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Measurement & Verification-Theory, Basics & Applications

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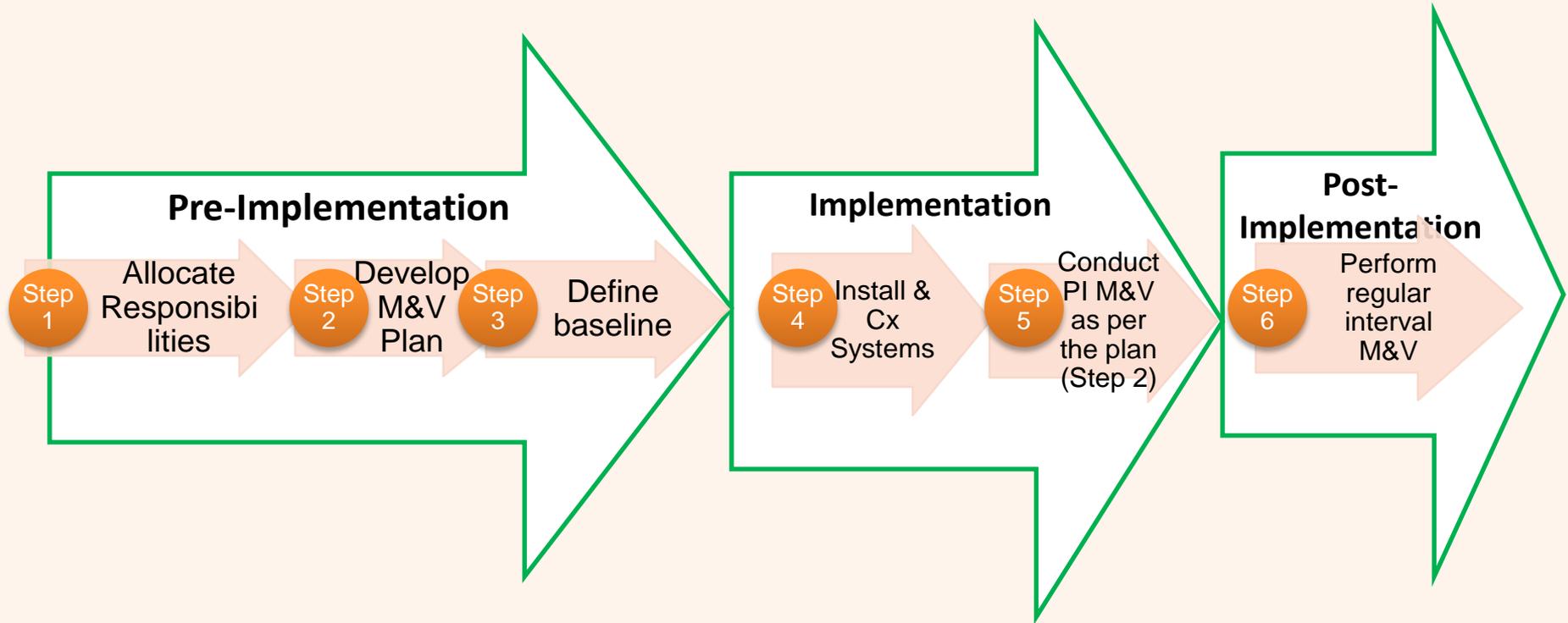
Overview

- Background
- M&V Process
- M&V Options
- Option Selection
- Applications
- Conclusions

Measurement & Verification

- Ensures accuracy of energy savings
- Mitigate risk for both the customer and the contractor
- Balances between M&V costs and savings certainty.
- Three widely accepted M&V Guidelines:
 - FEMP's M&V Guidelines for Federal Energy Projects- Version 3.0
 - International Performance Measurement & Verification Protocol Vol I 2009, prepared by Efficiency Valuation Organization
 - ASHRAE Guideline 14

M&V Process



Before Project Implementation

- Allocate project responsibilities
 - Between ESCO & agency
- Develop a project-specific M&V plan
 - Includes savings calculation methodology
 - Specifies ongoing activities that will occur during the contract term
- Define the baseline
 - Physical conditions through surveys, inspections, spot measurements, and short-term metering
 - Verify using utility bills

During Project Implementation

- Install & Cx equipment & systems
 - Ensure systems are working as intended
 - Inspect and test for functionality
 - Specify activities in a Cx Plan,
 - Document results in a Cx Report
- Conduct PI verification activities
 - Ensure proper equipment/systems were installed, are operating correctly,
 - Verify generate the predicted savings.
 - Include verification methods-surveys, inspections, spot measurements, and short-term metering.

After Project Implementation

- Perform regular-interval verification activities during performance period
 - Ensure systems continue to operate correctly
 - Continue to potentially generate the predicted savings

M&V Options

■ Option A

- Retrofit Isolation with Key Parameter Measurement

■ Option B

- Retrofit Isolation with All Parameter Measurement

■ Option C

- Utility Data Analysis

■ Option D

- Calibrated Computer Simulations

Option A

- One-time or short-term pre and post measurements
- Non-measured factors agreed upon by all parties, including hours of use or manufacturer's data
- Good Candidates for Option A M&V
 - Lighting retrofits
 - Water conservation measures

Option B

- Field measurement of the energy use of the affected ECM
- Measurement frequency ranges from Short-term to continuous
- Good Candidates for Option B M&V
 - Chiller replacements
 - VFD retrofits
 - Building automation system improvements
 - Renewable energy measures

Option C

- Whole building/facility metering
- Assess energy performance of an entire building
- Best used where savings are large enough and there is a high degree of interaction among measures
- Difficult to track performance of individual measures
- Usually requires regression analysis to account for any changes- weather, occupancy, operating hours etc.

Option D

- Involves use of computer simulation software to predict energy use
- Initial savings are based on a pre-retrofit simulation model;
- Actual savings are based on a calibrated post-retrofit simulation model
- High level of accuracy is required
- Best used where baseline data or post-retrofit data is unavailable or unreliable

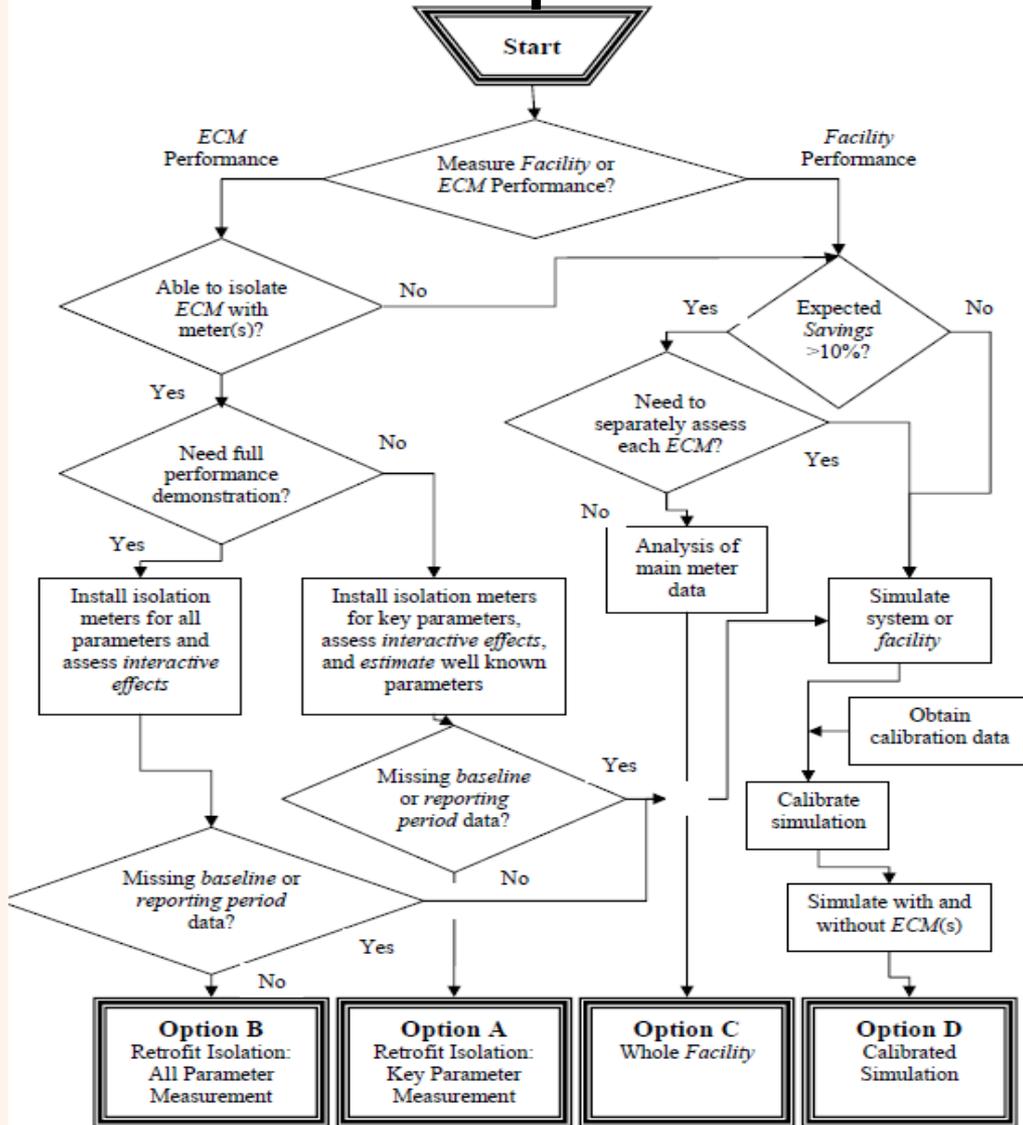
M&V Cost Issues

- Option A is the least expensive method
- Option B can be costly depending on the extent of required post-retrofit metering
- Cost for Option C depends on number of utility meters and post-retrofit data collection
- Developing a calibrated simulation model (Option D) is usually a costly endeavor

Suggested Options by Application

ECM Project Characteristic	Suggested Option			
	A	B	C	D
Need to assess <i>ECMs</i> individually	X	X		X
Need to assess only total facility performance			X	X
Expected <i>savings</i> less than 10% of utility meter	X	X		X
Multiple <i>ECMs</i>	X		X	X
Significance of some <i>energy</i> driving variables is unclear		X	X	X
<i>Interactive effects</i> of ECM are significant or unmeasurable			X	X
Many future changes expected within <i>measurement boundary</i>	X			X
Long term performance assessment needed	X		X	
Baseline data not available				X
Non-technical persons must understand reports	X	X	X	
Metering skill available	X	X		
Computer simulation skill available				X
Experience reading utility bills and performing regression analysis available			X	

M&V-Option Selection Process

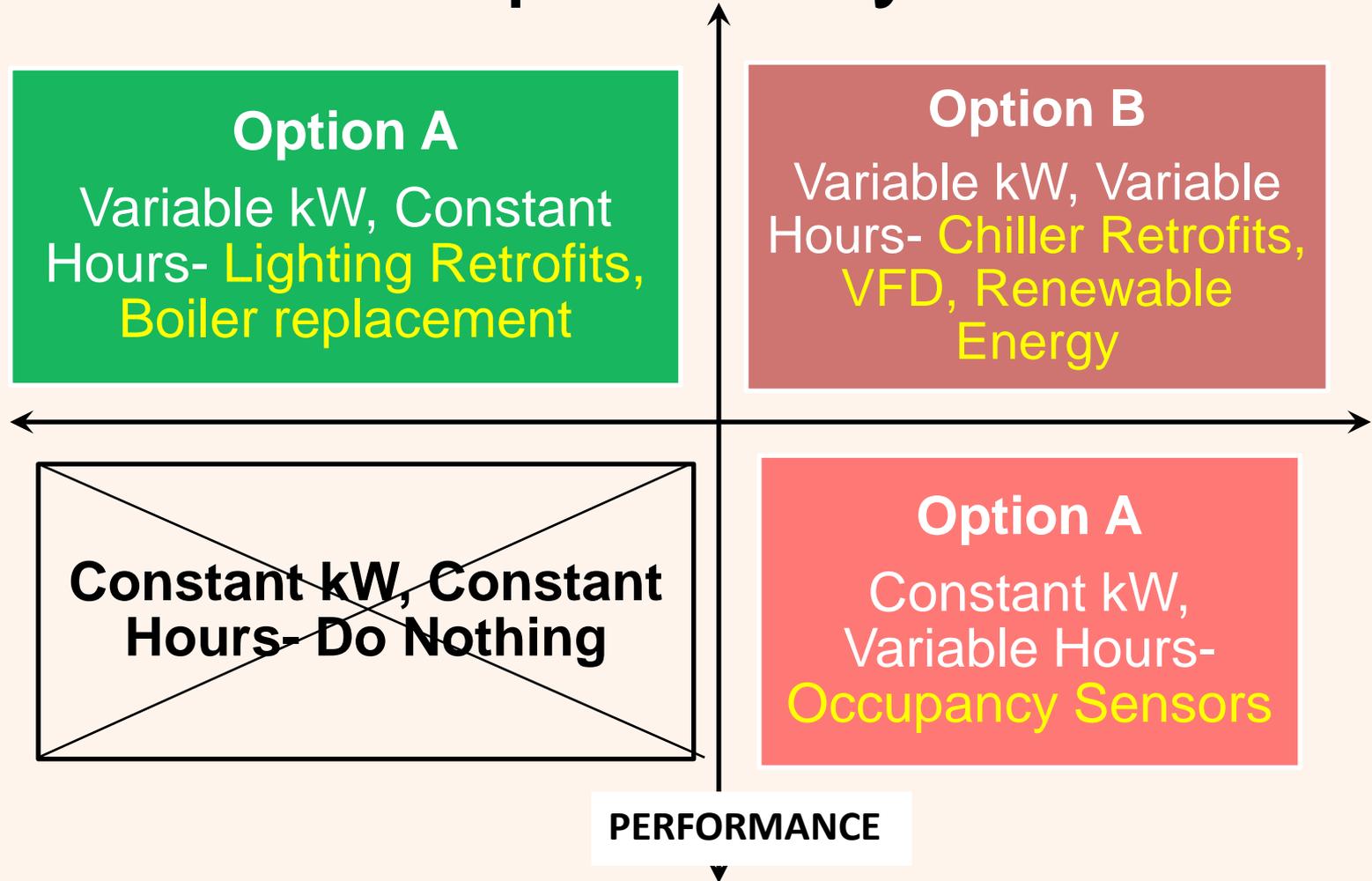


Source: IPMVP: Concepts and Options for Determining Energy and Water Savings Volume 1

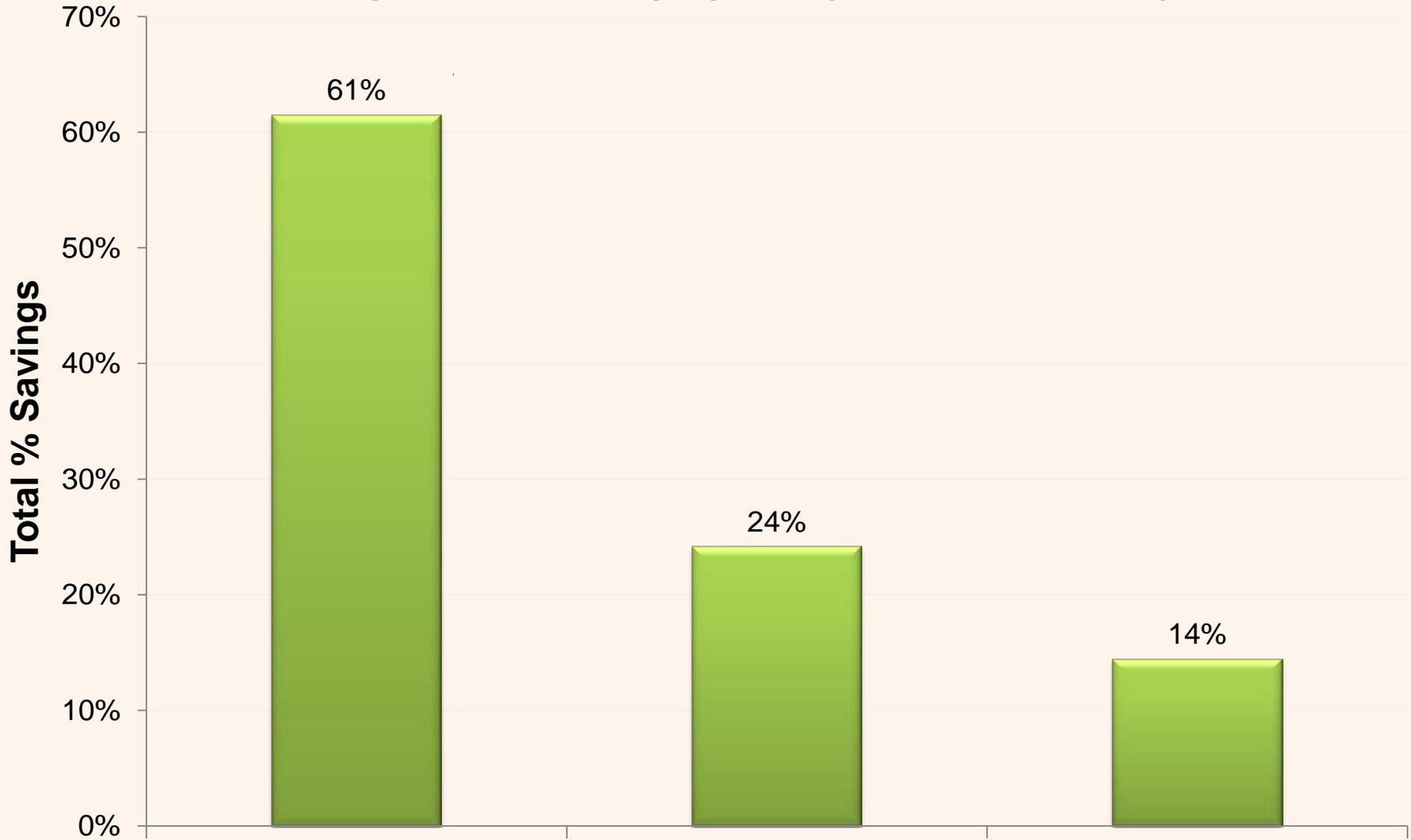
M&V-Applications

ECM→ M&V Option↓	Lighting, Occupancy Sensors	Chiller Retrofits	Interactive ECMs with High savings/baseline with available utility data	New Building Designed Better Than Code
Option A	√			
Option B		√		
Option C			√	
Option D				√

M&V Options by ECM



M&V Options for ECMs proposed (ESPC FY 2009 Data)

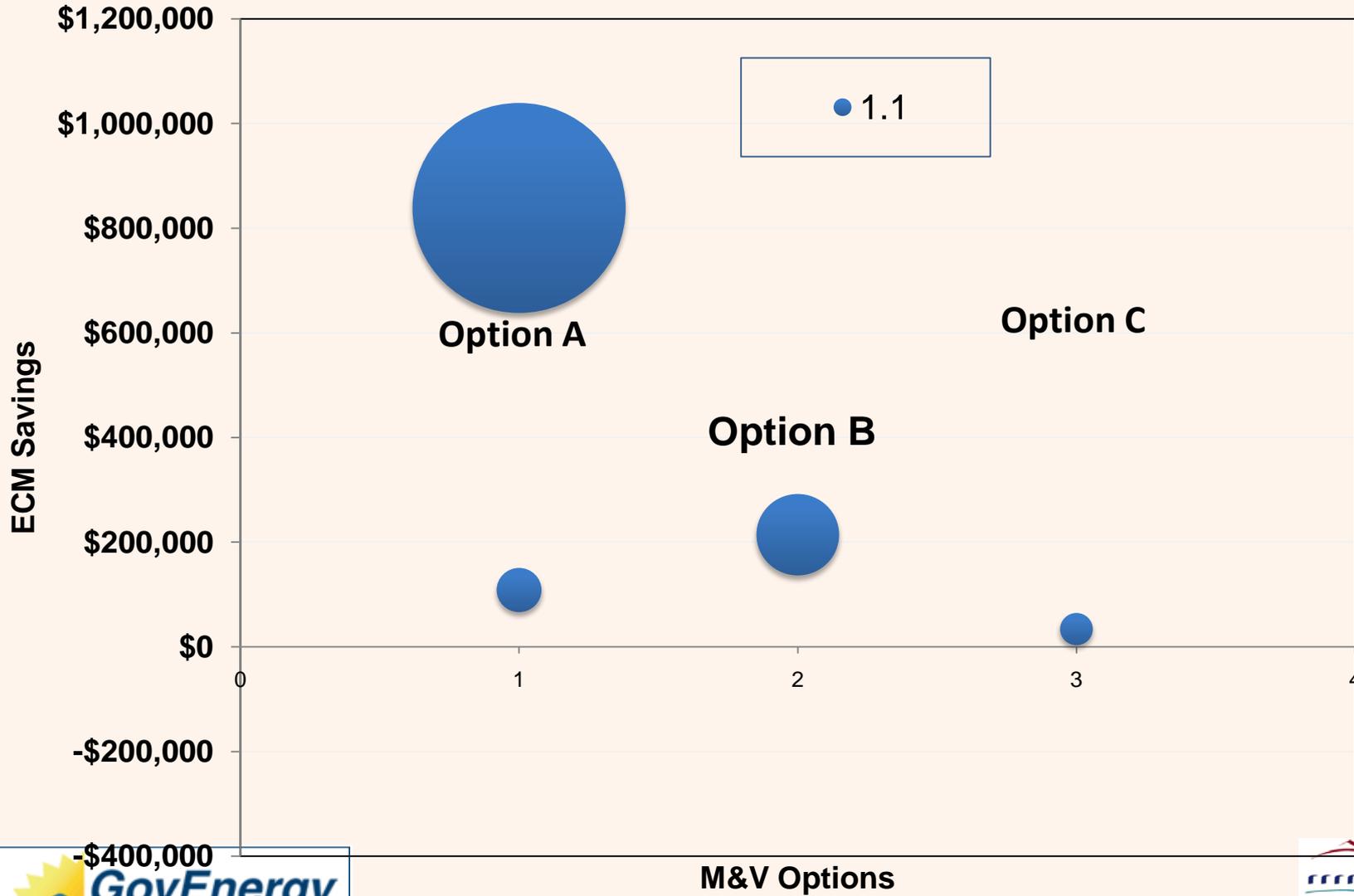


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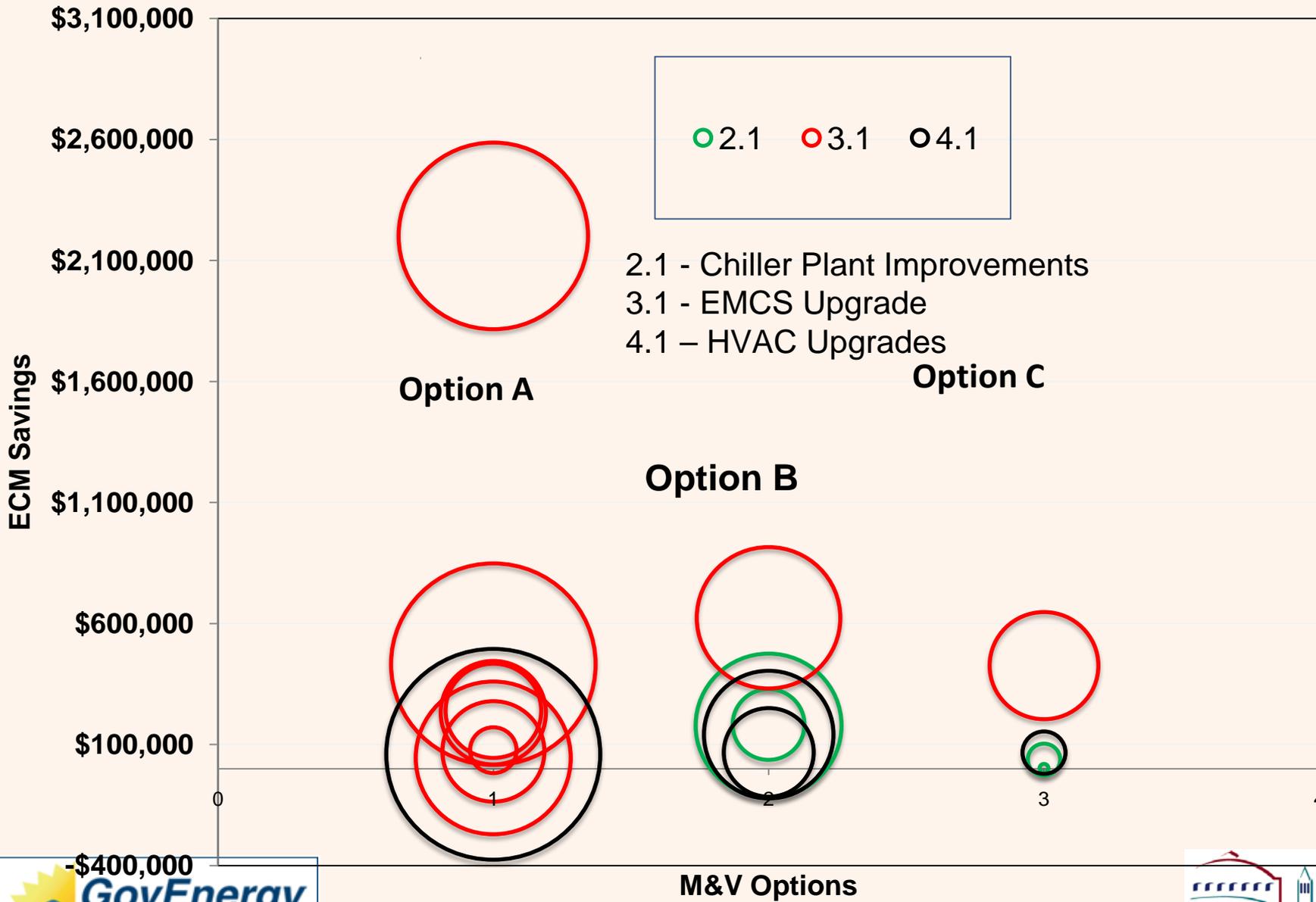
A
B
C
M&V Options



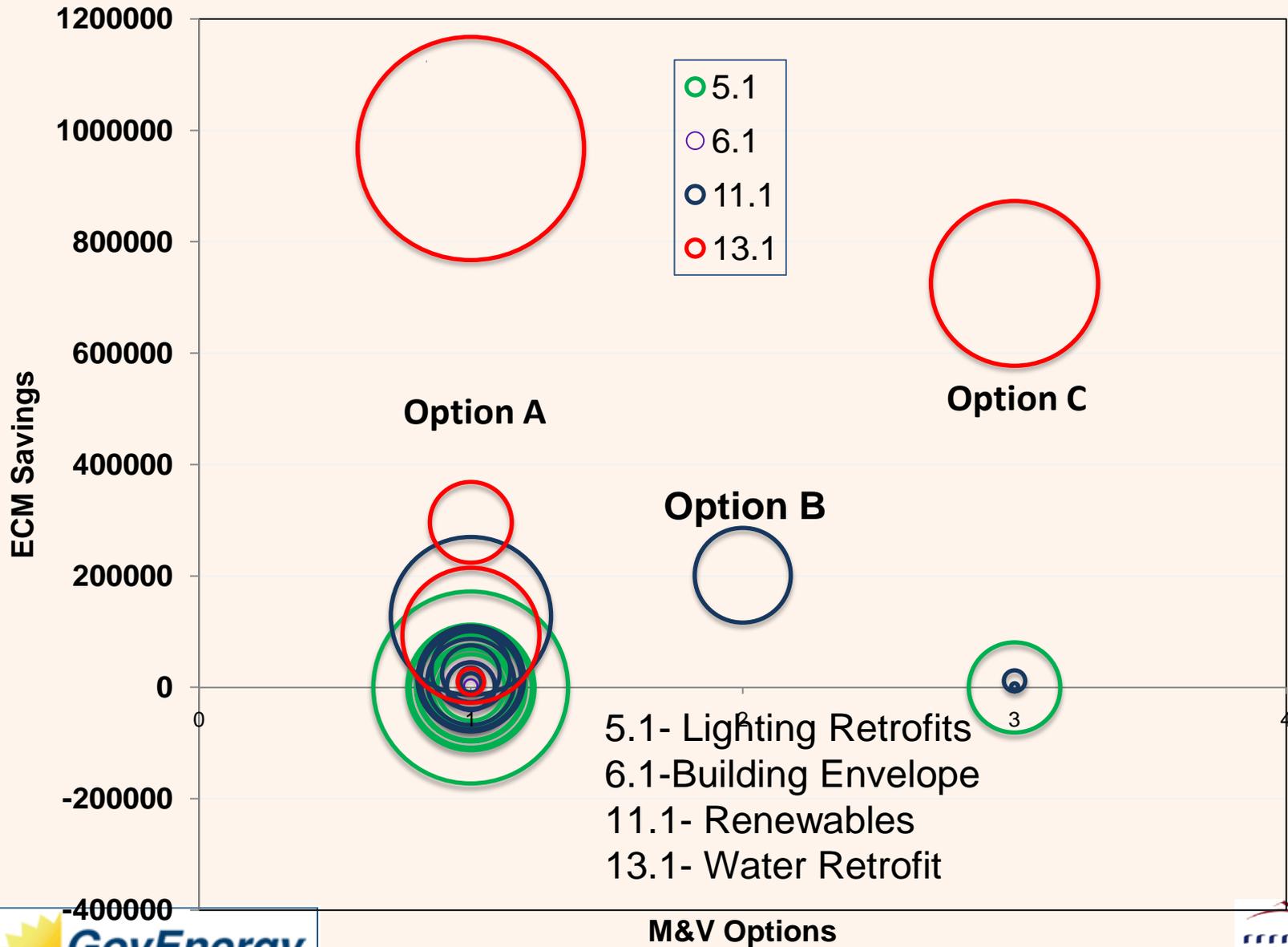
Proposed M&V Options for ECM-1.1- Boiler Plant Improvements (ESPC FY 2009 Data)



M&V Options for ECMs proposed (ESPC FY 2009 Data)



M&V Options for ECMs proposed (ESPC FY 2009 Data)



Conclusions

- Remember M&V is a critical component of a performance contract
- Choose the right M&V option that balances risk and M&V costs
 - ECM Level
 - Option A or Option B
 - System Level
 - Option C or Option D
- Identify what variables (pre and post) will be measured to ensure sustained performance

Resources

- FEMP's M&V Resources

- http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html

- LBNL's M&V Information Site

- <http://mnv.lbl.gov/>

- IPMVP, EVO, Efficiency Valuation Organization, World

- <http://www.evo-world.org/>

Questions

Thank you!

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