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Measurement, Verification, Evaluation, and Reporting (MV&E): Joint Committee Workshop

California Energy Commission
American Recovery and Reinvestment
Act (ARRA)

June 14, 2010

Presentation Overview

- Project Overview
 - Scope of Work
 - Project Team
 - Timeline
- MV&E Objectives, Approaches & Applications
 - DOE Guidance and Protocols
 - Impacts, Market Effects, Attribution
- MV&E for ARRA Programs
 - Activities to achieve objectives
 - Common data collection approaches
 - Common measures
- More examples (time permitting)

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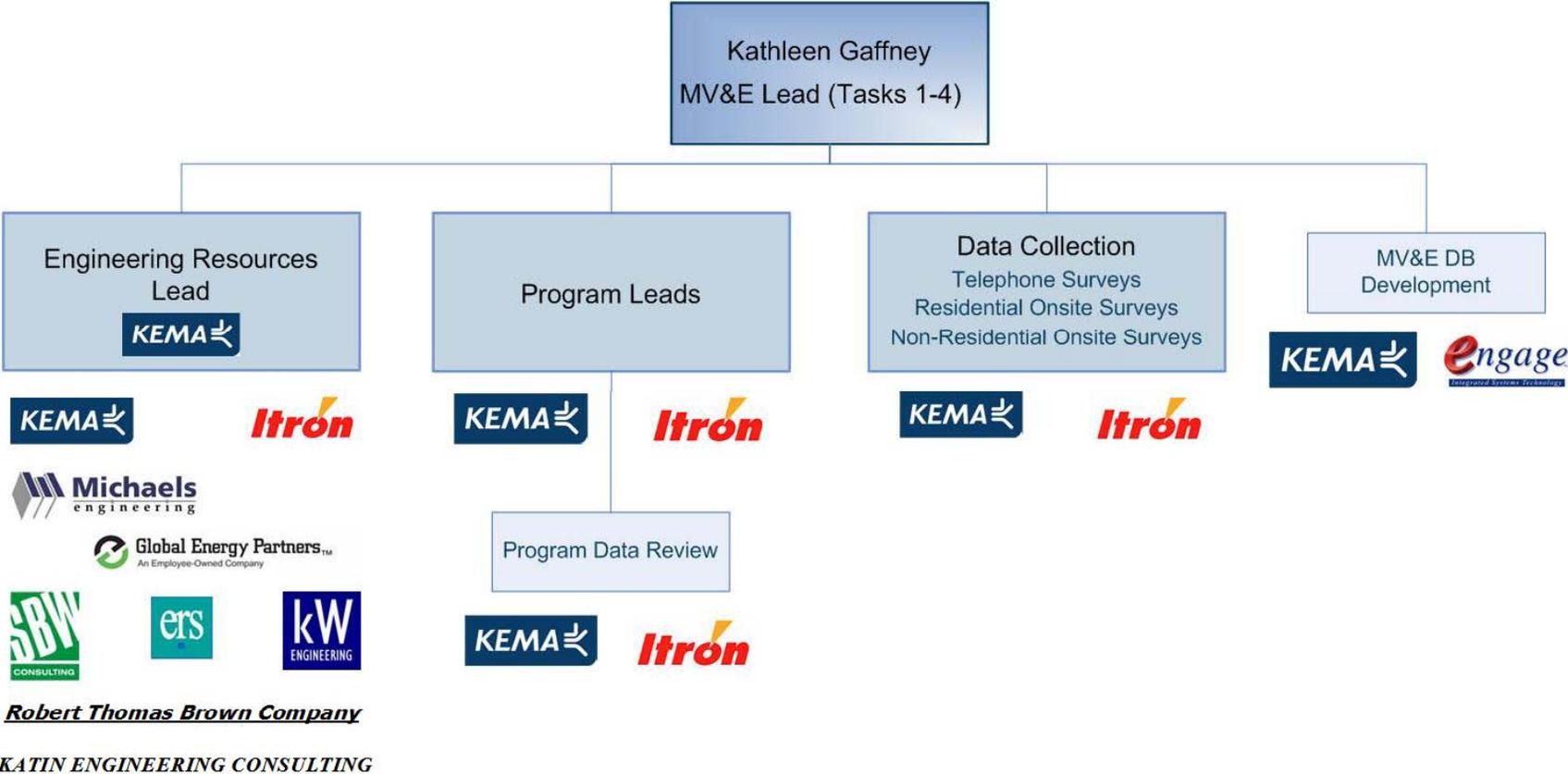
Energy Commission ARRA MV&E Scope of Work

- Planning (Tasks 1 and 3)
 - Initial Program Review
 - Preliminary Program Data Collection & Analysis
 - Prioritization & “Fast Track M&V”
 - Detailed MV&E Plan
 - Sample Design
 - Data Collection Approach
 - Analysis Plan
 - Timeline
 - Budget

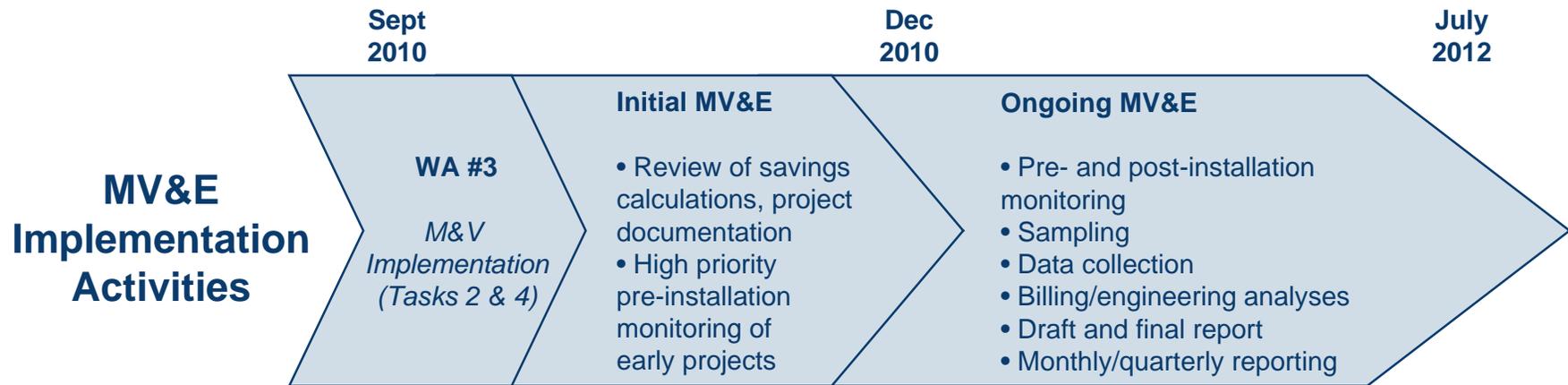
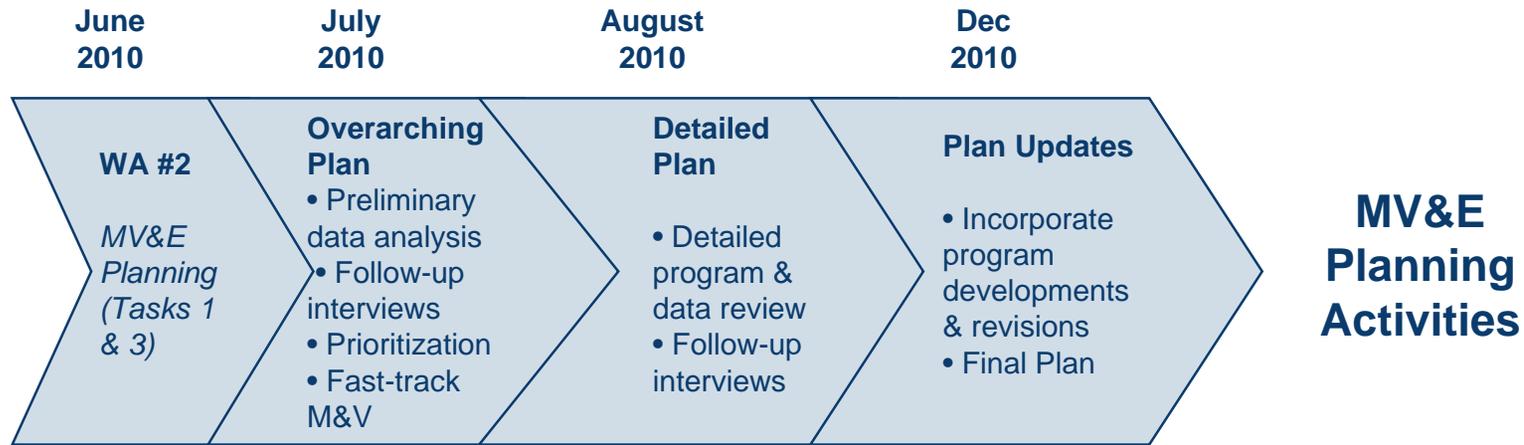
Energy Commission ARRA MV&E Scope of Work

- Implementation (Task 2 and 4)
 - Select Sample
 - Collect MV&E Data
 - Telephone surveys
 - Site visits
 - Pre-/post-monitoring as appropriate
 - Conduct MV&E Analyses
 - Billing
 - Engineering
 - Survey data
 - Report MV&E Results

The KEMA Team



MV&E Timeline



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Energy Commission MV&E Objectives

Objective	MV&E Focus
Ensure proper use of program funds	○
Confirm progress towards program implementation milestones	○
Verify installation of appropriate end-use technologies	●
Verify the accuracy of the reported energy savings	●
Assess programs' cost effectiveness	●
Determine energy savings/generation and peak demand reductions	●
Estimate climate change impacts (carbon emissions)	●
Evaluate market-transformation impacts (for SEP-funded programs)	●
Assess job impacts	○

● = Priority for MV&E efforts

○ = Joint effort with Energy Commission and Support Service Contractor



MV&E Objectives, Approaches & Protocols

Objective	Approach
Installation Verification	Apply CA verification-only protocols: review verification data collected by program implementers
Reported Savings Verification	Review implementation plans, reported savings and workpapers
Cost Effectiveness	Apply DOE Guidelines (BTU/\$1,000); collect data to support "E3" cost effectiveness tests
Energy & Peak Demand Impacts	Apply CA Protocols, IPMVP: site and/or measure specific evaluation
Carbon Emissions	Apply DOE and Energy Commission factors to energy savings
Market Transformation	Scoping study according to CA Protocols; coordination between Energy Commission, CPUC, and contractors

MV&E Protocols: Energy Savings & Market Effects

- CA Protocols and IPMVP are guidelines and do not prescribe methods or provide a template
- CA Protocols guide entire studies (Impact, Process, Market Effects, Sampling, etc.) and IPMVP guides measurement (M&V)
- IPMVP Options: A, B, C, D
- For 2006-08 CPUC Impact Evaluations, KEMA developed evaluation plans at the program-level and M&V plans at the measure-level (across programs) and project specific plans
- CPUC developed net savings methodologies, spillover guidance which meet protocols

MV&E Protocols: Impact Applications

- Applying IPMVP Options, “06-08 Experiences”
 - Option A: Time-of-use lighting logger deployment
 - Meter time lights are on, market average old wattage
 - Option B: Pre- and post-efficiency monitoring for air conditioner refrigerant charge measures
 - Meter power, temperatures, airflow to yield efficiency
 - Option D: Calibrated energy model simulation for non-residential new construction whole building and system level measures
 - Meter efficient equipment, full building audit and plan review to build energy model, calibrate to actual data

MV&E Protocols: Market Effects

- CIEE guidance
 - White Paper on Market Transformation Evaluation
 - Research plans for CPUC market effects studies
- CA Protocols
 - Program record review
 - Develop scoping study
 - Develop market change theory and logic model
 - Identify market change indicators
 - Identify data sources

Attribution of Effects

- DOE Guidance:
 - *Document effects that are above and beyond the effects that would have been achieved without ARRA funds. Studies should focus on net effects.*
 - *Effects of jointly funded initiatives will be allocated in proportion to percentage of funds...*
- Multiple programs serve markets targeted by many if not most ARRA programmatic activities
- For many programmatic activities, cooperation with or leveraging of other programs or funding sources is intentional

MV&E Method: Attribution

- Definition (all evaluated programmatic activities):
Development of formal hypotheses
 - Baseline behavior of other program sponsors in the absence of the program
 - Baseline behavior of targeted market actors in the absence of the program
- Validation (all evaluated programmatic activities):
Qualitative assessment of attribution hypotheses
 - Program sponsor and market actor interviews
 - Review of program documents & secondary sources
- Quantification (high rigor programmatic activities):
Quantitative assessment of attribution hypotheses and estimation of net savings attributable to the PAs

Attribution Applications

- Most studies of programs with complex attribution issues use multiple methods
- All methods strengthened by repeated observations over time
- Possible to achieve economies by combining similar programs or applying attribution results of one program to others like it

Program Types	Market Actor Self-Reports	Cross-sectional Methods	Expert Judging
Energy efficiency investments in public facilities	●	●	○
Financial support of efficient technology deployment	●	●	○
Technical assistance and training	●		○
Codes & standards development and enforcement		○	●
Research development and demonstration	●		●

● = Strong or typical application ○ = Other possible application

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MV&E Activities to Meet Objectives

Objective	Review Program Records	Secondary Research	Analysis using Deemed Values	Verification Surveys & Onsites	Site or Measure Specific MV&E	Indepth Interviews	Surveys (phone or online)
Installation Verification	●			●	○		
Reported Savings Verification	●		●		○	○	
Cost Effectiveness	●	●	●			○	
Energy & Peak Demand Impacts	●		●		●	○	○
Carbon Emissions	●		●		○		
Market Transformation	●	●				●	●
Job Impacts	●	●	○			●	●

● = Primary data collection ○ = Possible supporting data

Common Data Collection Approaches Across ARRA Programs

Data Collection by Program	SEP Retrofit Programs					SEP Non-Retrofit Programs		EECBG	Energy Efficient Appliance Rebate
	EE State Property Revolving Loan	Low Interest Energy Efficiency Financing	Compr. Residential Bldg. Retrofit	Municipal & Commercial Bldg. Targeted Retrofit	Municipal Financing	Clean Energy Business Finance	Green Jobs Workforce Training	Small City & County Direct Grants	
Site Specific MV&E	●	●		●	●			●	
Engineering Analysis using Deemed Values			●		●			●	●
Indepth Interviews	●		●	●	●	●			
Surveys (phone or online)		●	●	●	●			●	●
Verification			●		●				
Secondary Research, Literature Review						●	●		

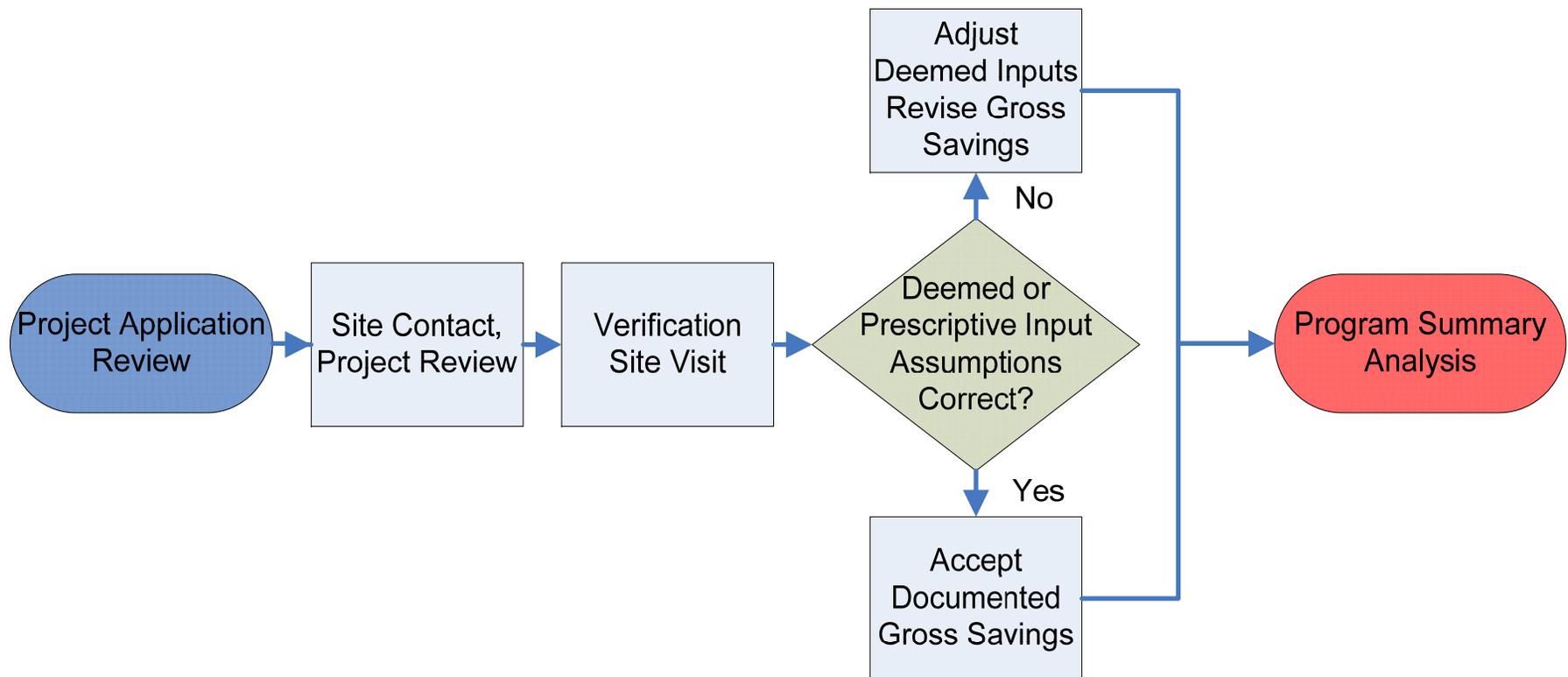
Common Measures – ARRA Programs

End Use Technology per ARRA Reporting Requirements	SEP Retrofit Programs					SEP Non-Retrofit Programs		EECBG	Energy Efficient Appliance Rebate
	EE State Property Revolving Loan	Low Interest Energy Efficiency Financing	Compr. Residential Bldg. Retrofit (3 Tiers)	Municipal & Commercial Bldg. Targeted Retrofit	Municipal Financing	Clean Energy Business Finance	Green Jobs Workforce Training	Small City & County Direct Grants	
Distributed Generation		R	R		R	M	E		
Domestic Hot Water		R	R		R		E		
Envelope Measures		R	R		R	M	E	R	
Non Energy Savings Measures		R						R	
HVAC - Air Conditioning		R	R	R	R	M	E	R	R
HVAC - Heating		R	R	R	R	M	E	R	
HVAC -Ventilation		R		R	R	M	E	R	
HVAC - Other		R		R	R		E	R	
HVAC Controls	R	R	R	R	R		E	R	
Lighting Retrofits, Interior		R	R	R	R	M	E	R	
Lighting Retrofits, Exterior		R		R	R	M		R	
Lighting Controls	R	R	R	R	R	M	E	R	
Other						M	E	R	R
Other Controls									
Kitchen Measures - Refrigeration						M			R
Kitchen Measures - Cooking						M			
Water/Wastewater/Waste		R	R		R	M	E	R	
Street Lights/Traffic Signals		R				M		R	

E – Education and training M – Manufacturing R – Retrofit measure
 * ARRA reporting requirement categories.

Some examples ...

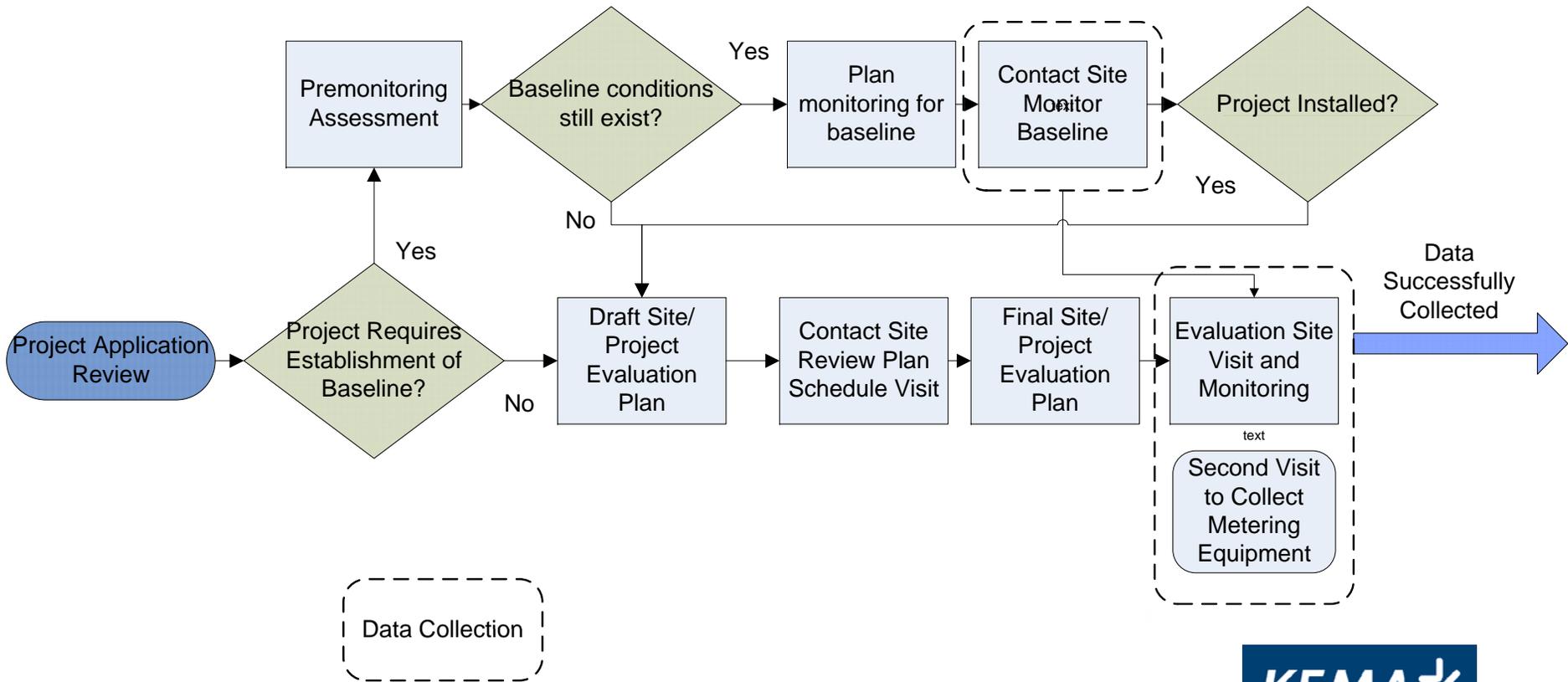
Site Level MV&E Process Flow: Street Lighting Example



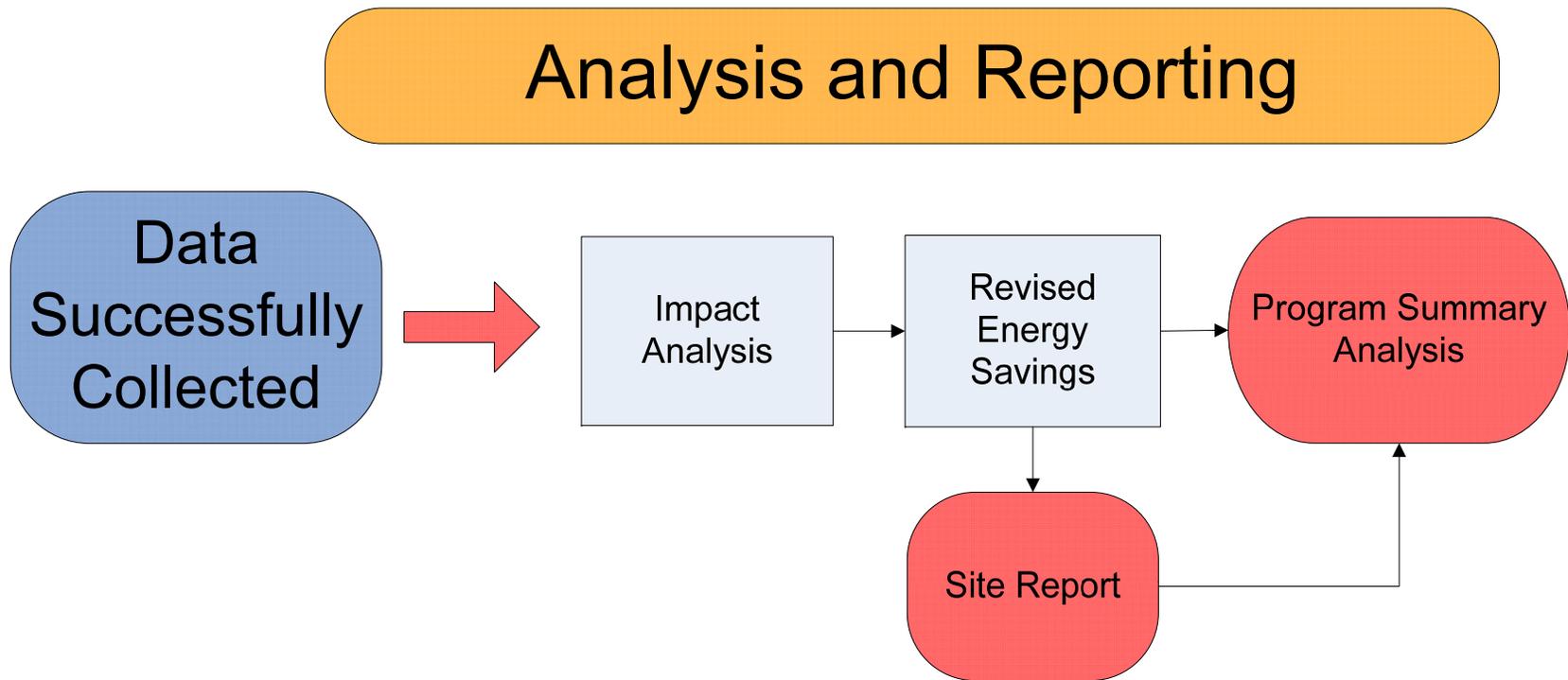
Site Level MV&E Process Flow

Example: HVAC Project

Planning and Data Collection



Site Level EM&V Process Flow Example: HVAC Project (cont.)



Comprehensive Residential Building Retrofit Program (SEP)

Subrecipients (4)	Eligible Measures: Specific Application	Technical Services Provided	Finance Mechanism	Evaluation Approach	Pre/Post Billing Rqmt. of Applic.
City & County of San Francisco	Tier 3 Whole Multi-Family Building Retrofits	Energy Audit/HERS II Rating; Field Verification; Diagnostic Testing; Training	Private Loan Capital, EE&C Block Grants, Federal, State & Local Grant Programs, Local Affordable Housing Funds & Lead Abatement Funds	<u>For Multi-Family Bldgs:</u> IPMVP D: Calibrated Simulation or IPMVP C: Site Billing Analysis <u>For Single-Family Bldgs:</u> IPMVP D: Calibrated Simulation or IPMVP A: Retrofit Isolation, Partial	One Year Pre-Req'd.
Association of Bay Area Governments	Tier 3 Whole House Retrofits & Tier 2 Prescriptive Measures, Single & Multi-Family Buildings				Some Pre-Req'd.
CA Rural Home Mortgage Finance Auth.	Tier 3 Whole House Retrofits				None Specified
Sacramento Regional Energy Alliance	Tiers 1, 2, 2+ & 3				Some Pre-Req'd.

- ARRA Funding: \$ 50,212,451

Municipal & Commercial Building Targeted Retrofit Program (SEP)

Eligible Measures: Specific Application	Subrecipients (3)	Technical Services Provided	Finance Mechanism	Evaluation Approach	Pre-Meter
HVAC - Controls: <i>Wireless</i>	Energy Solutions	Facility Screening, Project Identification & Scoping, Audits, Technology Performance Modeling, Technical & Economic Feasibility Analyses	Direct Installations & Financial Incentives	IPMVP D: Calibrated Simulation or IPMVP C: Billing Analysis	x
Kitchen - Refrigeration: <i>LED Case Lights, VisiCooler Controls, EMS Controls</i>	PECI & QuEST			IPMVP A: Retrofit Isolation	--
Lighting Controls: <i>Wireless & Daylighting</i>	Energy Solutions & QuEST				
Lighting Retrofits, Exterior: <i>Parking Lots & Bi-Level Fixt.</i>	Energy Solutions & QuEST				
Lighting Retrofits, Interior: <i>CFLs, Garages, Office & Classroom Integr. Sys., SMART Wall Fixt.</i>	Energy Solutions, PEGI & QuEST				

- ARRA Funding: \$ 29,610,637



Municipal Financing Program (SEP)

Target Sector	Subrecipients (5)	Eligible Measures: Specific Application	Evaluation Approach	Pre-Meter
Large Commercial Buildings	City of Los Angeles	Distributed Generation, Envelope Measures, HVAC - Other, HVAC Controls, Kitchen Measures - Refrigeration, Lighting Controls, Lighting Retrofits, Exterior & Interior, Water/Wastewater/Waste	Single-Family Residential Bldgs: IPMVP D: Calibrated Simulation or IPMVP A: Retrofit Isolation, Partial Municipal & Commercial Bldgs: IPMVP D: Calibrated Simulation or IPMVP C: Site Billing Analysis Industrial Sites: IPMVP D: Calibrated Simulation IPMVP B: Retrofit Isolation	x
Residential, Municipal & Commercial	City & County of San Francisco	<u>Residential:</u> Tier 2 & Tier 3 Retrofits <u>Muni. & Commercial:</u> HVAC - Other, HVAC Controls, Kitchen Measures - Refrigeration, Lighting Controls, Lighting Retrofits, Exterior & Interior.		x
Residential, Commercial & Industrial	North Coast Energy Independence	<u>Residential:</u> Tier 2 Retrofits & Tier 3 Retrofits <u>Commercial:</u> Lighting Fixtures & Controls, Interior & Exterior; Kitchen Measures - Refrigeration; HVAC Controls <u>Industrial:</u> Process Water Use Reduction; Distributed Generation; HVAC - Other		x
Residential, Commercial & Industrial	County of Sacramento	<u>Residential:</u> Tier 2 Retrofits & Tier 3 Retrofits <u>Commercial:</u> Distributed Generation, Domestic Hot Water, Lighting Fixtures & Controls, Interior & Exterior; Kitchen Measures - Refrigeration; HVAC Controls <u>Industrial:</u> Process Water Use Reduction; Distributed Generation; HVAC - Other		x
Residential, Commercial & Industrial	County of Sonoma	<u>Residential:</u> Tier 2 Retrofits & Tier 3 Retrofits <u>Commercial:</u> Distributed Generation, Domestic Hot Water, Lighting Fixtures & Controls, Interior & Exterior; Kitchen Measures - Refrigeration; HVAC Controls <u>Industrial:</u> Process Water Use Reduction; Distributed Generation; HVAC - Other		x

- ARRA Funding: \$ 30,176,912



Questions? Thank you!

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