather years.
Example: Mild summer in year 5 adjusted to average using TMY.



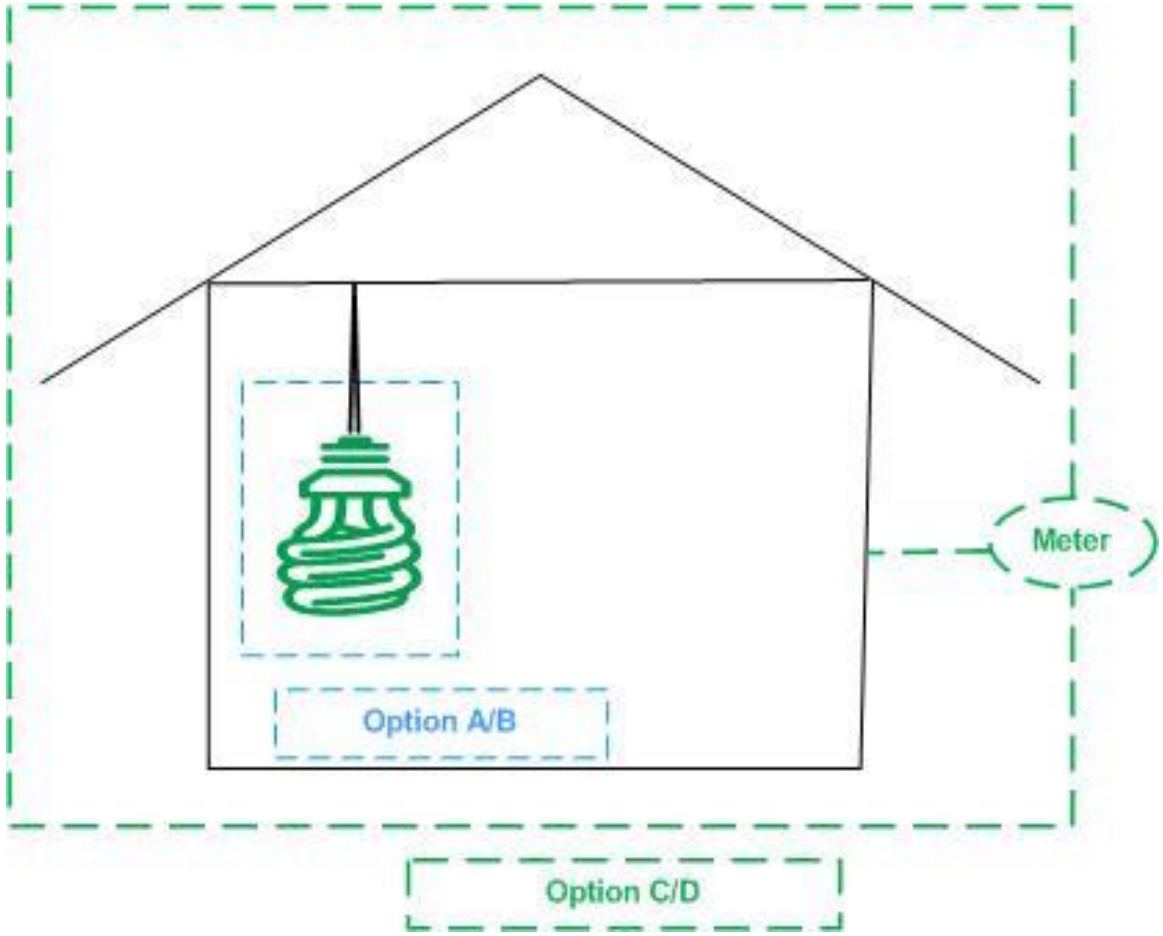
M&V Options: A, B, C, and D

- **Options address risk allocation**
- **Each ECM assigned an M&V option**
- **Measurements differ by:**
  - Level – individual system vs. whole building
  - Duration – spot, short-term, periodic, continual
  - Whether key values are held constant without performance period measurement
    - Example: hours of lighting operation may be determined in IGA and then fixed for purposes of savings calculation
  - Expense
    - Up-front – ranges from 1 to 15% (avg. 3%) of project investment
    - Annual – averages about 3% of annual savings
    - More complex, interactive ECMs justify more M&V effort

FEMP and IPMVP M&V Options

M&V Option	How savings are calculated
Option A: "Retrofit Isolation, Key Parameter" – Based on measurement of *key* parameter, either equipment performance or operational factors (usually equipment performance)	Engineering calculations using measured and estimated data
Option B: "Retrofit Isolation, All Parameters" – Based on measurements (usually periodic or continuous) taken of *all* relevant parameters; often entails long-term metering.	Engineering calculations using measured data
Option C: Based on *whole-building* or facility-level utility meter data adjusted for weather and/or other factors.	Analysis of utility meter data
Option D: Based on *computer simulation* of building or process; simulation is calibrated with measured data.	Comparing different models

Options A/B vs. Options C/D



Options A & B are retrofit isolation methods.

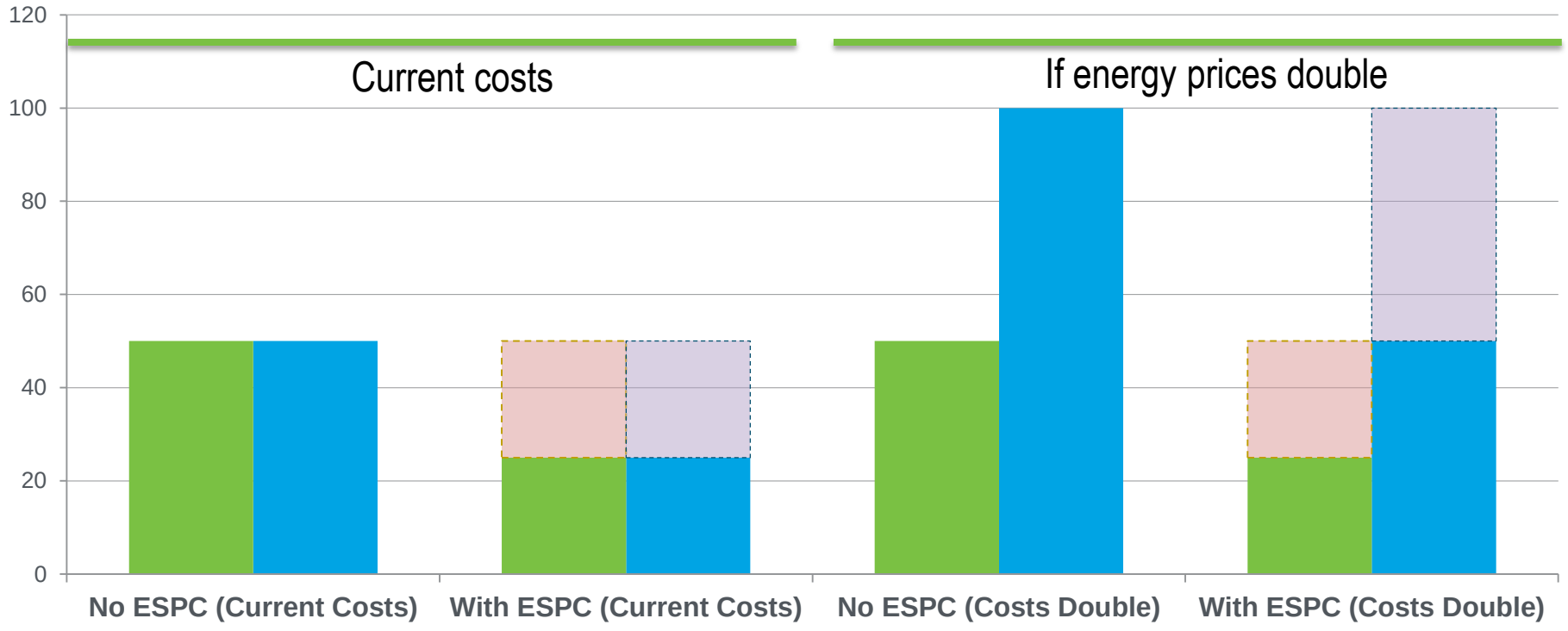
Options C&D are whole-facility methods.

The difference is where the boundary lines are drawn.

Energy Prices and ESPC

- When energy prices go up, savings appear to evaporate, because total utility costs go up
- What is the actual effect of per-unit energy price increases on ECMs' savings (cost avoidance)?
  - Yes, the bills may go up relative to prior levels, but …
  - Key issue is what ***they would be without*** the ESPC
- ESPC can be seen as a hedge against higher energy prices

What if energy prices increase?



Best M&V Practices During Project Development

- Understand ESCO's perspective
  - They're guaranteeing performance – is closer inspection (i.e., more M&V) in their interest?
- Recognize that goal is to reduce uncertainty in savings … but that adding M&V adds cost
  - Need to balance these two
  - More complex ECMs usually merit more M&V

Best M&V Practices During Project Development

- Make sure that ESCO-proposed baselines and fixed parameters for ECMs are sound
  - Because they are cornerstones of the savings calculation
- Stay involved throughout performance period
  - Review annual M&V reports, stay in touch with ESCO, etc.
  - Take advantage of FEMP's life-of-contract support

Review Questions

Q1: Why is M&V required in ESPC?

A: To verify that guaranteed savings are delivered and ensure that savings persist.

Q2: The degree/cost/rigor of M&V should be proportional to the ECM's _____ and _____.

A: savings and risk

Q3: Identify one source of one-time energy-related cost savings.

A: (1) Cost avoidance when ESPC includes something agency was planning to install itself;
(2) Implementation-period savings from ECMs installed and conditionally accepted early in construction

Review Questions

Q4: We can't directly measure savings, but we *can* measure energy *use*, _____ and _____.

A: before and after

Q5: Name the two retrofit-isolation M&V options.

A: Option A and Option B

Q6: M&V can reduce – but never eliminate – _____ .

A: Risk or uncertainty

Next: G – Risk, Responsibility, and Performance Matrix