NATIONAL EVALUATION OF THE STATE ENERGY PROGRAM: AN EVALUATION OF SELECT ACTIVITIES CONDUCTED UNDER THE STATE ENERGY PROGRAM

VOLUME II: APPENDICES A THROUGH J

Prepared for the US Department of Energy under the Supervision of Oak Ridge National Laboratory

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APPENDIX A. BROAD PROGRAM AREA CATEGORY AND SUBCATEGORY DEFINITIONS

A.1. BROAD PROGRAM AREA CATEGORY (BPAC) DEFINITONS

Table 1: Broad program area category definitions

BPAC	Distinguishing attributes relevant to primary BPAC designation
Building Retrofits	• Provides financial incentives for building retrofit and equipment replacement projects in nonresidential and residential buildings. • Nonresidential projects typically identify specific facilities, or facility owners in the grant application or PA description. • Residential programs do not identify specific projects, facilities, or customers.
Technical Assistance	• Provides technical assistance ***other than audits*** for building retrofit or equipment replacement projects: e.g., technical studies for specific improvements, building modeling, project financial analysis, and support in negotiating with contractors. • Open to commercial, industrial, and agricultural facility owners or specified subgroups thereof. • May be combined with financial incentives.
Energy Audits: Commercial, Industrial, and Agricultural	• Provides funding or direct services for energy audits of commercial, industrial, and agricultural facilities. Could range from simple checklist to investment-grade audits and mostly involves on-site delivery. • Audits are oriented to identify cost-effective building retrofit and/or equipment replacement projects. • May be combined with financial incentives.
Energy Audits: Residential	• Provides funding or direct services for energy audits of residential facilities. Could range from on-line to on-site audits. • Audits are oriented to identifying cost-effective building retrofit and/or equipment replacement projects. • May be combined with financial incentives.
Renewable Energy Market Development	• Provides financial incentives and/or technical assistance to support the development of renewable energy facilities including solar, wind, biomass, and small hydro. • Includes PAs that develop or expand existing manufacturing capacity for renewable energy equipment or components. • At least some portion of the output of the new or expanded capacity is intended for domestic installation.
Clean Energy Policy Support	• Educates state legislators, administration officials and regulators on policies to facilitate the completion of renewable energy facilities. Examples might include statewide zoning laws, feed-in tariffs, favorable back-up tariffs, and renewable portfolio standards.
Transportation	• Provides training, financial support, technical assistance, marketing assistance, and/or administrative assistance to facilitate the development and operation of car and van pools. • Supports capital improvements to support substitution of renewable fuels or electricity for conventional transportation fuels. • Supports improvements to fleet vehicle efficiency and operations. • Includes traffic signal optimization and control upgrades that reduce idling times.

BPAC	Distinguishing attributes relevant to primary BPAC designation
Traffic Signals	• Only provides incentives and technical support for LED traffic signals retrofit and replacement. • Controls upgrades that aim primarily at reducing idling times are included in the expanded Car Pool and Van Pool BPAC – now Transportation.
Building Codes and Standards	• Provides marketing support for products that meet the higher energy efficiency standards. • Provides training to vendors in marketing and installation of products that meet the higher energy efficiency standards. • Provides technical and administrative support for the development of more energy-efficient state and federal equipment standards and building codes. • Provides training and technical services to strengthen enforcement of the energy elements of state building codes.
Energy Efficiency Rating and Labeling	• Provides technical and administrative support for the development of energy efficiency ratings of energy-using equipment or buildings. • Provides marketing services to build customer awareness of the subject energy efficiency ratings. • Provides training and technical services to build vendor awareness and use of energy efficiency ratings in their business activities.
Government, School, and Institutional Procurement	• Provides technical and administrative support for government initiatives to purchase energy-efficient equipment or energy-efficient design services.
New Construction and Design	• Provides technical and administrative support for the development of energy efficiency ratings of energy-using equipment or buildings. • Provides marketing services to build customer awareness of the subject energy efficiency ratings. • Provides training and technical services to build vendor awareness and use of energy efficiency ratings in their business activities.
Loans, Grants, and Incentives	• Provides financial incentives for building retrofit and equipment replacement projects in nonresidential buildings. • Does not identify specific projects, facilities, or customers. • Incentives allocated according to an open application process for eligible customer groups. • Financial incentives are the principal program offering, but may be combined with others such as audits.
Tax Incentives and Credits	• Provides or facilitates access to state and federal tax credits for building retrofit or energy-efficient equipment replacement projects in residential facilities. • May be combined with technical services.
Administration	• General administration and back-office support for market title activities.
Energy Emergency Planning	• All activities related to mitigating energy disruptions during emergency situations. • Includes monitoring energy supplies, demand, and prices, and communicating this information to the public.

A.2. BPAC SUBCATEGORY DEFINITONS

Table 2: BPAC Subcategory definitions

Subcategory	Distinguishing PA attributes relevant to Subcategory designation	Applicable BPACs
Building Retrofits: Non-residential	• Specific projects, facilities, or facility owners identified in the grant application or PA description. • Participation limited to small number of owner organizations, e.g., state government agencies or state universities. • Incentives and other forms of assistance not allocated according to an open application process • Provides financial incentives for building retrofit and equipment replacement projects in nonresidential buildings.	• Administration • Building Retrofits • Loans, Grants, and Incentives
Building Retrofits: Residential	• Does not identify specific projects, facilities, or customers. • Incentives allocated according to an open application process for eligible customer groups. • Financial incentives are the principal program offering, but may be combined with others such as audits.	• Administration • Building Retrofits • Loans, Grants, and Incentives
Industrial Retrofit Support	• Does not identify specific projects, facilities, or customers. • Only supports projects in industrial facilities. • Incentives allocated according to an open application process for eligible customer groups.	• Administration • Loans, Grants, and Incentives • Industrial Retrofit Support
Traffic Signals	• Only provides incentives and technical support for LED traffic signals retrofit and replacement. Controls upgrades that aim primarily at reducing idling times are included in the expanded Car Pool and Van Pool BPAC – now Transportation.	• Administration • Loans, Grants, and Incentives • Traffic Signals
Technical Assistance to Building Owners	• Provides technical assistance *other than audits* for building retrofit or equipment replacement projects e.g., technical studies for specific improvements, building modeling, project financial analysis, and support in negotiating with contractors. • Open to commercial, industrial, and agricultural facility owners or specified subgroups thereof. • May be combined with financial incentives.	• Administration • Building Retrofits • Loans, Grants, and Incentives • Technical Assistance to Building Owners
Energy Audits: Commercial, Industrial, and Agricultural	• Provides funding for or direct services for energy audits of commercial, industrial, and agricultural facilities. • Audits are oriented to identifying cost-effective building retrofit and/or equipment replacement projects. • May be combined with financial incentives.	• Administration • Building Retrofits • Loans, Grants, and Incentives • Energy Audits: Commercial, Industrial and Agricultural
Tax Incentives and Credits	• Provides or facilitates access to state and federal tax credits for building retrofit or energy-efficient equipment replacement projects in residential	• Administration • Clean Energy Policy Support

Subcategory	Distinguishing PA attributes relevant to Subcategory designation	Applicable BPACs
	facilities. • May be combined with technical services.	
Energy Audits: Residential	• Provides funding or direct services for energy audits of residential facilities. • Audits are oriented to identifying cost-effective building retrofit and/or equipment replacement projects. • May be combined with financial incentives.	• Administration • Building Retrofits • Energy Audits: Residential
Renewable Energy Market Development: Projects	• Provides financial incentives and/or technical assistance to support the development of renewable energy facilities including solar, wind, biomass, and small hydro. • Facilities may be customer sited or utility-oriented. • Specific projects or customers may be identified in the application or the program may be open to applications from eligible customers. • Includes renewable projects exclusively installed on residential buildings.	• Administration • Clean Energy Policy Support • Loans, Grants, and Incentives • Renewable Energy Market Development • Technical Assistance to Building Owners
Renewable Energy Market Development: Manufacturing	• PAs develop or expand existing manufacturing capacity for renewable energy equipment or components. • At least some portion of the output of the new or expanded capacity is intended for domestic installation.	• Administration • Clean Energy Policy Support • Loans, Grants, and Incentives • Renewable Energy Market Development • Technical Assistance to Building Owners
Clean Energy Policy Support	• Educates state legislators, administration officials, and regulators on policies to facilitate the completion of renewable energy facilities. Examples might include statewide zoning laws, feed-in tariffs, favorable back-up tariffs, and renewable portfolio standards.	• Administration • Clean Energy Policy Support • Transportation, Including Carpools and Vanpools
Transportation, Including Carpools and Vanpools	• Provides training, financial support, technical assistance, marketing assistance, and/or administrative assistance to facilitate the development and operation of car and van pools. • Supports capital improvements to support substitution of renewable fuels or electricity for conventional transportation fuels. • Supports improvements to fleet vehicle efficiency and operations.	• Administration • Clean Energy Policy Support • Loans, Grants, and Incentives • Transportation, Including Carpools and Vanpools
Building Codes and Standards: Standards	• Provides technical and administrative support for the development of more energy-efficient state and federal equipment standards. • Provides marketing support for products that meet the higher energy efficiency standards. • Provides training to vendors in marketing and installation of products that meet the higher energy efficiency standards.	• Administration • Building Codes and Standards • New Construction and Design

Subcategory	Distinguishing PA attributes relevant to Subcategory designation	Applicable BPACs
Building Codes and Standards: Codes	• Provides technical and administrative support for the development of more energy-efficient state building codes. • Provides training and technical services to strengthen enforcement of the energy elements of state building codes.	• Administration • Building Codes and Standards • New Construction and Design
Energy Efficiency Rating and Labeling	• Provides technical and administrative support for the development of energy efficiency ratings of energy-using equipment or buildings. • Provides marketing services to build customer awareness of the subject energy efficiency ratings. • Provides training and technical services to build vendor awareness and use of energy efficiency ratings in their business activities.	• Administration • Energy Efficiency Rating and Labeling • Loans, Grants, and Incentives
Government, School, and Institutional Procurement	• Provides technical and administrative support for government initiatives to purchase energy-efficient equipment or energy-efficient design services.	• Administration • Government, School, and Institutional Procurement • Loans, Grants, and Incentives
Energy Emergency Planning	• All activities related to mitigating energy disruptions during emergencies. • Includes monitoring energy supplies, demand, and prices, and communicating this information to the public	• Administration • Clean Energy Policy Support • Energy Emergency Planning
New Construction and Design	• Provides technical and administrative support for the development of energy efficiency ratings of energy-using equipment or buildings. • Provides marketing services to build customer awareness of the subject energy efficiency ratings. • Provides training and technical services to build vendor awareness and use of energy efficiency ratings in their business activities.	• Administration • Building Codes and Standards • New Construction and Design • Technical Assistance to Building Owners
Workshops and Training: Targeted Training and/or Certification	• Training for facility managers, trades contractors, and engineering/design professionals. • Topics for EE, renewables, transportation, and other technical topics. • Includes certification programs and other pre-requisite type training and education programs. • Participant data should be available.	• Applicable to All BPACs
Workshops and Training: Generalized Workshops and Demonstrations	• Includes one-off workshops, on-site demonstrations, and other one-time projects that may or may not be bundled with other program activities (e.g., retrofit or financial incentive activities). • Broad-based information, education programs, and activities targeting the general public or consumers of all types. Includes school-based education programs. • Conference sponsorships. • Participants can generally not be tracked.	• Applicable to All BPACs

Subcategory	Distinguishing PA attributes relevant to Subcategory designation	Applicable BPACs
Workshops and Training: Generalized Marketing and Outreach	• Marketing and outreach support to raise awareness, provide general information, and encourage behavior change, etc. • Not targeted at a specific site or project, but may be targeted at specific segments or types of projects. • Recipients of the education are not traceable.	• Applicable to All BPACs
Administration	• General administration and back-office support for market title activities.	• Applicable to All BPACs

APPENDIX B. SUMMARY OF RESEARCH PLANNING ACTIVITIES

B.1. OVERVIEW

This appendix provides a brief history of how the research plan for the SEP National Evaluation was developed and refined. Key events from the study's inception through finalization of the study design and sample are summarized in **Table 3**.

Table 3: Timeline of significant SEP evaluation design and planning events

Event	Date
White Paper on National SEP Evaluation Developed for DOE and Approved by Panel of Evaluation Experts	October 2007
Network Committee Meets to Provide Input for Scope of Work	November 2008
Draft Scope of Work Prepared	December 2008
Peer Review Panel Meets to Review Draft Scope of Work	January 2009
Detailed Scope of Work Finalized	February 2010
Evaluation Contractor Team Selected through Competitive Solicitation Process	May 2010
Evaluation Team Prepares Draft Detailed Study Plan	March 2011
Peer Review Panel Meets to Provide Input on Draft Study Plan	March 2011
Network Committee Meets to Provide Additional Input	May 2011
Detailed Study Plan Finalized	June 2011
Information Collection Request Submitted to OMB	February 2012
OMB Approves Information Collection Request	December 2012
Sample of Activities Finalized Following Evaluability Assessments	October 2013

Additional information on selected key activities that are not addressed in other appendices is provided below.

B.2. WHITE PAPER ON NATIONAL SEP EVALUATION

In 2005, ORNL conducted an evaluation of the SEP. That study, which can be found at http://weatherization.ornl.gov/pdf/ORNL-CON-492%20FINAL.pdf, was based on a review of evaluation literature for the various types of programmatic activities offered by SEP. Essentially, the evaluation sorted SEP efforts into broad program categories, counted state activities within each of those categories, and then used energy savings findings from previous evaluations of similar kinds of programmatic activities to estimate impacts. That undertaking represented the first major step in the SEP evaluation effort.

In 2007, the Weatherization and Intergovernmental Programs Office (WIPO) contracted with TecMarket Works (TMW) to develop a white paper presenting an approach for prioritizing and evaluating SEP efforts employing rigorous evaluation methods to improve the reliability of the impact estimates for all SEP activities. The white paper was developed by TMW and peer reviewed by nationally recognized evaluation experts (Mr. Paul DeCotis, Dr. Marty Kushler, Dr. Lori Megdal, and Dr. Ed Vine). The paper identified a multi-year evaluation approach that focused on a set of programmatic activities — representing the most important, the most costly, or the least understood — that could be used to estimate total effects across the entire SEP. That paper is available at http://www.tecmarket.net/documents/Final%20SEP%20Evaluation%20White%20Paper%2010-18.pdf.

B.3. NETWORK COMMITTEE INPUT

ORNL and the contactor team sought input from a Network Committee of key stakeholders on several different occasions during the design and planning of the SEP National Evaluation. The Network Committee was composed primarily of State staff and officials with interest, responsibility, and/or direct involvement in the design and implementation of SEP activities in their jurisdictions. The membership of the Committee, which changed over time, was made up of roughly equal numbers of State Energy Office (SEO) directors and SEP managers.

The first Network Committee meeting was held in Washington, D.C., in November 2008 and consisted of a day and a half of facilitated meetings to gather input for the upcoming SEP evaluation. After being provided with background information on past SEP evaluation efforts and the white paper, participants were asked to identify areas on which the upcoming evaluation should focus and the broad questions that it should address. The Committee also discussed the most important program effects to study and established a priority order for evaluating various program types that factored in the experiences of the individual states with national SEP spending and activity levels. The meeting concluded with a discussion of state resources that could be accessed for specific data and how to coordinate and streamline the data collection process.

The second Network Committee meeting was convened electronically (via telephone and computer) in May 2011. At that time, a draft detailed evaluation plan had already been developed and reviewed by a Peer Review Panel of evaluation experts, so this meeting did not focus on soliciting input on study design. Rather, the meeting was designed to obtain input on how the evaluation team could best interact with the States to optimize their cooperation and ensure the usefulness of study results. Discussion focused on information needed from the states, the nature of state records in key topical areas, and approaches to data collection that could utilize the States' strengths and minimize their burden. The meeting also addressed the types of information on study findings needed by the States and how that should be presented.

Two other Network Committee meetings were held, one in July 2011 and one in July 2012. The first of those meetings addressed a number of detailed questions raised by the states in the May 2011 session regarding the design and implementation of the SEP National Evaluation. The discussion covering a wide variety of topics, dealing with evaluation scope and policy issues, data collection, and data analysis. The July 2012 meeting focused on the specific types of information to be gathered from the States and service recipients and solicited input on what data were likely to be difficult to obtain and the best ways to collect those data.

B.4. PEER REVIEW OF DETAILED STUDY PLAN

A peer review panel of evaluation experts reviewed the Detailed Study Plan and in March 2012 met with representatives from the contractor team, DOE, and ORNL to discuss the plan in-depth. The panel prepared a subsequent memorandum, dated April 17, 2012, which included the following key observations and recommendations:

1. *Apply standard naming conventions for methodology and terminology where possible, including measure names and tracking data reporting, to ensure that policy makers, program administrators, DOE, states, and other interested parties fully understand and appropriately interpret the evaluation results.*
2. *Recognize that many of the SEP program areas focus on foundation elements that require long-term perspectives and that these require somewhat different evaluation resource allocation (towards workforce, training and education) within cumulative impact analyses. However given the importance of SEP in building a foundation in the market that is necessary for other efficiency efforts to gain a foothold and be able to expand impacts, the Panel encourages KEMA to recognize where possible these benefits, and if available, use other federal and local evaluations to better estimate impacts and describe SEP's role in this multileveled and interactive catalyst for long term market change.*
3. *Recognize the long-term influences of SEP in the building construction code and standards development process and attempt to quantify where possible the effects of the SEP code adoption and implementation efforts in this change process.*
4. *Focus evaluation resources on outcomes measurement (rather than benefit cost analyses) and SEP-attributable impacts where this can be done well, within resource constraints (energy savings and job creation, rather than CO2 reductions). Develop impact estimates recognizing the short and long-term impacts on jobs and energy savings.*
5. *Establish priorities for the analysis of the programs, such that the evaluation is conducted with sufficient rigor and precision to be credible, and that some programs proposed for study (without sufficient rigor or precision) may need to be dropped from the evaluation.*
6. *Fairly and appropriately account for the multiple rounds of projects being funded by the financing programs, taking into account the expected operating life of the revolving funds, and not limit impacts to just the resulting projects and their associated energy and job impacts during the short duration of the ARRA-funded period.*
7. *Facilitate additional input from the Panel, as a number of pertinent data points were unknown at the time of this review, such as what and how much data exists on the state programs. The Panel recommends considering reconvening this panel via conference call to review progress at a point in time when more data are available.*

Those inputs, along with the rest of the panel's comments, were carefully considered and factored into the final detailed evaluation plan, which was completed in June 2011. That document can be found at: http://weatherization.ornl.gov/pdfs/DetailedSEPEvaluationPlanFinal063011.pdf.

B.5. OMB REVIEW AND APPROVAL OF INFORMATION COLLECTION REQUEST

In compliance with the terms of the Paperwork Reduction Act, the contactor team prepared an Information Collection Request (ICR) package containing all survey instruments to be used to collect identical data from 10 or more respondents, along with a detailed set of supporting materials describing the proposed study. That package was submitted to OMB February 2012 and final approval was received in December of that year. Key events in the ICR submission and review process are summarized in **B.2**.

Table 4: Timeline of key events in OMB approval process

Event	Date
ICR Submitted to OMB	February 2012
OMB Meets with Evaluation Team to Discuss ICR for SEP Evaluation	March 2012
OMB Sends Evaluation Team Comments and Questions on ICR	April 2012
Evaluation Team Sends OMB Responses to its Comments and Suggestions	May 2012
Evaluation Team Briefs OMB on Proposed Evaluation and All ICR Materials	June 2012
OMB Provides Evaluation Team with Feedback on Survey Instruments	July 2012
Evaluation Team Prepares Detailed Response Matrix for OMB	July 2012
OMB Holds Conference Call with Evaluation Team Regarding Selected Survey Questions	August 2012
Evaluation Team Sends Revised ICR Package to OMB Containing All Requested Changes to Survey Instruments and Supporting Materials	August 2012
OMB Approves Information Collection Request	December 2012

APPENDIX C. DETAILED SAMPLING AND WEIGHTING METHODOLOGY

C.1. OVERVIEW OF SEP PROGRAMMATIC ACTIVITIES AND SAMPLING PLAN

As discussed previously in this report, the overall objective of this evaluation was to provide quantitative estimates, at the national level, of key program outcomes resulting from the SEP in the PY 2008 and ARRA periods. The principal outcomes quantified include:

- Energy savings and renewable energy generation
- Labor impacts
- Carbon emissions reductions
- Energy bill savings and cost-effectiveness.

Over the course of the study periods, SEP funded thousands of initiatives representing a wide range of strategies to reduce energy consumption including:

- Direct subsidy of energy-related capital improvements
- Subsidy of capital improvements via reduced interest loans and guarantees
- Technical training and support for facility managers and equipment vendors
- Support for building code development and enforcement
- Support for broad energy policy development.

Given the breadth of the SEP funded initiatives, evaluation of these activities required a two-stage sampling approach. In the first stage, a sample of individual state-level initiatives, referred to as Programmatic Activities (PAs), was selected. These PAs were assessed to determine their eligibility for this evaluation. If eligible, various sampling activities were employed within the PA in order to gather the necessary data from informants that were needed to derive estimates for the outcome measures noted above. Sampling done within each PA comprises Stage 2 of the design.

For the first sampling stage, PAs were partitioned into strata that make up similar types of initiatives. The first grouping was by BPAC. Results of this study are reported by BPAC. Each BPAC was further divided into BPAC Subcategories (SubCat), which varied by BPAC. For example, PAs that provide loans, grants, and incentives constitute one BPAC, which is further divided into the following Subcategories:

- Administration
- Alternative Fuels, Ride Share, and Traffic Optimization
- Building Retrofits: Nonresidential
- Building Retrofits: Residential
- Industrial Retrofit Support

- Renewable Energy Market Development: Manufacturing
- Renewable Energy Market Development: Projects
- Technical Assistance to Building Owners
- Workshops and Training: Generalized Marketing and Outreach
- Workshops and Training: Generalized Workshops and Demonstrations.

The groupings defined by the BPAC Subcategory combinations served as sampling strata at the first sampling stage in this evaluation. Once all programmatic activities were classified into BPACs and Subcategories, a sample of PAs was selected for analysis within each BPAC Subcategory stratum, as described in detail later in this section.

The rationale for this approach of classifying PAs and sampling them within BPAC Subcategory groups reflects two methodological considerations. First, the variation in key outcome indicators is smaller for groups of PAs that share the same types of initiatives and have similar operational systems compared to the population of PAs as a whole. Second, the research methods appropriate for the evaluation of an individual PA varied between BPAC and Subcategories, but tended to be similar for PAs within a BPAC and Subcategory. Hence, PAs were stratified into homogeneous subgroups defined by BPAC Subcategory to both improve statistical sampling efficiency and allow efficient execution of the evaluations of individual PAs.

Quantification of outcome indicators for each sampled PA required collection of data and information from individuals involved in those initiatives, including program participants, program administrators, and staff; vendors who serve program participants; and observers of the targeted markets and policy organizations. It is worth noting that this study did not include an evaluation of non-SEP programs. Commonly, SEP-funded programs have other funding sources in addition to SEP. In order to assess the impact of SEP, DOE must also understand the relative impact of similar leveraged or cost-shared programs to SEP's funded efforts. The exact configuration of the study subjects will vary by BPAC and BPAC Subcategory.

For example, for PAs that provide financial incentives, technical support, or training to facility owners to encourage energy-efficient capital improvements, we interviewed samples of participants to characterize what measures they took and the influence of the program upon their decisions. Probability sampling methods for selecting participants were employed in Stage 2 of the design. This approach supported proper extrapolation of the results to the PA level.

Other types of PAs, such as efforts to change state-level building codes or regulations in regard to renewable energy facilities, did not generate lists of participants. Moreover, the number of individuals engaged in these efforts is relatively small so reliable assessment of program outcomes required opinions from specific experts who have a detailed understanding of the associated processes, rather than random selection. Quantification of outcomes for these types of PAs did not make use of statistical sampling techniques in Stage 2.

Once estimates of outcomes were made (e.g., energy savings, jobs, and emissions reductions) for each PA, the PA level outcomes were expanded to the full BPAC group using appropriate weighting and estimation processes that properly accounted for the complex sample design associated with this evaluation effort. Sampling errors in the form of margin of errors are reported in this report for many of the outcome measures. Sampling errors were estimated using a process that also accounted for the complex sample design of this evaluation.

Figure 1 summarizes the sample design, data collection, and analysis process that were used for this evaluation. The remaining sections of this appendix will discuss these steps in greater detail.

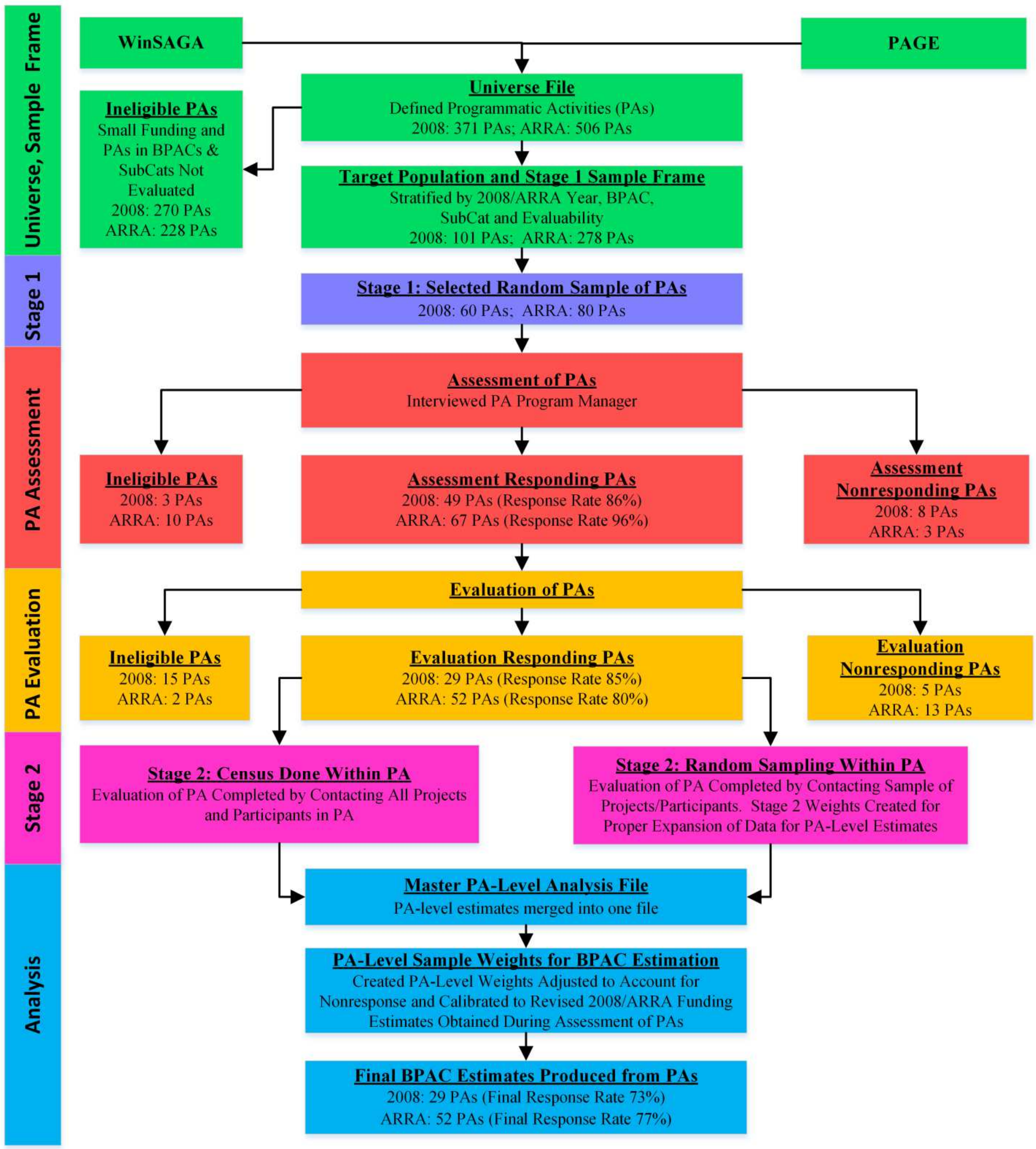

Figure 1: Summary of PY 2008/ARRA-period sample design and analysis process

C.2. UNIVERSE FILE, TARGET POPULATION AND SAMPLE FRAME

The first steps in the sample selection process were to define the target population for this evaluation, to develop an appropriate sample frame of PAs, and to define appropriate first-stage stratification variables that enabled us to control the sample size for various subgroups while simultaneously providing both precision and data collection efficiency by combining similar PAs into appropriate strata.

The process of specifying the target population and constructing a sample frame began by first constructing a universe file that accounted for all funding distributed to states as part of the PY 2008 and ARRA-period programs. The construction of the Universe File began by merging the WinSAGA and PAGE management and information systems (hereafter referred to as "systems").[1] Within each system, PY 2008/ARRA-period grants awarded to states were listed as separate records under different Market Titles. Note that a state could have multiple market titles on these files. DOE reviewed the information available for each market title on these files and determined whether to treat the entire market title as a single PA, or as two or more distinct PAs. In rare instances, multiple small market titles within the same state with similar types of activities were combined into a single PA for purposes of the universe file. From the information provided, DOE identified the funding amounts associated with each PA in the universe file, and assigned each one to a single BPAC and Subcategory. Thus, the universe file consisted of a set of PAs characterized by BPAC and Subcategory as well as by state and funding level.

After reviewing the universe file, it was decided to restrict the target population for this evaluation in two respects:

1. First, the smaller PAs were categorized as ineligible for this evaluation because it was assumed that due to their small PY 2008/ARRA-period funding size, their impact on estimates of the final outcomes of interest would be minimal. Eliminating smaller Pas also reduced data collection costs.
2. Second, several BPACs and several Subcategories within BPACs were declared ineligible for this evaluation. The process of determining the final set of eligible BPACs and Subcategories began by considering both the amount of funding associated with the PAs and their potential impact on estimates of the outcomes of interest. Additionally, during data collection it was found that some of the BPAC Subcategory combinations that were initially considered eligible were out-of-scope for this evaluation because the necessary evaluation data from the PAs could not be collected. This was generally due to data unavailability or because the initial discussions with a PA point-of-contact suggested the PA was incorrectly classified.

After considering these two restrictions, the subcontractor team defined the target population for this evaluation as selected Subcategories in four PY 2008 BPACs and in four ARRA-period BPACs. The eight BPACs and selected Subcategories are listed in **Table 5**. The table shows there are three BPAC Subcategory groups that are part of the target population, but were not evaluated in this study. During the initial discussions with a point-of-contact associated with PAs selected in these Subcategories, data were gathered that suggested the sampled PAs would be better classified into other BPAC Subcategory groups that were evaluated in this study. This reclassification occurred frequently during the initial assessment of each sample PA, and in fact, we found many instances

[1] The WinSAGA and PAGE systems were where SEP sub-grantees reported their program's progress to DOE for PY 2008 and the ARRA period, respectively.

where a sampled PA split between several other BPAC Subcategory combinations — some of which were eligible for this evaluation and others that were not. All new information on PY 2008/ARRA-period SEP grant funding, including the amount of PY 2008/ARRA-period SEP funding allocated to each piece of a split, was retained and used during the sample weighting process for this evaluation. PAs that moved to a new BPAC Subcategory combination were evaluated as part of their new category. This movement of PAs to new categories resulted in the three BPAC Subcategories with no evaluated PAs as noted in **Table 5**.

Table 5: BPACs and Subcategories that define the target population for this evaluation

BPAC	Subcategory	Is BPAC/SubCat Evaluated in this Study?
PY 2008		
1.Building Retrofits	Building Retrofits: Nonresidential	Yes
	Building Retrofits: Residential	No
	Technical Assistance to Building Owners	Yes
	Workshops and Training: Generalized Workshops and Demonstrations	Yes
2. Clean Energy Policy Support	Policy and Market Studies; Legislative Support	Yes
3. Loans, Grants, and Incentives	Alternative Fuels, Ride Share and Traffic Optimization	Yes
	Building Retrofits: Nonresidential	Yes
	Building Retrofits: Residential	Yes
	Technical Assistance to Building Owners	No
4. Technical Assistance to Building Owners	Technical Assistance to Building Owners	Yes
ARRA-period		
5. Building Codes and Standards	Building Code Development and Support	Yes
	Workshops and Training: Generalized Workshops and Demonstrations	No
	Workshops and Training: Targeted Training and/or Certification	Yes
6. Building Retrofits	Building Retrofits: Nonresidential	Yes
	Building Retrofits: Residential	Yes
7. Loans, Grants, and Incentives	Building Retrofits: Nonresidential	Yes
	Building Retrofits: Residential	Yes
	Renewable Energy Market Development: Manufacturing	Yes
	Renewable Energy Market Development: Projects	Yes
8. Renewable Energy Market Development	Renewable Energy Market Development: Manufacturing	Yes
	Renewable Energy Market Development: Projects	Yes

In addition to restricting the BPAC Subcategories that would comprise the target population, as noted earlier, it was further decided to omit PAs that received the smallest amount of funding for sampling and data-collection efficiency purposes. The smallest PAs were omitted from the frame systematically while maintaining the goal of retaining at least 80% or more coverage of the funding in the eight BPACs from the original universe file.

A summary of the universe file, the sample frame, and the final set of evaluable BPAC Subcategories is provided in **Table 6** to **Table 9**. **Table 6** provides a summary of the number of PAs in the PY 2008, **Table 7**, provides a summary of the funding associated with PAs in PY 2008, and **Table 8** and **Table 9** show analogous summaries for the ARRA-period PAs. These summaries show the funding and BPAC Subcategory designations from the original WinSAGA/PAGE universe file and do not reflect the changes in funding or movement of PAs to different BPAC Subcategories that occurred during the PA data-collection assessment period associated with this evaluation. **Table 6** and **Table 7** indicate that the initial universe file reflected $65,403K in funding for the PY 2008. For PY 2008, there were 371 PAs in the initial universe file, 27% (101) were on the final frame for this evaluation and 60 of these (59% of the 101) were selected for the evaluation. The PY 2008 frame for this evaluation covered 54% of the funding in the original universe file and the selected sample covered 85% of the funding on the sample frame.

Similarly, **Table 8** and **Table 9** indicate the initial universe file reflected $2,701,704K in funding for the ARRA-period PAs. There were 506 PAs in the initial universe file, 55% (278) were on the final frame for this evaluation, and 80 of these (29% of 278) were selected for the evaluation. The ARRA-period SEP frame covered 83% of the funding in the original universe file and the selected sample covered 30% of the funding on the sample frame.

Note that revised estimates of funding coverage for each of the eight BPACs that reflect the movement of PAs to different BPAC Subcategory groups as well as reflect changes in the funding provided to a PA (also learned during the PA assessment data collection phase) will be presented in Section C.5. The coverage estimates presented in Section C.5 represent the best estimate of coverage for each BPAC associated with this evaluation.

Table 6: Summary of PY 2008 SEP universe, sample frame and selected sample, number of PAs

BPAC	Subcategory	Is BPAC/ SubCat Evaluated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Sample Frame	Frame/ Universe	Selected Sample	Selected/ Frame
Total	**Total**		**371**	**101**	**27.2%**	**60**	**59.4%**
Building Retrofits	**Total**		**72**	**40**	**55.6%**	**24**	**60.0%**
	Administration		3	0	0.0%	0	0.0%
	Building Retrofits: Nonresidential	Yes	6	4	66.7%	4	100.0%
	Building Retrofits: Residential		4	4	100.0%	4	100.0%
	Energy Audits: Commercial, Industrial, and Agricultural		2	0	0.0%	0	0.0%
	Energy Audits: Residential		1	0	0.0%	0	0.0%
	Technical Assistance to Building Owners	Yes	13	11	84.6%	8	72.7%
	Workshops and Training: Generalized Marketing and Outreach		15	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	Yes	22	21	95.5%	8	38.1%
	Workshops and Training: Targeted Training and/or Certification		6	0	0.0%	0	0.0%
Clean Energy Policy Support	**Total**		**42**	**31**	**73.8%**	**12**	**38.7%**
	Administration		3	0	0.0%	0	0.0%
	Policy and Market Studies; Legislative Support	Yes	38	31	81.6%	12	38.7%
	Workshops and Training: Generalized Marketing and Outreach		1	0	0.0%	0	0.0%
Loans, Grants, and Incentives	**Total**		**37**	**24**	**64.9%**	**19**	**79.2%**
	Administration		7	0	0.0%	0	0.0%
	Alternative Fuels, Ride Share, and Traffic Optimization	Yes	10	10	100.0%	7	70.0%
	Building Retrofits: Nonresidential	Yes	8	8	100.0%	7	87.5%
	Building Retrofits: Residential	Yes	2	2	100.0%	2	100.0%
	Industrial Retrofit Support		1	0	0.0%	0	0.0%

BPAC	Subcategory	Is BPAC/ SubCat Evaluated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Sample Frame	Frame/ Universe	Selected Sample	Selected/ Frame
	Renewable Energy Market Development: Manufacturing		1	0	0.0%	0	0.0%
	Renewable Energy Market Development: Projects		2	0	0.0%	0	0.0%
	Technical Assistance to Building Owners		4	4	100.0%	3	75.0%
	Workshops and Training: Generalized Marketing and Outreach		0	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		2	0	0.0%	0	0.0%
Technical Assistance to Building Owners	**Total**		**13**	**6**	**46.2%**	**5**	**83.3%**
	Administration		2	0	0.0%	0	0.0%
	Technical Assistance to Building Owners	Yes	7	6	85.7%	5	83.3%
	Workshops and Training: Generalized Workshops and Demonstrations		3	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		1	0	0.0%	0	0.0%
Administration	**Total**		**51**	**0**	**0.0%**	**0**	**0.0%**
	Administration		26	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		15	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		8	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		2	0	0.0%	0	0.0%
Building Codes and Standards	**Total**		**23**	**0**	**0.0%**	**0**	**0.0%**
	Administration		1	0	0.0%	0	0.0%
	Building Code Development and Support		5	0	0.0%	0	0.0%

BPAC	Subcategory	Is BPAC/ SubCat Evaluated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Sample Frame	Frame/ Universe	Selected Sample	Selected/ Frame
	Technical Assistance to Building Owners		3	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		2	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		7	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		5	0	0.0%	0	0.0%
Energy Audits: Commercial, Industrial, and Agricultural	**Total**		**12**	**0**	**0.0%**	**0**	**0.0%**
	Administration		2	0	0.0%	0	0.0%
	Energy Audits: Commercial, Industrial, and Agricultural		9	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		1	0	0.0%	0	0.0%
Energy Audits: Residential	**Total**		**2**	**0**	**0.0%**	**0**	**0.0%**
	Energy Audits: Residential		1	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		1	0	0.0%	0	0.0%
Energy Efficiency Rating and Labeling	**Total**		**4**	**0**	**0.0%**	**0**	**0.0%**
	Administration		1	0	0.0%	0	0.0%
	Building Code Development and Support		1	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		2	0	0.0%	0	0.0%
Energy Emergency Planning	**Total**		**21**	**0**	**0.0%**	**0**	**0.0%**
	Energy Emergency Planning		21	0	0.0%	0	0.0%
Government, School, and Institutional Procurement	**Total**		**4**	**0**	**0.0%**	**0**	**0.0%**

BPAC	Subcategory	Is BPAC/ SubCat Evaluated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Sample Frame	Frame/ Universe	Selected Sample	Selected/ Frame
	Government, School and Institutional Procurement		2	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		2	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		0	0	0.0%	0	0.0%
New Construction and Design	**Total**		**10**	**0**	**0.0%**	**0**	**0.0%**
	New Construction and Design		1	0	0.0%	0	0.0%
	Technical Assistance to Building Owners		2	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		4	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		3	0	0.0%	0	0.0%
Renewable Energy Market Development	**Total**		**43**	**0**	**0.0%**	**0**	**0.0%**
	Administration		4	0	0.0%	0	0.0%
	Renewable Energy Market Development: Manufacturing		1	0	0.0%	0	0.0%
	Renewable Energy Market Development: Projects		11	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		8	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		18	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		1	0	0.0%	0	0.0%

BPAC	Subcategory	Is BPAC/ SubCat Evaluated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Sample Frame	Frame/ Universe	Selected Sample	Selected/ Frame
Tax Incentives and Credits	**Total**		**1**	**0**	**0.0%**	**0**	**0.0%**
	Workshops and Training: Targeted Training and/or Certification		1	0	0.0%	0	0.0%
Transportation, Including Carpools and Vanpools	**Total**		**29**	**0**	**0.0%**	**0**	**0.0%**
	Administration		4	0	0.0%	0	0.0%
	Alternative Fuels, Ride Share, and Traffic Optimization		4	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		11	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		9	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		1	0	0.0%	0	0.0%
Industrial Retrofit Support	**Total**		**7**	**0**	**0.0%**	**0**	**0.0%**
	Industrial Retrofit Support		3	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		1	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		3	0	0.0%	0	0.0%

Table 7: Summary of PY 2008 SEP universe, sample frame and selected sample, funding

BPAC	Subcategory	Is BPAC/ SubCat Evaluated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Sample Frame	Frame/Universe	Selected Sample	Selected/Frame
Total	**Total**		**$65,402,875**	**$35,536,725**	**54.3%**	**$30,230,855**	**85.1%**
Building Retrofits	**Total**		**$10,272,050**	**$8,325,702**	**81.1%**	**$6,429,034**	**77.2%**
	Administration		$61,020	$0	0.0%	$0	0.0%
	Building Retrofits: Nonresidential	Yes	$913,228	$903,728	99.0%	$903,728	100.0%
	Building Retrofits: Residential		$576,183	$576,183	100.0%	$576,183	100.0%
	Energy Audits: Commercial, Industrial, and Agricultural		$306,265	$0	0.0%	$0	0.0%
	Energy Audits: Residential		$65,000	$0	0.0%	$0	0.0%
	Technical Assistance to Building Owners	Yes	$4,074,048	$4,060,411	99.7%	$2,953,626	72.7%
	Workshops and Training: Generalized Marketing and Outreach		$1,285,479	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	Yes	$2,799,380	$2,785,380	99.5%	$1,995,497	71.6%
	Workshops and Training: Targeted Training and/or Certification		$191,447	$0	0.0%	$0	0.0%
Clean Energy Policy Support	**Total**		**$6,086,856**	**$5,690,342**	**93.5%**	**$3,075,674**	**54.1%**
	Administration		$362,085	$151,159	41.7%	$0	0.0%
	Policy and	Yes	$5,714,771	$5,539,183	96.9%	$3,075,674	55.5%

	Market Studies; Legislative Support Workshops and Training: Generalized Marketing and Outreach		$10,000	$0	0.0%	$0	0.0%
Loans, Grants, and Incentives	**Total**		**$21,932,099**	**$19,719,988**	**89.9%**	**$18,984,215**	**96.3%**
	Administration		$977,556	$0	0.0%	$0	0.0%
	Alternative Fuels, Ride Share, and Traffic Optimization	Yes	$2,932,203	$2,932,203	100.0%	$2,437,774	83.1%
	Building Retrofits: Nonresidential	Yes	$9,392,550	$9,392,550	100.0%	$9,177,550	97.7%
	Building Retrofits: Residential	Yes	$2,332,255	$2,332,255	100.0%	$2,332,255	100.0%
	Industrial Retrofit Support		$11,985	$0	0.0%	$0	0.0%
	Renewable Energy Market Development: Manufacturing		$295,000	$0	0.0%	$0	0.0%
	Renewable Energy Market Development: Projects		$421,409	$0	0.0%	$0	0.0%
	Technical Assistance to Building Owners		$5,062,979	$5,062,979	100.0%	$5,036,635	99.5%
	Workshops and Training: Generalized Marketing and Outreach		$408,939	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		$97,222	$0	0.0%	$0	0.0%

Technical Assistance to Building Owners	**Total**		**$2,051,828**	**$1,800,693**	**87.8%**	**$1,741,933**	**96.7%**
	Administration		$79,353	$0	0.0%	$0	0.0%
	Technical Assistance to Building Owners	Yes	$1,801,193	$1,800,693	100.0%	$1,741,933	96.7%
	Workshops and Training: Generalized Workshops and Demonstrations		$75,402	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification		$95,880	$0	0.0%	$0	0.0%
Administration	**Total**		**$6,926,518**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration		$4,574,627	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		$1,731,127	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		$542,456	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification		$78,308	$0	0.0%	$0	0.0%
Building Codes and Standards	**Total**		**$5,887,628**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration		$3,468	$0	0.0%	$0	0.0%
	Building Code Development and Support		$393,875	$0	0.0%	$0	0.0%
	Technical Assistance to Building Owners		$2,972,522	$0	0.0%	$0	0.0%
	Workshops and		$12,816	$0	0.0%	$0	0.0%

	Training: Generalized Marketing and Outreach					
	Workshops and Training: Generalized Workshops and Demonstrations	$1,622,416	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification	$882,531	$0	0.0%	$0	0.0%
Energy Audits: Commercial, Industrial, and Agricultural	**Total**	**$1,564,793**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration	$194,355	$0	0.0%	$0	0.0%
	Energy Audits: Commercial, Industrial, and Agricultural	$1,290,438	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification	$80,000	$0	0.0%	$0	0.0%
Energy Audits: Residential	**Total**	**$322,575**	**$0**	**0.0%**	**$0**	**0.0%**
	Energy Audits: Residential	$96,000	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification	$226,575	$0	0.0%	$0	0.0%

Energy Efficiency Rating and Labeling	**Total**	**$659,357**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration	$35,000	$0	0.0%	$0	0.0%
	Building Code Development and Support	$515,635	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach	$108,722	$0	0.0%	$0	0.0%
Energy Emergency Planning	**Total**	**$2,218,426**	**$0**	**0.0%**	**$0**	**0.0%**
	Energy Emergency Planning	$2,218,426	$0	0.0%	$0	0.0%
Government, School, and Institutional Procurement	**Total**	**$98,382**	**$0**	**0.0%**	**$0**	**0.0%**
	Government, School and Institutional Procurement	$25,607	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach	$30,722	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification	$42,053	$0	0.0%	$0	0.0%
New Construction and Design	**Total**	**$433,479**	**$0**	**0.0%**	**$0**	**0.0%**
	New Construction and Design	$9,000	$0	0.0%	$0	0.0%
	Technical Assistance to Building Owners	$45,443	$0	0.0%	$0	0.0%
	Workshops and	$226,350	$0	0.0%	$0	0.0%

	Training: Generalized Marketing and Outreach					
	Workshops and Training: Generalized Workshops and Demonstrations	$152,686	$0	0.0%	$0	0.0%
Renewable Energy Market Development	**Total**	**$4,212,735**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration	$113,550	$0	0.0%	$0	0.0%
	Renewable Energy Market Development: Manufacturing	$17,526	$0	0.0%	$0	0.0%
	Renewable Energy Market Development: Projects	$856,398	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach	$291,634	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	$2,926,128	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification	$7,500	$0	0.0%	$0	0.0%
Tax Incentives and Credits	**Total**	**$361,541**	**$0**	**0.0%**	**$0**	**0.0%**
	Workshops and Training: Targeted Training and/or Certification	$361,541	$0	0.0%	$0	0.0%
Transportation, Including	**Total**	**$1,988,424**	**$0**	**0.0%**	**$0**	**0.0%**

Carpools and Vanpools						
	Administration	$140,471	$0	0.0%	$0	0.0%
	Alternative Fuels, Ride Share, and Traffic Optimization	$279,942	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach	$454,379	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	$973,617	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification	$140,015	$0	0.0%	$0	0.0%
Industrial Retrofit Support	**Total**	**$386,183**	**$0**	**0.0%**	**$0**	**0.0%**
	Industrial Retrofit Support	$69,513	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach	$28,722	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	$287,947	$0	0.0%	$0	0.0%

Table 8: Summary of ARRA-period universe, sample frame and selected sample, number of PAs

BPAC	Subcategory	Is BPAC/ SubCat Evalu-ated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Sample Frame	Frame/ Universe	Selected Sample	Selected/Frame
Total	**Total**		**506**	**278**	**54.9%**	**80**	**28.8%**
Building Codes and Standards	**Total**		**27**	**19**	**70.4%**	**9**	**47.4%**
	Building Code Development and Support	Yes	12	10	83.3%	5	50.0%
	Workshops and Training: Generalized Marketing and Outreach		2	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		2	2	100.0%	1	50.0%
	Workshops and Training: Targeted Training and/or Certification	Yes	11	7	63.6%	3	42.9%
Building Retrofits	**Total**		**111**	**81**	**73.0%**	**21**	**25.9%**
	Administration		4	0	0.0%	0	0.0%
	Building Retrofits: Nonresidential	Yes	71	70	98.6%	17	24.3%
	Building Retrofits: Residential	Yes	12	11	91.7%	4	36.4%
	Energy Audits: Commercial, Industrial, and Agricultural		3	0	0.0%	0	0.0%
	Energy Audits: Residential		3	0	0.0%	0	0.0%
	Technical Assistance to Building Owners		6	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		4	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		1	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		7	0	0.0%	0	0.0%

Loans, Grants, and Incentives	**Total**		**151**	**118**	**78.1%**	**30**	**25.4%**
	Administration		8	0	0.0%	0	0.0%
	Alternative Fuels, Ride Share and Traffic Optimization		8	0	0.0%	0	0.0%
	Building Retrofits: Nonresidential	Yes	40	40	100.0%	10	25.0%
	Building Retrofits: Residential	Yes	12	12	100.0%	4	33.3%
	Energy Audits: Commercial, Industrial, and Agricultural		2	0	0.0%	0	0.0%
	Energy Efficiency Rating and Labeling		1	0	0.0%	0	0.0%
	Industrial Retrofit Support		3	0	0.0%	0	0.0%
	Renewable Energy Market Development: Manufacturing	Yes	12	12	100.0%	4	33.3%
	Renewable Energy Market Development: Projects	Yes	56	54	96.4%	12	22.2%
	Technical Assistance to Building Owners		2	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		1	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		4	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification		2	0	0.0%	0	0.0%
Renewable Energy Market Development	**Total**		**84**	**60**	**71.4%**	**20**	**33.3%**
	Administration		1	0	0.0%	0	0.0%
	Renewable Energy Market Development: Manufacturing	Yes	9	9	100.0%	4	44.4%
	Renewable Energy Market Development: Projects	Yes	53	51	96.2%	16	31.4%
	Technical Assistance to Building Owners		5	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and		3	0	0.0%	0	0.0%

	Outreach					
	Workshops and Training: Generalized Workshops and Demonstrations	7	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification	6	0	0.0%	0	0.0%
Administration	**Total**	**42**	**0**	**0.0%**	**0**	**0.0%**
	Administration	23	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach	13	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	6	0	0.0%	0	0.0%
Clean Energy Policy Support	**Total**	**30**	**0**	**0.0%**	**0**	**0.0%**
	Administration	1	0	0.0%	0	0.0%
	Policy and Market Studies; Legislative Support	29	0	0.0%	0	0.0%
Energy Audits: Commercial, Industrial, and Agricultural	**Total**	**10**	**0**	**0.0%**	**0**	**0.0%**
	Energy Audits: Commercial, Industrial, and Agricultural	7	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification	3	0	0.0%	0	0.0%
Energy Audits: Residential	**Total**	**3**	**0**	**0.0%**	**0**	**0.0%**
	Energy Audits: Residential	1	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification	2	0	0.0%	0	0.0%
Energy Efficiency Rating and Labeling	**Total**	**1**	**0**	**0.0%**	**0**	**0.0%**
	Government, School and Institutional Procurement	1	0	0.0%	0	0.0%
Government, School, and Institutional Procurement	**Total**	**1**	**0**	**0.0%**	**0**	**0.0%**
	Administration	1	0	0.0%	0	0.0%
	Total	**10**	**0**	**0.0%**	**0**	**0.0%**

New Construction and Design						
	Building Code Development and Support	1	0	0.0%	0	0.0%
	New Construction and Design	2	0	0.0%	0	0.0%
	Technical Assistance to Building Owners	3	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	3	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification	1	0	0.0%	0	0.0%
Technical Assistance to Building Owners	**Total**	**7**	**0**	**0.0%**	**0**	**0.0%**
	Technical Assistance to Building Owners	4	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	2	0	0.0%	0	0.0%
	Workshops and Training: Targeted Training and/or Certification	1	0	0.0%	0	0.0%
Traffic Signals	**Total**	**4**	**0**	**0.0%**	**0**	**0.0%**
	Traffic Signals	4	0	0.0%	0	0.0%
Transportation, Including Carpools and Vanpools	**Total**	**20**	**0**	**0.0%**	**0**	**0.0%**
	Administration	1	0	0.0%	0	0.0%
	Alternative Fuels, Ride Share, and Traffic Optimization	16	0	0.0%	0	0.0%
	Workshops and Training: Generalized Marketing and Outreach	3	0	0.0%	0	0.0%
Industrial Retrofit Support	**Total**	**5**	**0**	**0.0%**	**0**	**0.0%**
	Industrial Retrofit Support	4	0	0.0%	0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	1	0	0.0%	0	0.0%

Table 9: Summary of ARRA-period universe, sample frame and selected sample, funding

BPAC	Subcategory	Is BPAC/ SubCat Evalu-ated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Sample Frame	Frame/ Uni-verse	Selected Sample	Selected/Frame
Total	**Total**		**$2,701,703,558**	**$2,246,387,802**	**83.1%**	**$664,936,131**	**29.6%**
Building Codes and Standards	**Total**		**$34,185,099**	**$32,680,150**	**95.6%**	**$24,252,432**	**74.2%**
	Building Code Development and Support	Yes	$10,528,543	$10,381,043	98.6%	$3,822,939	36.8%
	Workshops and Training: Generalized Marketing and Outreach		$1,221,878	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		$19,223,610	$19,223,610	100.0%	$18,563,843	96.6%
	Workshops and Training: Targeted Training and/or Certification	Yes	$3,211,069	$3,075,498	95.8%	$1,865,650	60.7%
Building Retrofits	**Total**		**$746,987,535**	**$663,245,222**	**88.8%**	**$148,526,924**	**22.4%**
	Administration		$7,071,050	$0	0.0%	$0	0.0%
	Building Retrofits: Nonresidential	Yes	$583,694,988	$571,694,988	97.9%	$131,366,754	23.0%
	Building Retrofits: Residential	Yes	$96,027,893	$91,550,234	95.3%	$17,160,170	18.7%
	Energy Audits: Commercial, Industrial, and Agricultural		$8,566,173	$0	0.0%	$0	0.0%
	Energy Audits: Residential		$4,609,619	$0	0.0%	$0	0.0%
	Technical Assistance to Building Owners		$14,057,727	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		$6,654,404	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		$667,990	$0	0.0%	$0	0.0%

	Workshops and Training: Targeted Training and/or Certification		$25,637,692	$0	0.0%	$0	0.0%
Loans, Grants, and Incentives	**Total**		**$1,215,157,857**	**$1,112,659,917**	**91.6%**	**$357,987,990**	**32.2%**
	Administration		$12,349,374	$0	0.0%	$0	0.0%
	Alternative Fuels, Ride Share, and Traffic Optimization		$19,770,793	$0	0.0%	$0	0.0%
	Building Retrofits: Nonresidential	Yes	$458,006,007	$458,006,007	100.0%	$213,551,393	46.6%
	Building Retrofits: Residential	Yes	$103,398,448	$103,398,448	100.0%	$23,120,877	22.4%
	Energy Audits: Commercial, Industrial, and Agricultural		$7,484,928	$0	0.0%	$0	0.0%
	Energy Efficiency Rating and Labeling		$3,000,000	$0	0.0%	$0	0.0%
	Industrial Retrofit Support		$40,450,000	$0	0.0%	$0	0.0%
	Renewable Energy Market Development: Manufacturing	Yes	$251,957,503	$251,957,503	100.0%	$86,496,144	34.3%
	Renewable Energy Market Development: Projects	Yes	$299,335,959	$299,297,959	100.0%	$34,819,576	11.6%
	Technical Assistance to Building Owners		$5,258,220	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		$350,500	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		$4,247,962	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification		$9,548,163	$0	0.0%	$0	0.0%
Renewable Energy Market Development	**Total**		**$461,754,544**	**$437,802,512**	**94.8%**	**$134,168,785**	**30.6%**
	Administration		$732,196	$0	0.0%	$0	0.0%
	Renewable Energy	Yes	$118,323,694	$118,323,694	100.0%	$64,356,735	54.4%

	Market Development: Manufacturing						
	Renewable Energy Market Development: Projects	Yes	$319,538,818	$319,478,818	100.0%	$69,812,050	21.9%
	Technical Assistance to Building Owners		$5,465,000	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		$734,353	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		$2,108,465	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification		$14,852,017	$0	0.0%	$0	0.0%
Administration	**Total**		**$72,684,669**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration		$58,469,522	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach		$11,580,347	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations		$2,634,800	$0	0.0%	$0	0.0%
Clean Energy Policy Support	**Total**		**$29,830,322**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration		$1,501,881	$0	0.0%	$0	0.0%
	Policy and Market Studies; Legislative Support		$28,328,441	$0	0.0%	$0	0.0%
Energy Audits: Commercial, Industrial, and Agricultural	**Total**		**$19,143,554**	**$0**	**0.0%**	**$0**	**0.0%**
	Energy Audits: Commercial, Industrial, and Agricultural		$17,921,554	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification		$1,222,000	$0	0.0%	$0	0.0%

Energy Audits: Residential	**Total**	**$4,772,425**	**$0**	**0.0%**	**$0**	**0.0%**
	Energy Audits: Residential	$4,500,000	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification	$272,425	$0	0.0%	$0	0.0%
Energy Efficiency Rating and Labeling	**Total**	**$9,810**	**$0**	**0.0%**	**$0**	**0.0%**
	Government, School and Institutional Procurement	$9,810	$0	0.0%	$0	0.0%
Government, School and Institutional Procurement	**Total**	**$712,026**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration	$712,026	$0	0.0%	$0	0.0%
New Construction and Design	**Total**	**$10,234,255**	**$0**	**0.0%**	**$0**	**0.0%**
	Building Code Development and Support	$1,000,000	$0	0.0%	$0	0.0%
	New Construction and Design	$5,808,755	$0	0.0%	$0	0.0%
	Technical Assistance to Building Owners	$3,148,000	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	$257,500	$0	0.0%	$0	0.0%
	Workshops and Training: Targeted Training and/or Certification	$20,000	$0	0.0%	$0	0.0%
Technical Assistance to Building Owners	**Total**	**$7,496,088**	**$0**	**0.0%**	**$0**	**0.0%**
	Technical Assistance to Building Owners	$6,886,088	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	$210,000	$0	0.0%	$0	0.0%

	Workshops and Training: Targeted Training and/or Certification	$400,000	$0	0.0%	$0	0.0%
Traffic Signals	**Total**	**$4,461,208**	**$0**	**0.0%**	**$0**	**0.0%**
	Traffic Signals	$4,461,208	$0	0.0%	$0	0.0%
Transportation, Including Carpools and Vanpools	**Total**	**$53,510,956**	**$0**	**0.0%**	**$0**	**0.0%**
	Administration	$200,000	$0	0.0%	$0	0.0%
	Alternative Fuels, Ride Share and Traffic Optimization	$52,360,633	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Marketing and Outreach	$950,323	$0	0.0%	$0	0.0%
Industrial Retrofit Support	**Total**	**$40,763,209**	**$0**	**0.0%**	**$0**	**0.0%**
	Industrial Retrofit Support	$40,163,209	$0	0.0%	$0	0.0%
	Workshops and Training: Generalized Workshops and Demonstrations	$600,000	$0	0.0%	$0	0.0%

During the process of classifying each PA into an appropriate BPAC Subcategory, the PAs were additionally classified into groups defined by level of rigor needed to collect the required data needed for the evaluation. After assigning a rigor-level to each PA on the sample frame, PAs were further classified into two evaluability groups that distinguish those PAs that are more likely to be evaluable at the target level of rigor. In addition to BPAC and Subcategory, the two-level evaluability variable served as a Stage 1 stratification variable during the sample selection process.

Rigor and evaluability were defined for each PA as follows:

Rigor Level PAs were classified into a "High" rigor and "Medium-High" rigor level during the frame development process. These categories partitioned the PAs based on the energy savings verification method that would be used during data collection. Specifically:

High rigor evaluations required verification of savings through best practice methods, particularly methods recognized in the *California Evaluation Protocols, DOE's Impact Evaluation Framework for Technology Deployment Programs*, and the *International Performance Measurement and Verification Protocol*. These methods included on-site verification of a sample number of projects supported by the program, whole building utility meter billing analysis, surveys of participants and nonparticipants, and combinations of building simulation modeling and other engineering analysis with the first two methods. In some cases, these verification methods were mixed with less intensive approaches such as file review and telephone contact with program participants to increase sample size. Sample results were expanded to the population using statistical methods, such as direct estimation with appropriately adjusted sampling weights or weighted ratio estimation.

Medium-high rigor evaluations required verification of savings with individual participants using less intensive data collection and analysis methods than those prescribed for high rigor. Most of the input data were collected through telephone contact with participants and supplemented by review of program documentation. These data were combined with documented input assumptions and applied to standard engineering formulae to estimate savings for all or a sample of participants. On-site data collection was used in exceptional cases, such as when a single project represents a large portion of potential savings for the PA, or where needed to support key assumptions used in the engineering-based assessments. Sample sizes were also smaller in the medium-high rigor assessments.

Evaluability Each PA was assigned an evaluability score of "high" or "moderate" indicating the chance of successfully completing an evaluation at the targeted rigor if the PA was selected into the evaluation sample. Evaluability scores were based on the following criteria:

Match of actual program operations to the BPAC definition. The contractor team developed detailed working definitions for each BPAC. If, after detailed review of activities, the contractor team found that a PA had been misclassified, it was evaluated consistent with its actual activity. However, its expansion weight was based on the BPAC it was selected from.

Progress in implementation. In order to carry out high or medium-high rigor evaluations, a program needed to have resulted in a sufficient number of the targeted actions, such as completion of retrofit projects or installations of renewable energy equipment, for a sample to be drawn and tested. Prior to evaluating any sampled PA, the contractor team provided established criteria to assess evaluability and the status of program or project completion. This only applied to the sampled ARRA-funded period PAs (not the sampled PAs from PY 2008) with current and valid reporting guidance and progress tracking-mechanisms that ensure accuracy of the program's or project's status. At the time the sample frame was constructed, all funding had been obligated under ARRA and program/project completion was considered as one of many variables in the evaluability assessment.

Quality and availability of program records. For high and medium-high rigor evaluations, it was necessary to contact participants in the program. In most cases we needed to characterize the services that participants received from the program at the individual level. If such records were not available at the time of PA selection and could not be reconstructed within schedule and budget constraints, then the PA was dropped from the sample and a substitute selected.

A summary of the sample frame and selected sample by BPAC, Subcategory, and evaluability classification is provided in **Table 10** and

Table 11**.** The evaluability partition resulted in 54 frame PY 2008 SEP PAs in the Moderate group and 47 in the High group. The evaluability partition resulted in 103 frame ARRA-period SEP PAs in the Moderate group and 175 in the High group.

The BPAC, Subcategory, and evaluability groups defined in **Table 10** and

Table 11 represent the final first stage strata for this evaluation.

Table 10: Summary of PY 2008 SEP sample frame and sample by strata

First Stage Strata				Funding			Number of PAs		
BPAC	Subcategory	Evalu-ability	Is BPAC/ SubCat Evalu-ated in this Study?	Sample Frame	Selected PAs	Selected/ Frame	Sample Frame	Selected PAs	Selected/Frame
Total	**Total**	**Total**		**$35,385,566**	**$30,230,855**	**85.4%**	**101**	**60**	**59.4%**
	Total	Moderate		$26,061,572	$24,053,542	92.3%	54	36	66.7%
	Total	High		$9,323,994	$6,177,313	66.3%	47	24	51.1%
Building Retrofits	**Total**	**Total**		**$8,325,702**	**$6,429,034**	**77.2%**	**40**	**24**	**60.0%**
	Building Retrofits: Nonresidential	Moderate	Yes	$903,728	$903,728	100.0%	4	4	100.0%
	Building Retrofits: Residential	Moderate		$576,183	$576,183	100.0%	4	4	100.0%
	Technical Assistance to Building Owners	Moderate	Yes	$2,478,613	$2,478,613	100.0%	4	4	100.0%
	Technical Assistance to Building Owners	High	Yes	$1,581,798	$475,013	30.0%	7	4	57.1%
	Workshops and Training: Generalized Workshops and Demonstrations	Moderate	Yes	$1,035,211	$667,999	64.5%	8	3	37.5%
	Workshops and Training: Generalized Workshops and Demonstrations	High	Yes	$1,750,169	$1,327,498	75.8%	13	5	38.5%
Clean Energy Policy Support	**Total**	**Total**		**$5,539,183**	**$3,075,674**	**55.5%**	**31**	**12**	**38.7%**
	Policy and Market Studies; Legislative Support	Moderate	Yes	$3,350,793	$2,204,403	65.8%	17	7	41.2%
	Policy and Market Studies; Legislative Support	High	Yes	$2,188,390	$871,270	39.8%	14	5	35.7%

Loans, Grants, and Incentives	**Total**	**Total**		**$19,719,988**	**$18,984,215**	**96.3%**	**24**	**19**	**79.2%**
	Alternative Fuels, Ride Share, and Traffic Optimization	Moderate	Yes	$2,932,203	$2,437,774	83.1%	10	7	70.0%
	Building Retrofits: Nonresidential	Moderate	Yes	$7,040,000	$7,040,000	100.0%	2	2	100.0%
	Building Retrofits: Nonresidential	High	Yes	$2,352,550	$2,137,550	90.9%	6	5	83.3%
	Building Retrofits: Residential	Moderate	Yes	$2,332,255	$2,332,255	100.0%	2	2	100.0%
	Technical Assistance to Building Owners	Moderate		$4,786,635	$4,786,635	100.0%	2	2	100.0%
	Technical Assistance to Building Owners	High		$276,344	$250,000	90.5%	2	1	50.0%
Technical Assistance to Building Owners	**Total**	**Total**		**$1,800,693**	**$1,741,933**	**96.7%**	**6**	**5**	**83.3%**
	Technical Assistance to Building Owners	Moderate	Yes	$625,951	$625,951	100.0%	1	1	100.0%
	Technical Assistance to Building Owners	High	Yes	$1,174,742	$1,115,982	95.0%	5	4	80.0%

Note: Table displays only the BPACs and Subcategories that were on the sample frame.

Table 11: Summary of ARRA-period sample frame and sample by strata

First Stage Strata				Funding			Number of PAs		
BPAC	Subcategory	Evalu-ability	Is BPAC/ SubCat Evalu-ated in this Study	Sample Frame	Selected PAs	Selected/ Frame	Sample Frame	Selected PAs	Select-ed/ Frame
Total	**Total**	**Total**		**$2,246,387,802**	**$664,936,131**	**29.6%**	**278**	**80**	**28.8%**
	Total	Moderate		$874,726,088	$320,129,589	36.6%	103	30	29.1%
	Total	High		$1,371,661,714	$344,806,542	25.1%	175	50	28.6%
Building Codes and Standards	**Total**	**Total**		**$32,680,150**	**$24,252,432**	**74.2%**	**19**	**9**	**47.4%**
	Building Code Development and Support	Moderate	Yes	$5,592,500	$315,000	5.6%	4	1	25.0%
	Building Code Development and Support	High	Yes	$4,788,543	$3,507,939	73.3%	6	4	66.7%
	Workshops and Training: Generalized Workshops and Demonstrations	Moderate		$19,223,610	$18,563,843	96.6%	2	1	50.0%
	Workshops and Training: Targeted Training and/or Certification	Moderate	Yes	$895,000	$315,000	35.2%	3	1	33.3%
	Workshops and Training: Targeted Training and/or Certification	High	Yes	$2,180,498	$1,550,650	71.1%	4	2	50.0%
Building Retrofits	**Total**	**Total**		**$663,245,222**	**$148,526,924**	**22.4%**	**81**	**21**	**25.9%**
	Building Retrofits: Nonresidential	Moderate	Yes	$139,709,662	$37,348,301	26.7%	13	3	23.1%
	Building Retrofits: Nonresidential	High	Yes	$431,985,326	$94,018,453	21.8%	57	14	24.6%
	Building Retrofits: Residential	Moderate	Yes	$91,550,234	$17,160,170	18.7%	11	4	36.4%

Loans, Grants, and Incentives	**Total**	**Total**		**$1,112,659,917**	**$357,987,990**	**32.2%**	**118**	**30**	**25.4%**
	Building Retrofits: Nonresidential	Moderate	Yes	$210,771,833	$139,770,607	66.3%	16	4	25.0%
	Building Retrofits: Nonresidential	High	Yes	$247,234,175	$73,780,786	29.8%	24	6	25.0%
	Building Retrofits: Residential	Moderate	Yes	$103,398,448	$23,120,877	22.4%	12	4	33.3%
	Renewable Energy Market Development: Manufacturing	Moderate	Yes	$59,756,366	$5,315,866	8.9%	4	1	25.0%
	Renewable Energy Market Development: Manufacturing	High	Yes	$192,201,137	$81,180,278	42.2%	8	3	37.5%
	Renewable Energy Market Development: Projects	Moderate	Yes	$68,182,009	$11,174,312	16.4%	23	4	17.4%
	Renewable Energy Market Development: Projects	High	Yes	$231,115,950	$23,645,264	10.2%	31	8	25.8%
Renewable Energy Market Development	**Total**	**Total**		**$437,802,512**	**$134,168,785**	**30.6%**	**60**	**20**	**33.3%**
	Renewable Energy Market Development: Manufacturing	Moderate	Yes	$20,020,860	$14,370,860	71.8%	2	1	50.0%
	Renewable Energy Market Development: Manufacturing	High	Yes	$98,302,834	$49,985,875	50.8%	7	3	42.9%
	Renewable Energy Market Development: Projects	Moderate	Yes	$155,625,567	$52,674,753	33.8%	13	6	46.2%
	Renewable Energy Market Development: Projects	High	Yes	$163,853,251	$17,137,297	10.5%	38	10	26.3%

Note: Table displays only the BPACs and SubCats that were on the sample frame.

C.3. STAGE 1: SELECTING PROGRAMMATIC ACTIVITIES

Table 10 and

Table 11 summarized the selected PA sample sizes and frame number of PAs in each of the strata for both the PY 2008 and ARRA-period evaluations. Those strata where the sampling fraction (Selected/Frame) was equal to 100% are the certainty strata for this evaluation. They are considered "certainty" strata because all frame units were selected into the sample. In the remaining strata, called the noncertainty strata, the sample of PAs was selected randomly and with probability proportionate to the PA's funding. This method of selection gives those PAs with a larger funding a proportional greater chance of being selected into the study. However, all PAs within each first stage strata had some chance of being selected, regardless of their size.

C.4. STAGE 2: SAMPLING WITHIN PAS

As discussed in Section C.1, for BPAC Subcategories involving end-user projects, particularly the Building Retrofit Subcategories, a second stage sample of individual projects or participants was selected within each selected PA. For each selected project, data were collected via a telephone survey.

To design these second stage samples, the PA evaluation teams followed standard survey sampling procedures in order to develop precise, statistically defensible, unbiased estimates of the outcomes of interest for each PA. It is worth noting that most of the sampled PAs had a relatively small number of projects/participants associated with it. In these situations, all participants were contacted about all their projects so no random sampling was done within the PA. In general, PAs with a smaller number of projects and participants still experienced some nonresponse so appropriate within-PA sample weights were constructed even for these smaller PAs where a census was done in order to adequately account for any nonresponse in the estimation process.

The second stage sampling process for all PAs followed the same basic process as outlined below.

1. **Determine an appropriate Stage 2 sampling unit**. Generally, we attempted to match the sampling unit to the purchase decision-making unit in order to capture and make best use of information on attribution of program influence on the quantity of measures, timing, and efficiency levels of equipment installed in direct relationship to the savings estimate. However, this was not always possible due to logistical, schedule, and tracking system problems. We developed a variety of methods to deal with this problem. For example, for some PAs we assessed attribution at the program level through large sample surveys of participants, surveys of vendors, sales and shipment data analysis, or combinations of the above.
2. **Stage 2 sample frame.** The Stage 2 sample frame for each PA consisted of the database of facility owners or projects that have received support from the PA. In most cases the databases that were available to sample from contained various items that could be used for stratification and sampling purposes such as project costs, estimates of energy savings based on engineering calculations, or more qualitative characterizations.
3. **Stage 2 sample selection.** In most cases, all projects/participants associated with a PA were contacted during the Stage 2 data collection effort. For those PAs with a larger number of project/participants – a randomly selected subsample of projects/participants was selected. The samples were generally selected using a stratified, random approach. If a suitable size measure existed on the sample frame within each stratum, projects/participants were selected

with probability proportionate to the size. If no suitable size measure existed, then units were randomly selected within each PA with equal probability. Size measures sought for this selection process included PY 2008/ARRA-period funding granted to each project/participant or the estimated energy savings impact of a project/participant that can be attributed to the PY 2008/ARRA-period programs.

4. **Sample weighting.** Sample weights were constructed for each project/participant. The weight began with the inverse of the probability of selection and in nearly all cases included some adjustment for nonresponse. The objective of both the weighting and estimation process at this stage was to develop appropriate, unbiased design estimates for the PA. Sample weights that would account for the selection of PAs for this evaluation and were used for the final BPAC estimation process are discussed in Section C.5.
5. **Estimation.** Weighted estimates of totals and means for a PA were constructed with the nonresponse-adjusted sample weight using standard estimation techniques. A separate ratio estimator was used to develop estimates of totals in situations where item nonresponse existed in order to obtain unbiased estimates of the population totals.

In summary, the ultimate objective in Stage 2 was to develop estimates of the outcome measures of interest for the PA using scientifically and statistically defensible techniques that maximized the precision of the within-PA estimates, minimized burden to respondents, and minimized costs associated with collecting the data. In most cases, as noted above, the estimation process entailed contacting all participants that were affiliated with the PA, which means a census was taken. In rare instances, a random sample was taken. Random sampling techniques were employed when the number of projects/participants was relatively large.

C.5. WEIGHTING

After the within-PA data collection was completed, a final nonresponse adjusted sample weight was created for each PA. This sample weight was used to expand the PA-level estimates back to the BPAC-level during the final estimation phase of this evaluation. The final estimation process is discussed in the next section.

The PA-level weights that allowed the PA-level results to expand back to the BPAC target population consisted of several components. These included the inverse of the probability of selecting the PA at Stage 1, several adjustments to account for nonresponse at varying phases during the data collection process, and several components that were applied to calibrate the weighted funding estimates to the "best" estimate of total target population funding for each BPAC and Subcategory. The "best" estimates of total target population funding were derived using data collected during the PA assessment phase of data collection. The five weighting factors that comprised the final expansion weight for each PA are as follows:

1. The unconditional probability of selecting the PA at Stage 1 of the design. PAs selected with certainty received an initial weight of 1.00. Other PAs received a weight equal to the inverse of their probability of being selected at Stage 1.

2. The sample weight was simply a calibration adjustment that forced the weighted sum of funding estimated from the selected PAs to equal the target population total by year (PY 2008 or ARRA-period), BPAC, and Subcategory. At this point in the weight adjustment process, the best estimate of total funding for each BPAC and Subcategory was still the data represented on the original WinSAGA/PAGE universe file.

3. The sample of PAs were sent to data collection where an assigned PA-lead attempted to contact a suitable person associated with the PA in order to gather some initial information on the PA to determine its eligibility for this evaluation. Nonresponse was encountered at this phase of the process, and a suitable adjustment to the sample weights was applied to correct for this.

   During the initial contact, the PA-lead gathered initial information on where the PY 2008/ARRA-period funding was spent. In most cases, PAs were spent their funding on a variety of activities, some of which were more suitably classified into other BPACs and Subcategories. During this initial assessment interview, the PA-lead gathered the information necessary to establish the new distribution of funding to the BPACs and Subcategories. If funding was received in one of the eligible BPACs or Subcategories, then the BPAC/Subcategory subset of the PA with the largest funding in the evaluation's target population was selected for this evaluation. Otherwise, the PA was declared ineligible for this evaluation.

4. The assessment data collected during the initial contact with the PAs provided a wealth of information that was used to adjust the target population funding totals for each BPAC and Subcategory. Another weight adjustment was applied to those PAs selected for evaluation that forced their weighed funding levels to sum to the newly acquired target population estimated funding derived from the assessment data.

5. After being selected for evaluation, if additional nonresponse was encountered (primarily because the PA could not be evaluated for any reason), a nonresponse adjustment was applied to the weights.

   During the process of creating the final sample weights it was more efficient to combine the fourth and fifth factor into a single weight adjustment factor that reflected both a nonresponse and a calibration adjustment. Subsequently, in concept, the weight consisted of a product of five factors, but in practice, the weight was defined as a product of four.

Those PAs that were successfully evaluated comprised the final set of respondents for this evaluation. This study concluded with 81 responding PAs.

Table 12 summarizes the number of PAs at each phase of the data collection and weighting process. For the PY 2008 SEP, 60 PAs were selected from the frame of 101 PAs. A total of 49 responded during the assessment for a response rate of 86%, and 29 PAs were evaluated, which yielded a final PA-level response rate of 73.3%.

For the ARRA-period SEP sample, 80 PAs were selected from the frame of 278 PAs, a total of 67 responded during the assessment for a response rate of 96%, and 52 PAs were evaluated, yielding a final response rate of 76.6%.

In **Table 12**, response rates are defined as the number of respondents divided by the number of eligible PAs. In general, PAs were classified as ineligible if they did not receive any PY 2008/ARRA-period funding or if the funding they received was spent on activities that were better classified in BPACs or Subcategories that were not considered eligible for this evaluation (i.e., the BPAC/Subcategory was not part of the target population). The final response rate in this table is the product of the response rate observed during the assessment and the response rate observed during the evaluation phases of data collection.

Considering the breadth, depth, and scope of this data collection, achieving a response rate of 73.3% and 76.6% is generally considered respectable for an effort such as this.

Table 12: Summary of PY 2008 and ARRA-period sample frame and sample by strata

Category	PY 2008	ARRA	Weight Adjustment
Total PAs on Frame	**101**	**278**	
PAs Selected for Evaluation	60	80	Weight factor #1 and #2 was created at this stage to account for the Frame PAs
Assessment Data Collection			
PAs Ineligible	3	10	
PAs Nonresponding	8	3	Weight factor #3 accounted for these nonrespondents
PAs Responding	49	67	Weight factor #4 calibrated the sample to equal revised funding estimates obtained from PAs responding during the assessment.
Response Rate	86.0%	95.7%	
Evaluation			
PAs Ineligible	15	2	
PAs Nonresponding	5	13	Weight factor #5 accounted for these nonrespondents.
PAs Responding	29	52	
Response Rate	85.3%	80.0%	
Final Response Rate	**73.3%**	**76.6%**	

The nonresponse and calibration adjustments noted above were created using a model-based, calibration technique for deriving adjustments [see for example, Folsom and Singh (2000)]. This method has numerous advantages over other ways of deriving a weight adjustment, such as the weighting class approach that involves applying a simple ratio adjustment within groups (called weighting classes). These advantages include:

- More variables can be used in the adjustment process than what can be used with the standard weighting class ratio adjustment. The use of a greater number of variables can reduce the nonresponse and coverage bias associated with the final estimates. All adjustments were created by survey year (PY 2008 and ARRA-period) and include indicator variables for BPAC, Subcategory, and where possible, the interaction of BPAC and Subcategory.
- Since adjustments are created using a modelling approach, one can test for and include the statistically significant predictors for each adjustment.

- Unlike the weighting class approach, continuous variables can be used in the adjustment process. This was particularly attractive for this evaluation because we were interested in preserving the weighted number of PAs after applying each weight adjustment. However, more importantly, we were also interested in preserving the weighted amount of funding (a continuous variable) associated with each BPAC and Subcategory. In other words, at each stage of the weight adjustment process we sought to create adjusted sample weights that would yield weighted funding estimates that equaled the target population estimates exactly.

There was no need to include higher order interactions of variables in the adjustment that would be required with a standard weighting class ratio adjustment. Using lower order interactions of variables helped minimize the effects of unequal weighting, which in turn maximizes precision of the final estimate by keeping sampling errors as low as possible. There was also no need to collapse weighting class cells using this model-based approach. To overcome the problem of cells not having enough respondents, the corresponding interaction term in the adjustment was simply excluded.

C.6. BPAC COVERAGE ESTIMATES

It was noted in Section C.5 that an adjustment was made to the sample weights (factor #4) that calibrated the weighted funding estimates to better estimates of funding associated with each eligible BPAC/Subcategory. These better estimates incorporated information gathered on the assessed sample of 49 PY 2008 and 67 ARRA-period PAs. These better estimates of funding also enabled us to develop a better estimate of coverage of a BPAC from this evaluation. This revised coverage estimate incorporated the assessment data for survey eligible PAs in the sample frame with original WinSAGA/PAGE universe data associated with those PAs associated with Subcategories not in the target population. Revised funding and coverage rates are summarized in **Table 13** and **Table 14**.

Table 13 suggests that for PY 2008, this evaluation is covering:

- 45% of the funding associated with PAs in the Building Retrofit BPAC
- 92% of the funding in the Clean Energy Policy Support BPAC
- 78% of the funding in the Loans, Grants, and Incentives BPAC
- 88% of the funding in the Technical Assistance to Building Owners BPAC.

The smaller coverage rate for the PY 2008 Building Retrofits BPAC is primarily due to PAs selected in this BPAC and later determined to be ineligible for this evaluation because their funding was more appropriately classified into another BPAC or another Subcategory within the Building Retrofit BPAC that was not part of the target population.

Similarly, **Table 14** indicates for the ARRA-period, this evaluation is covering:

- 89% of the funding in the Building Codes and Standards ARRA-period BPAC
- 88% of the funding in the Building Retrofits BPAC
- 86% of the funding in the Loans, Grants, and Incentives BPAC
- 93% of the funding in the Renewable Energy Market Development BPAC.

Note that these coverage rates are a measure of the proportion of each BPAC's funding that is covered by this evaluation. The portion not covered includes both the Subcategories that were purposely omitted from the sample frame as well as the smaller PAs that were omitted for sampling efficiency purposes. This was discussed in Section C.2.

In some studies, statisticians and analysts will incorporate an additional post-stratification adjustment to the sample weights in order to account for sample frame under-coverage, such as that noted in **Table 13** and **Table 14**. From an estimation point-of-view, a post-stratification adjustment does not necessarily impose a coverage bias in estimates provided if the part of the target population not covered by the sample frame represents a random subset of the target population. For this evaluation that was not the case. Several Subcategories within the eight BPACs were purposely omitted from the evaluation, and several BPACs that might have PAs that ultimately would have been classified into these eight BPACs during the assessment data-collection phase were omitted from the frame. Since the Subcategories and BPACs omitted from the sample frame are likely very different than those that were evaluated, it was decided to not apply an additional post-stratification adjustment to the sample weights to account for the under-coverage noted in **Table 13** and **Table 14**.

Table 13: Summary of PY 2008 SEP revised total funding and coverage rates for evaluated BPACs and Subcategories

BPAC	Subcategory	Is BPAC/ SubCat Evaluated in this Study?	Universe Funding (Data from the WinSAGA and PAGE Systems)	Revised Estimate of Universe Funding	Final Estimate of Funding Covered by This Evaluation (From Assessment Data)	Estimated Coverage Rate
Building Retrofits	**Total**	**Yes**	**$10,272,050**	**$7,481,211**	**$3,350,548**	**44.8%**
	Building Retrofits: Nonresidential	Yes	$913,228	$570,814	$556,592	97.5%
	Technical Assistance to Building Owners	Yes	$4,074,048	$2,746,101	$938,167	34.2%
	Workshops and Training: Generalized Workshops and Demonstrations	Yes	$2,799,380	$2,307,102	$1,855,788	80.4%
	Administration		$61,020	n/a	n/a	n/a
	Building Retrofits: Residential		$576,183	n/a	n/a	n/a
	Energy Audits: Commercial, Industrial, and Agricultural		$306,265	n/a	n/a	n/a
	Energy Audits: Residential		$65,000	n/a	n/a	n/a
	Workshops and Training: Generalized Marketing and Outreach		$1,285,479	n/a	n/a	n/a
	Workshops and Training: Targeted Training and/or		$191,447	n/a	n/a	n/a

	Certification					
Clean Energy Policy Support	**Total**	**Yes**	**$6,086,856**	**$4,991,349**	**$4,602,280**	**92.2%**
	Policy and Market Studies; Legislative Support	Yes	$5,714,771	$4,787,036	$4,602,280	96.1%
	Administration		$362,085	n/a	n/a	n/a
	Workshops and Training: Generalized Marketing and Outreach		$10,000	n/a	n/a	n/a
	Workshops and Training: Generalized Workshops and Demonstrations		$0	n/a	n/a	n/a
Loans, Grants, and Incentives	**Total**	**Yes**	**$21,932,099**	**$15,445,552**	**$12,045,327**	**78.0%**
	Alternative Fuels, Ride Share, and Traffic Optimization	Yes	$2,932,203	$2,754,790	$2,727,036	99.0%
	Building Retrofits: Nonresidential	Yes	$9,392,550	$7,651,183	$7,508,919	98.1%
	Building Retrofits: Residential	Yes	$2,332,255	$2,030,548	$1,809,372	89.1%
	Administration		$977,556	n/a	n/a	n/a
	Industrial Retrofit Support		$11,985	n/a	n/a	n/a
	New Construction and Design		$0	n/a	n/a	n/a
	Renewable Energy Market Development: Manufacturing		$295,000	n/a	n/a	n/a
	Renewable Energy Market Development: Projects		$421,409	n/a	n/a	n/a
	Technical Assistance to Building Owners		$5,062,979	n/a	n/a	n/a
	Workshops and Training: Generalized Marketing and Outreach		$408,939	n/a	n/a	n/a
	Workshops and Training: Generalized Workshops and Demonstrations		$97,222	n/a	n/a	n/a
	Other, Out of Scope		$0	n/a	n/a	n/a
Technical Assistance to Building Owners	**Total**	**Yes**	**$2,051,828**	**$5,928,510**	**$5,238,418**	**88.4%**
	Technical Assistance to Building Owners	Yes	$1,801,193	$5,238,836	$5,238,418	100.0%
	Administration		$79,353	n/a	n/a	n/a
	Workshops and		$75,402	n/a	n/a	n/a

	Training: Generalized Workshops and Demonstrations Workshops and Training: Targeted Training and/or Certification		$95,880	n/a	n/a	n/a

Table 14: Summary of ARRA-period revised total funding and coverage rates for evaluated BPACs and Subcategories

BPAC	Subcategory	Is BPAC/ SubCat Evaluated in this Study?	Universe (Data from the WinSAGA and PAGE Systems)	Revised Estimate of Universe Funding	Final Estimate of Funding Covered by This Evaluation (From Assessment Data)	Estimated Coverage Rate
Building Codes and Standards	**Total**	**Yes**	**$34,185,099**	**$12,197,769**	**$10,829,590**	**88.8%**
	Building Code Development and Support	Yes	$10,528,543	$8,215,830	$8,081,735	98.4%
	Workshops and Training: Targeted Training and/or Certification	Yes	$3,211,069	$2,871,106	$2,747,855	95.7%
	Workshops and Training: Generalized Marketing and Outreach		$1,221,878	n/a	n/a	n/a
	Workshops and Training: Generalized Workshops and Demonstrations		$19,223,610	n/a	n/a	n/a
Building Retrofits	**Total**	**Yes**	**$746,987,535**	**$678,634,183**	**$594,973,231**	**87.7%**
	Building Retrofits: Nonresidential	Yes	$583,694,988	$579,283,965	$565,201,448	97.6%
	Building Retrofits: Residential	Yes	$96,027,893	$33,842,510	$29,771,782	88.0%
	Administration		$7,071,050	n/a	n/a	n/a
	Energy Audits: Commercial, Industrial, and Agricultural		$8,566,173	n/a	n/a	n/a
	Energy Audits: Residential		$4,609,619	n/a	n/a	n/a
	Renewable Energy Market Development:		$0	n/a	n/a	n/a

	Projects					
	Technical Assistance to Building Owners		$14,057,727	n/a	n/a	n/a
	Workshops and Training: Generalized Marketing and Outreach		$6,654,404	n/a	n/a	n/a
	Workshops and Training: Generalized Workshops and Demonstrations		$667,990	n/a	n/a	n/a
	Workshops and Training: Targeted Training and/or Certification		$25,637,692	n/a	n/a	n/a
Loans, Grants, and Incentives	**Total**	**Yes**	**$1,215,157,857**	**$984,210,550**	**$847,736,289**	**86.1%**
	Building Retrofits: Nonresidential	Yes	$458,006,007	$271,343,553	$261,464,681	96.4%
	Building Retrofits: Residential	Yes	$103,398,448	$105,324,016	$105,324,016	100.0%
	Renewable Energy Market Development: Manufacturing	Yes	$251,957,503	$163,120,092	$162,911,597	99.9%
	Renewable Energy Market Development: Projects	Yes	$299,335,959	$321,094,766	$318,035,995	99.0%
	Administration		$12,349,374	n/a	n/a	n/a
	Alternative Fuels, Ride Share, and Traffic Optimization		$19,770,793	n/a	n/a	n/a
	Energy Audits: Commercial, Industrial, and Agricultural		$7,484,928	n/a	n/a	n/a
	Energy Efficiency Rating and Labeling		$3,000,000	n/a	n/a	n/a
	Industrial Retrofit Support		$40,450,000	n/a	n/a	n/a
	Technical Assistance to Building Owners		$5,258,220	n/a	n/a	n/a
	Traffic Signals		$0	n/a	n/a	n/a
	Workshops and Training: Generalized Marketing and Outreach		$350,500	n/a	n/a	n/a
	Workshops and Training: Generalized Workshops and Demonstrations		$4,247,962	n/a	n/a	n/a
	Workshops and		$9,548,163	n/a	n/a	n/a

	Training: Targeted Training and/or Certification					
	Other, Out of Scope		$0	n/a	n/a	n/a
Renewable Energy Market Development	**Total**	**Yes**	**$461,754,544**	**$454,314,184**	**$424,161,606**	**93.4%**
	Renewable Energy Market Development: Manufacturing	Yes	$118,323,694	$105,186,560	$105,186,560	100.0%
	Renewable Energy Market Development: Projects	Yes	$319,538,818	$322,539,258	$318,975,046	98.9%
	Administration		$732,196	n/a	n/a	n/a
	Technical Assistance to Building Owners		$5,465,000	n/a	n/a	n/a
	Workshops and Training: Generalized Marketing and Outreach		$734,353	n/a	n/a	n/a
	Workshops and Training: Generalized Workshops and Demonstrations		$2,108,465	n/a	n/a	n/a
	Workshops and Training: Targeted Training and/or Certification		$14,852,017	n/a	n/a	n/a
	Other, Out of Scope		$0	n/a	n/a	n/a

C.7. REFERENCES

Folsom, R.E. and Singh A.C. (2000) "The generalized exponential model for sampling weight calibration for extreme values, non-response, and post-stratification." Proceeding of the 2000 American Statistical Association, Survey Research Methods Section, pp.598-603.

APPENDIX D. FINAL PA EVALUABILITY ASSESSMENT METHODOLOGY

The SEP program evaluation had two stages of data collection: (1) PA evaluability assessment and (2) PA-level evaluation. An overview of both stages of data collection is displayed in **Figure 2**. Stage 1 data collection occurred after Stage 1 sampling. In this preliminary stage of data collection, the contractor team conducted an evaluability assessment, which verified program funding, BPAC Subcategory classification, and that there were enough data available to conduct the evaluation. If a PA was classified as evaluable, it became one of the 81 PAs being evaluated and went on to Stage 2 of data collection. Stage 2 of data collection incorporated all surveys and on-site visits done for each PA's individual evaluation. Stage 2 sampling occurs within Stage 2 of data collection.

Following **Figure 2** is the evaluability assessment template used for interviewers to record their findings during Stage 1 of data collection. It includes the final dispositions a PA could receive for whether it was evaluable or non-evaluable. Stage 2 data collection survey and on-site instruments can be found in Volume IV of this report.

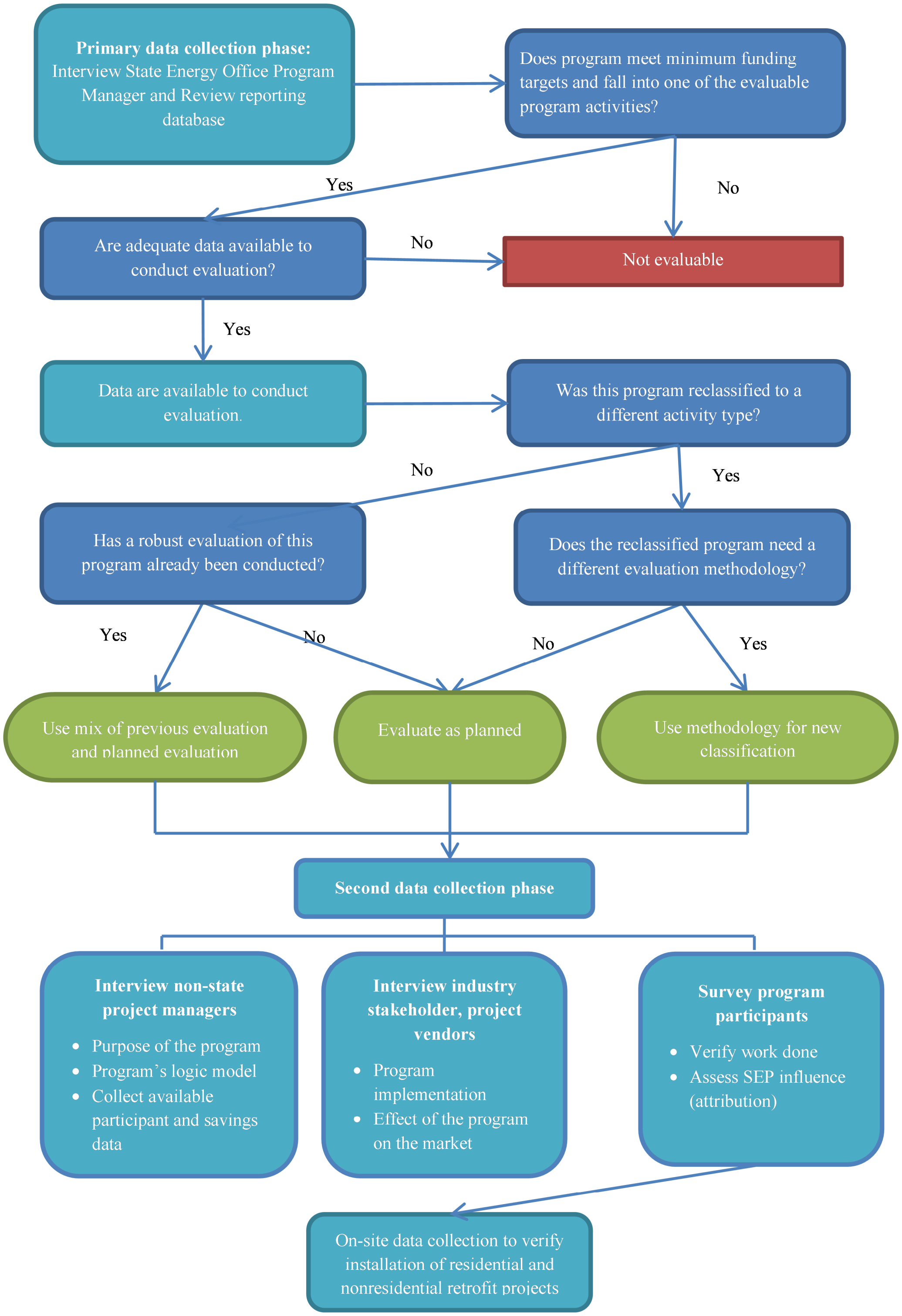

Figure 2: Process flow of primary and secondary data collection phases

D.1. EVALUABILITY ASSESSMENT TEMPLATE FORM – PAGE 1

1. SAMPLE DATA

Market Title:
KEMA Record ID:
Year (PY 2008 or ARRA-period):
BPAC:
Subcategory:
Funding amount from Sample: $

2. BACKGROUND AND OVERVIEW

1. Basic summary of PA (Source: PAGE Narrative and SEO Project Manager).
2. List all related PAs sampled (primary and secondary) from sample data for this BPAC/Subcategory (Source: SEP Sample on Sharepoint Site: National SEP Evaluation > Client Site > Final Contract Deliverables > Final Sample).

REC ID	State	Funding from Sample ($)	Market Title

3. List all PAs in State during the program year, if any (Source: SEP Sample Frame on Sharepoint Site: National SEP Evaluation > Team Site > Archives).

REC ID	State	Funding from Sample ($)	Market Title	BPAC	Subcategory

4. Program Status [Highlight]
   a. Status
      i. Project Ongoing
      ii. Project Complete
      iii. Project Suspended
      iv. Other________
   b. Program completion date______________

D.2. EVALUABILITY ASSESSMENT TEMPLATE FORM – PAGE 2

3. CLASSIFICATION REVIEW

1. Appropriateness of BPAC/Subcategory assignment for sampled PA; refer to list provided (New content; SKIP TO Q2 IF REPEATING ASSESSMENT DUE TO CLASSIFICATION CHANGE)
    a. Is it appropriate? [highlight selection]
        i. YES
        ii. NO
        iii. NO PA MATCH
        iv. CANNOT CONFIRM WITH RESPONDENT
    b. What is alternate assignment? [highlight selection]
        i. No Changes/Not Applicable
        ii. Alternate BPAC Assignment: SPECIFY ____________________________
        iii. Alternate Subcategory Assignment SPECIFY ______________________
        iv. Alternate BPAC and Subcategory Assignment
            1. BPAC____
            2. Subcategory____
2. What is total funding for the market title verified by SEO:$_______________________
    a. List all sub-activities that apply in the following table, the associated funding amounts, and classify the BPAC/Subcategory combinations.
        i. Do not combine sub-activities with identical BPAC/Subcategory assignments. (Insert rows above the grey row as necessary.)
        ii. If any sub-activities for this verified market title are separately specified in the Sample Frame (from 3), list them too.

Sub-activity	**BPAC**	**Subcategory**	**Scope (Y/N)**	**Funding $**	**Percent of Total**
i).Market Title Total	(Must equal $ in Q2)			$	100%
ii).Funding to Sampled Assignment				$	%

    b. Describe in detail Final BPAC/Subcategory sub-activities, assignment of sub-activities within the sampled PA, funding, and source of data.
3. After combining sub-activities by BPAC/Subcategory assignment, please list dominant BPAC/Subcategory assignment (having most funding):

BPAC	
Subcategory	
Verified funding amount ($)	
Proportion of overall verified funding (%)	

D.3. EVALUABILITY ASSESSMENT TEMPLATE FORM – PAGE 3

Decision Rules for Classification Review

Review the following Decision Rules based on the classification review. If none of them apply or this assessment is being completed for a reclassification, then continue to next page. If any Determination applies, please note Disposition Code and skip to Page 6.

Determination	Recommended Action	Disposition Code
Final funding disposition of the dominant BPAC/Subcategory is different than sampled PA, and is in scope, but requires a different energy impact estimation methodology.	STOP. Repeat Evaluability Assessment because of classification change due to updated program detail or funding information requiring an alternate energy impact estimation methodology and team assignment.	D
PA classification/scope can be confirmed but State/SEO respondent is uncooperative then STOP.	STOP. Recommend Substitute PA. PA is confirmed in scope but State/SEO is uncooperative.	G
For PY 2008: When the combined funding of like Sub-Activities is less than $20,000, they are out of scope. If final disposition of funding for each combined in-scope sub-activities is less than $20,000.	STOP. Recommend substitute; PA is out-of-scope.	H
For ARRA: When the combined funding of like Sub-Activities is less than $100,000, they are out of scope. If final disposition of funding for each combined in-scope sub-activities is less than $100,000.	STOP. Recommend substitute; PA is out-of-scope.	H
Final funding disposition of the dominant BPAC/Subcategory is different than sampled PA, and is NOT in scope.	STOP. Recommend substitute; PA is out-of-scope.	H
PA classification/scope cannot be confirmed.	STOP. Recommend substitute; Cannot confirm PAs scope/classify BPAC/Subcategory cell.	I

D.4. EVALUABILITY ASSESSMENT TEMPLATE FORM – PAGE 4

4. METHODOLOGY REVIEW

1. Insert PA logic model. Link inputs and activities to all relevant outputs and outcomes:

Inputs (Ex. Funds, staff)	**Activities** (Ex. Outreach, meetings)	**Outputs** (Ex. People reached, units installed)	**Outcomes** (Energy or carbon saved, renewable energy generated)

2. Is there an existing program evaluation for this market title for the SEO SEP funded activity for this year?
   a. NO
   b. YES [PLEASE DESCRIBE METHODOLOGY AND COMPARE TO DETAILED STUDY PLAN METHODOLOGY FOR PA]
3. Are we able to identify appropriate respondents with sufficient detail and depth for fielding applicable survey instruments? [Highlight selection]
   a. YES [DESCRIBE LEVEL OF DETAIL]
   b. NO [PLEASE DESCRIBE]
4. Are data collection instruments applicable such that impact and attribution can be assessed using intended methods? [Highlight selection]
   a. YES
   b. NO [PLEASE DESCRIBE]
   c. NO BUT AN ACCEPTABLE ALTERNATIVE EXISTS FOR THE AVAILABLE BUDGET [SHOULD BE RARE—PLEASE DESCRIBE AND CONSULT KEMA EA LEAD]
5. **FOR ALL RETROFIT, RENEWABLE OR TECHNICAL ASSISTANCE PAs:** Are program tracking or project data available for engineering savings calculations with sufficient detail for engineering estimation? [Highlight selection]
   a. YES [DESCRIBE LEVEL OF DETAIL]
   b. NO [PLEASE DESCRIBE]
6. **FOR ALL WORKSHOP AND TRAINING PAs**: Are participant data and associated project detail sufficient for estimating savings using engineering methods? [Highlight selection]
   a. YES [DESCRIBE LEVEL OF DETAIL]
   b. NO [PLEASE DESCRIBE]

D.5. EVALUABILITY ASSESSMENT TEMPLATE FORM – PAGE 5

Decision Rules for Methodology Review

Review the following Decision Rules and highlight the most appropriate one. Please describe recommended Evaluability Assessment on the following page.

Determination	**Recommended Action**	**Disposition Code**
This PA is evaluable, properly classified, and the dominant amount of funding to sub-activities matches the original sampled PA BPAC/Subcategory.	Evaluate as Planned.	A
This PA is evaluable, properly classified, and the dominant amount of funding to sub-activities matches the original sampled PA BPAC/Subcategory. This PA has previously been evaluated by the State/SEO.	Evaluate using a combination of planned methodology and pre-existing State SEP evaluation results.	B
This PA is evaluable; however, the dominant amount of funding to sub-activities does not match the original sampled PA BPAC/Subcategory.	Evaluate with planned methodology but note BPAC and/or Subcategory classification change due to updated program detail or funding information.	C
This PA originally received an Evaluability D assignment, has been reassessed and is evaluable, properly re-classified for the dominant amount of funding.	Evaluate using methodology associated with reclassified BPAC/Subcategory; Previous Evaluability Assessment of D.	E
If any responses to questions 3, 4, 5 or 6 in the Methodology Review are (b)?	Recommend substitute; Data not available but PA is in Scope.	F
If PA classification/scope can be confirmed but State/SEO respondent is uncooperative.	Recommend substitute; PA is confirmed in scope but State/SEO is uncooperative.	G

D.6. EVALUABILITY ASSESSMENT TEMPLATE FORM – PAGE 6

5. FINAL EVALUABILITY ASSESSMENT [HIGHLIGHT SELECTION]

A. Evaluate using planned methodology.

B. Evaluate using a combination of planned methodology and pre-existing State SEP evaluation results.

C. Evaluate with planned methodology but note BPAC and/or Subcategory classification change due to updated program detail or funding information.

BPAC	
Subcategory	
Verified funding amount ($)	
Proportion of overall verified funding (%)	

D. Repeat Evaluability Assessment because of classification change due to updated program detail or funding information requiring an alternate energy impact estimation methodology and team assignment.

Recommended BPAC	
Recommended Subcategory	
Verified funding amount ($)	
Proportion of overall verified funding (%)	
New Team Assignment	

D.7. EVALUABILITY ASSESSMENT TEMPLATE FORM – PAGE 7

E. Evaluate using methodology associated with reclassified BPAC/Subcategory; Previous Evaluability Assessment of D.

Confirmed BPAC	
Confirmed Subcategory	
Verified funding amount ($)	
Proportion of overall verified funding amount (%)	

F. Recommend substitute; Data not available but in scope

G. Recommend substitute; Refused but in scope

H. Recommend substitute; Out of scope

I. Recommend substitute; Cannot confirm scope/classify BPAC/Subcategory cell

6. DESCRIBE REASONS FOR EVALUABILITY ASSESSMENT BELOW

APPENDIX E. FINAL DATA COLLECTION DISPOSITION BY SURVEY INSTRUMENT

E.1. DATA COLLECTION DISPOSITION BY BPAC BY SURVEY INSTRUMENT

The data collection process occurred in two stages, which go along with the two sampling stages. Stage 1 of data collection occurred after Stage 1 sampling, and involved the interviews with the SEO staff to assess the evaluability of the PAs. Stage 2 of data collection included the survey and on-site data collection. **Table 15** and **Table 16** provide the response rates by BPAC and survey instrument for Stage 2 data collection for the PY 2008 and ARRA-periods respectively. While these results are at the survey instrument level, the actual tracking of completes was done at the PA level.

Unless otherwise specified, the counts in Columns A through E in both tables represent individual participant contacts, even though some surveys were sampled at the measure level. The sample (Column A) represents the number of contacts sampled from the total population for a particular survey instrument. For more information on Stage 2 sampling within PAs, refer to Section C.4. The targeted number of completes (Column B) represents the number of completes the studies aimed to achieve. Columns C, D, and E are actual dispositions of contacts in the sample and these three columns add up to column A. The completes (Column C) are those who completed the survey, as opposed to those who were found ineligible after being contacted (Column D), [2] or those who either refused or could not be reached during survey fielding (Column E). The final two columns in the tables provide the percent of targeted completes reached and the response rate. In cases where the target was not achieved due to high level of nonresponse, we were still able to collect enough data to conduct the analysis for each PA.

[2] An ineligible record include sample points with non-working phone numbers, wrong phone numbers, or when the eligible respondent is no longer available, perhaps because they have moved in the case of residential surveys, or they no longer work there in the case of non-residential surveys.

Table 15: PY 2008 data collection disposition by BPAC, by survey instrument

BPAC	Survey Type	A Sample	B Targeted Completes	C Completes	D Ineligible	E Nonresponse	Percent of Targeted Completes (C/B)	Response Rate (C/(A-D))
Building Codes and Standards		20	8	7	0	13	88%	35%
	Codes and Standards Programs (Construction Firm Reps)	14	4	3	0	11	75%	21%
	Codes and Standards Programs (State and Local Code Official)	6	4	4	0	2	100%	67%
Building Retrofits		509	116	45	215	249	39%	15%
	Retrofits (Vendors, Installers, Project Developers): Nonresidential	12	12	4	6	2	33%	67%
	Retrofits: Nonresidential Sector Owners	13	10	6	4	3	60%	67%
	Retrofits: Recipient of TA, Workshops, Training for Nonresidential Sector	451	68	18	200	233	26%	7%
	Retrofits: Recipient of TA, Workshops, Training for Residential Sector	9	8	5	2	2	63%	71%
	Tech Assistance (Market Actor)	14	10	8	1	5	80%	62%
	Training and Technical Assistance (Program Delivery Contractors)	9	7	3	2	4	43%	43%
	Nonresidential On-site (Site-level)	1	1	1	0	0	100%	100%
Clean Energy Policy Support (CEPS)		63	50	46		17	92%	73%
	CEPS (Energy Tech Subgrantees)	3	3	3			100%	100%
	CEPS (Energy Tech Suppliers)	1	1	1			100%	100%
	CEPS (Biomass – Program Administrator)	1	1	1			100%	100%
	CEPS (Biomass - Generation Unit Owners)	6	4	4		2	100%	67%
	CEPS (Biomass - Stakeholders)	7	7	7			100%	100%
	CEPS (Biomass - Projects)	9	9	9			100%	100%
	CEPS ([Program] - Non-Pilot)	9	5	4		5	80%	44%
	CEPS ([Program] - Pilots)	9	5	5		4	100%	56%
	CEPS ([Program] Stakeholder)	9	6	6		3	100%	67%
	CEPS ([Program] Subgrantee)	1	1	1			100%	100%

CEPS (Solar - Demonstration Project)	1	1	1			100%	100%
CEPS (Solar- Stakeholder)	4	4	4			100%	100%
Loans, Grants and Incentives	233	96	61	59	113	64%	35%
Retrofits (Vendors, Installers, Project Developers): Residential	33	11	10		23	91%	30%
Retrofits: Residential Sector Owners	126	27	15	59	52	56%	22%
Transportation (Subgrantees)	26	21	21	0	5	100%	81%
Transportation (Suppliers)	9	5	4		5	80%	44%
Nonresidential On-site (Site-level)	2	2	2		0	100%	100%
Residential On-site (Site-level)	37	30	9		28	30%	24%
Technical Assistance	242	78	43	29	170	55%	20%
Retrofits: Recipient of TA, Workshops, Training for Nonresidential Sector	229	73	38	29	162	52%	19%
Training and Technical Assistance (Program Delivery Contractors)	13	5	5	0	8	100%	38%
Grand Total	**1,067**	**348**	**202**	**303**	**562**	**58%**	**26%**

Table 16: ARRA-period data collection disposition by BPAC, by survey instrument

		A	B	C	D	E	F		
BPAC	**Survey Type**	**Sample**	**Minimum Target Completes (A-E)*.3/(1.1^2)**	**Targeted Completes**	**Completes**	**Ineligible**	**Nonresponse**	**Percent of Targeted Completes (D/C)**	**Response Rate (D/A-E)**
Building Codes and Standards		415	103	137	77	60	278	56%	22%
	Codes and Standards Programs (Construction Firm Reps)	214	54	69	40	24	150	58%	21%
	Codes and Standards Programs (State and Local Code Official)	199	47	66	35	36	128	53%	21%
	Training and Technical Assistance (Program Delivery Contractors)	2	2	2	2	0	0	100%	100%
Building Retrofits		637	165	410	357	74	207	87%	63%
	Retrofit (Program Delivery Contractors) Residential	2	2	2	2			100%	100%
	Retrofits (Non-SEP Program Managers) Nonresidential	2	1	2	2	0	0	100%	100%
	Retrofits (Non-SEP Program Managers) Residential	4	2	2	2		2	100%	50%
	Retrofits (Vendors, Installers, Project Developers): Nonresidential	101	30	61	51	16	34	84%	60%
	Retrofits (Vendors, Installers, Project Developers): Residential	46	13	16	13	1	33	81%	29%
	Retrofits: Nonresidential Sector Owners	344	80	207	167	56	121	81%	58%
	Retrofits: Residential Sector Owners	30	10	22	26		4	118%	87%
	Nonresidential On-site (Site-level)	48	12	48	47		1	98%	98%
	Residential On-site (Site- level)	60	15	50	47	1	12	94%	80%
Loans, Grants and Incentives		6,230	309	695	698	5,115	417	100%	63%

Renewables (Non-SEP Program Managers) Residential	4	3	4	2	0	2	50%	50%
Renewables (Vendors, Installers, Project Developers): Nonresidential	6	2	6	4	1	1	67%	80%
Renewables (Vendors, Installers, Project Developers): Nonresidential	12	3	7	4	2	6	57%	40%
Renewables (Vendors, Installers, Project Developers): Residential	68	20	37	42	2	24	111%	64%
Renewables: Nonresidential Sector Owners	202	52	119	121	13	68	92%	64%
Renewables: Residential Sector Owners	412	71	173	180	134	98	104%	65%
Retrofit (Program Delivery Contractors) Residential	6	3	6	6			100%	100%
Retrofits (Vendors, Installers, Project Developers): Nonresidential	1	1	1	1			100%	100%
Retrofits (Vendors, Installers, Project Developers): Nonresidential	43	15	28	32	3	8	114%	80%
Retrofits: Nonresidential Sector Owners	57	19	45	40	5	12	89%	77%
Retrofits: Residential Sector Owners	5,350	100	203	199	4,955	196	98%	50%
Renewable Energy Market Development (Subgrantees)	24	9	21	22	0	2	105%	92%
Nonresidential On-site (Site-level)	45	11	45	45		0	100%	100%
Renewable Energy Market Development	248	56	147	95	54	97	65%	49%
Renewables (Vendors, Installers, Project Developers): Residential	1	1	1	1			100%	100%
Renewables: Nonresidential Sector Owners	10	5	10	9	0	1	70%	90%
Renewables: Residential Sector Owners	188	34	95	62	54	72	65%	46%
Renewable Energy Market Development (Subgrantees)	33	10	28	25	0	8	89%	76%
Grand Total	**7,530**	**633**	**1,389**	**1,227**	**5,303**	**999**	**88%**	**55%**

APPENDIX F. DETAILED BPAC EXPANSION METHODOLOGY

F.1. OVERVIEW

All estimates presented in this report were computed using the fully calibrated and nonresponse adjusted sample weight discussed in Appendix C, Section C.5. Estimates are reported for the following four PY 2008 and four ARRA-period BPACs:

PY 2008:

- Building Retrofits
- Clean Energy Policy Support
- Loans, Grants, and Incentives
- Technical Assistance to Building Owners.

ARRA-period:

- Building Codes and Standards
- Building Retrofits
- Loans, Grants, and Incentives
- Renewable Energy Market Development.

In many sections of this report, estimates of the total over the four PY 2008 BPACs and the four ARRA-period BPACs are also presented.

Note that the estimates in this report reflect only selected Subcategories in the eight BPACs evaluated in this study and do not represent all market titles that were classified in these eight BPACs in the universe file,[3] nor do these estimates represent non-evaluated BPACs. A discussion of the universe file, the study's target population, and BPAC funding coverage associated with this evaluation is provided in Appendix C.

F.2. ESTIMATION AND VARIANCE ESTIMATION

All estimates in this report were created using direct weighted estimation techniques. However, because the weights were calibrated to the correct population funding totals,[4] using direct weighted estimation techniques is equivalent to using a Separate Ratio Estimator with funding as the size measure. There was no item nonresponse in this study, so corrections for item nonresponse were unnecessary.

To illustrate the estimator, suppose

h = Group defined by survey year (PY 2008 or ARRA-period), BPAC and Subcategory.

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[3] The universe file accounted for all funding distributed to states as part of the PY 2008 and ARRA-period programs.

[4] See Appendix C, Section C.5.

i = PA within group *h*

x_{hi} = Is some outcome measure from the evaluation for PA *i*. For example, this might be the energy savings estimate associated with electricity (kWh) attributed to PY 2008/ARRA-period.

s_{hi} = PY 2008 or ARRA-period funding for PA *i* in group *h*.

S_h = Total funding for group *h* on the sample frame (not just the sample). This was derived using the assessment data and represents our best estimate of total funding for group *h* in the target population.

w_{hi} = The calibrated and nonresponse-adjusted sample weight for PA *i*.

Then estimates of a total $\tilde{X}$ were formed using a separate ratio estimator as follows:

$$\tilde{X} = \sum_h S_h \frac{\sum_i w_{hi} x_{hi}}{\sum_i w_{hi} s_{hi}} \qquad (1)$$

As noted in Appendix C, Section C.5, the adjusted sample weights were created so that the final weighted funding sum across responding PAs equals the best estimate of total funding for the BPAC/Subcategory that was derived during the assessment of the PAs. This means:

$$\sum_i w_{hi} s_{hi} = S_h \quad \text{for each group } h.$$

Therefore, the separate ratio estimator defined by Equation (1) is equivalent to the direct weighted survey estimator:

$$\tilde{X} = \sum_h \sum_i w_{hi} x_{hi}$$

Variance estimates were computed for many statistics displayed in this report. The variance estimates were computed using the Taylor series linearization method. This method was first suggested by Tepping (1968) and has been discussed in numerous articles and books since then [see, for example, Binder (1983) and Wolter (1985)]. In general, the Taylor series linearization process for estimating variances accounts for the complex design features that are often found in survey samples, such as stratification, clustering and/or unequal weighting. Therefore, this variance estimation process was appropriate for estimates reported in this analysis.

F.3. ESTIMATES WITH LOW PRECISION

In this report, some estimates are flagged with an asterisk (*), indicating that the estimate exhibits low precision. An estimate is considered to have low precision if one or both of the following was true:

1. Fewer than five responding PAs contributed to the estimate.
2. The relative standard error of the estimate was 75% or greater. The relative standard error is the design-based standard error divided by the estimate itself. The design-based standard error is the

standard error of an estimate that account for the complex design features of the study, such as stratification and unequal weighting.

Several tables in this report present the margin of error associated with an estimate. The margin of error is the radius of the 90% confidence interval and is defined as:

Margin of Error = $t_{df} \cdot \hat{\sigma}_{design}$

Where: t_{df} is a constant from the studentized t-distribution that equals roughly 1.67 and

$\hat{\sigma}_{design}$ is the design-based standard error of the estimate.

Hence, the 90% confidence interval of an estimate is the estimate +/- its margin of error.

F.4. LABOR IMPACTS, AVOIDED CARBON EMISSIONS, BILL SAVINGS, AND COST-EFFECTIVENESS ESTIMATES

Estimates for labor impacts, avoided carbon emissions, and bill savings, as well as several estimates for cost-effectiveness, were generated using various models and algorithms that employed direct survey estimates as inputs. These models and algorithms are discussed in Appendices H, I, and J. The following notes about these estimates and the inputs used in these models are important to consider:

- Estimates of precision are not presented for the labor impacts, avoided carbon emissions, and several cost-effectiveness estimates presented in this report. These estimates, however, are subject to sampling error that is likely of the same magnitude as that reported for the energy impact and bill savings estimates. The margin of error (a measure of sampling error) associated with various energy impact and bill savings estimates are presented in Appendix K. Note that the energy impact and bill savings estimates (as well as some others) were used as inputs into the models and algorithms used to generate estimates for the labor impacts, avoided carbon emissions, and cost-effectiveness sections of this report.
- Several models and algorithms used to generate estimates required location-specific inputs in order to account for geographic variation in model parameters and algorithm assumptions. Some of the models and algorithms required state-specific estimates while others only required estimates by the U.S. Bureau of Economic Analysis regions. This evaluation did not have the sample size to support obtaining direct survey, state- and region-specific estimates within evaluated BPACs and Subcategories. Therefore to account for geographic variation, state-level estimates were created as follows:
    - If a state had one or more evaluated PAs in a specific BPAC and Subcategory, then the state-level estimate was created using data associated with the state.
    - Otherwise direct survey estimation (discussed in Section F.2 above) was used to estimate national totals for each BPAC and Subcategory, such as the total SEP-attributable energy savings associated with electricity or gas. These estimates of totals were proportioned to the states with no sampled PAs proportional to the funding that the state received within a BPAC and Subcategory.

- These BPAC by Subcategory by state estimates of totals were summed to the required geographic level necessary for the model or algorithm under consideration. This process of deriving state-level estimates within each BPAC and Subcategory adds additional sampling error and potentially some bias to the estimates generated from the models and algorithms.

Figure 3 through **Figure 30** show the variation in funding by State for each BPAC and Subcategory under consideration in this evaluation. **Figure 3** through **Figure 15** show the variation in funding for the PY 2008 BPACs and **Figure 16** through **Figure 30** how the variation in funding for the ARRA-period BPACs that were evaluated. Some items to note about this distribution:

- **Figure 3** and **Figure 16** show the distribution of funding by state over all the BPACs and Subcategories evaluated in this study. **Figure 3** shows that California, New York, Texas, Illinois, Michigan, New Jersey, Louisiana, and South Carolina received a proportionally greater amount of funding (compared to other States) for PY 2008 BPACs under consideration. **Figure 16** shows that California, Texas, Illinois, New York, Florida, Louisiana, Michigan, Virginia, Tennessee, Wisconsin, and Georgia received a proportionally greater amount of funding for the ARRA-period BPACs under consideration.
- Some of the results by Subcategory are unexpected. For example, in **Figure 4**, which shows the distribution of funding given to PAs in the PY 2008 Building Retrofits BPAC (all Subcategories considered in this evaluation.) This figure shows that most of the funding was allocated to Louisiana, Michigan and South Dakota. In addition, **Figure 23** shows that the states receiving the greatest amount of funding in the ARRA-period Loans, Grants, and Incentives BPAC (all Subcategories considered in this evaluation) were California, Texas, Oklahoma, Florida, Indiana, Wisconsin, Michigan, Virginia, and New Jersey.
- **Figure 31** and **Figure 32** show the distribution of funding over all BPACs and Subcategories in the original Universe File. These maps reflect all funding, not just the funding affiliated with the BPACs and Subcategories evaluated in this study. These maps are somewhat similar to **Figure 3** and **Figure 16**. **Figure 31** indicates that most of the PY 2008 funding in the original Universe File was given to California, Wyoming, Texas, Louisiana, Hawaii, Illinois, Michigan, South Carolina, New York, and New Jersey. **Figure 32** indicates that most of the ARRA-period funding in the original Universe File was given to California, Texas, Louisiana, Illinois, Wisconsin, Michigan, Ohio, New York, Georgia, and Florida.

The bias in estimates generated from the models and algorithms that used geographic estimates is unknown and depends on three things:

1. The bias depends on the differences in PY 2008 (or ARRA-period) funding between States and regions. As noted above, this can vary substantially depending on the BPAC and Subcategory under consideration.
2. The bias depends on how sensitive the model and algorithm is to variations in geographic estimates that are used as inputs. This will vary by model and algorithm.
3. And more importantly, the bias depends on how different the population parameters are between States and regions. This variation is simply unknown given the survey data that is being analyzed in this evaluation.

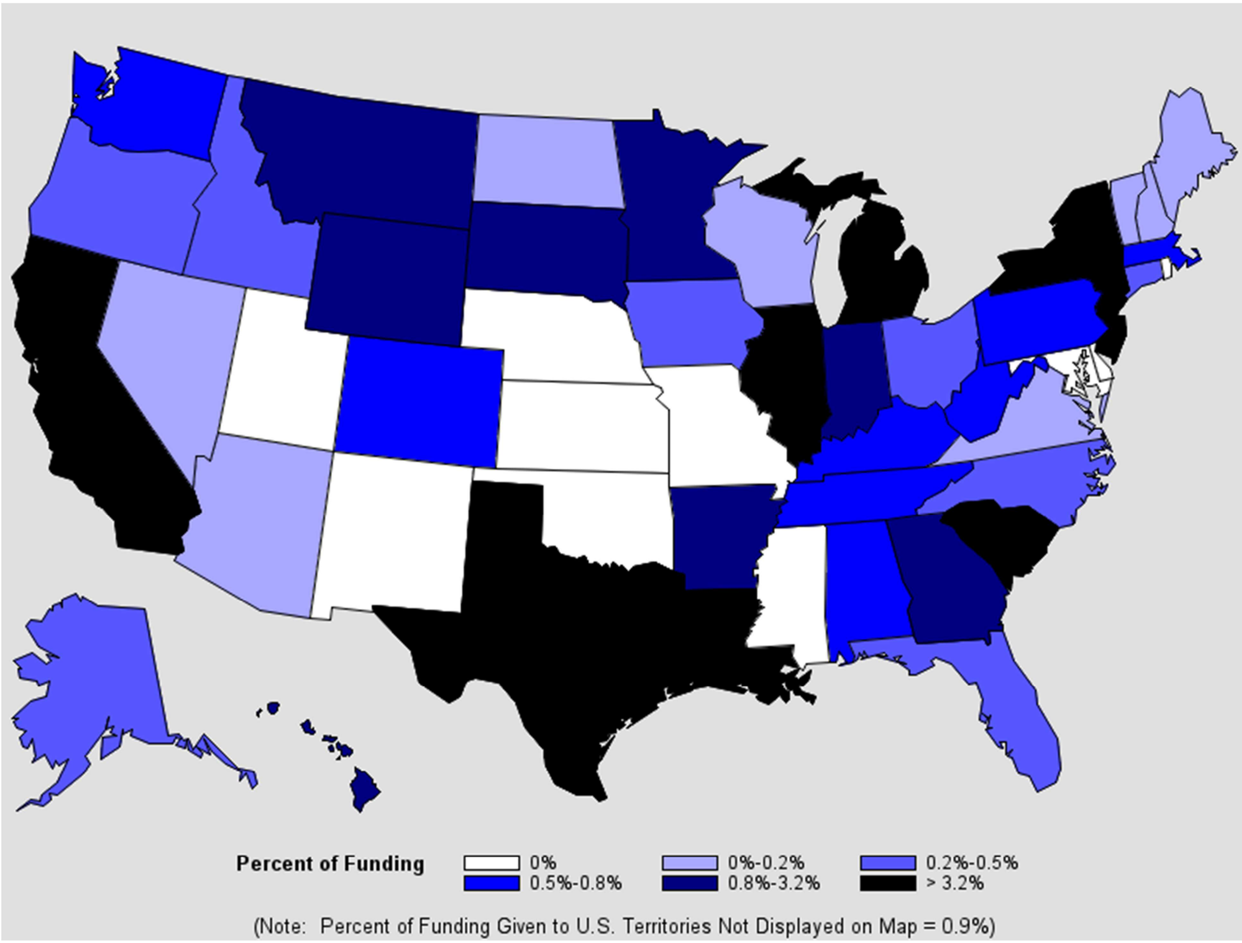

Figure 3: PY 2008 SEP, BPAC=Total over all evaluated BPACs, Subcategory=Total, Percent of funding by state

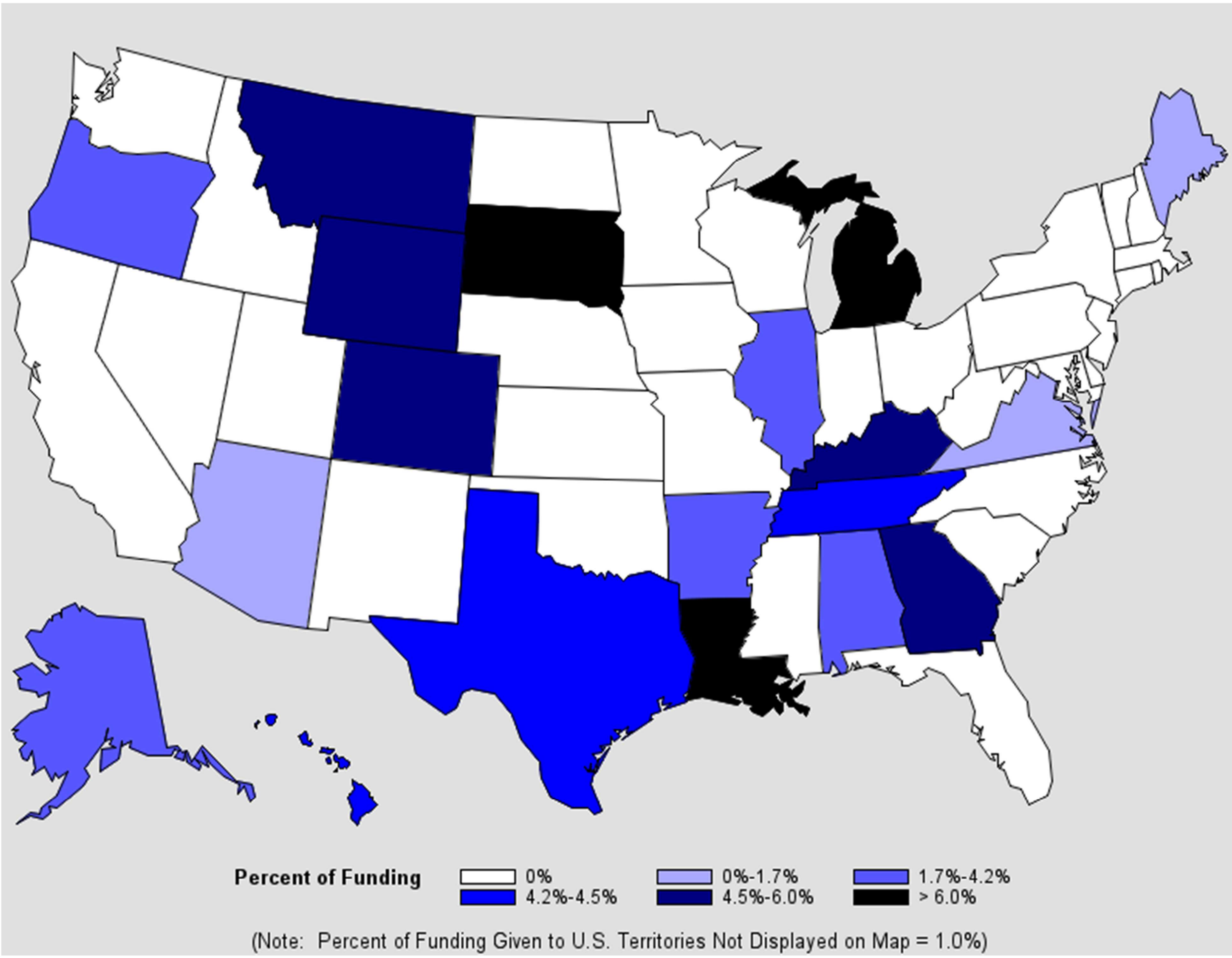

Figure 4: PY 2008 SEP, BPAC=Building Retrofits, Subcategory=Total, Percent of funding by state

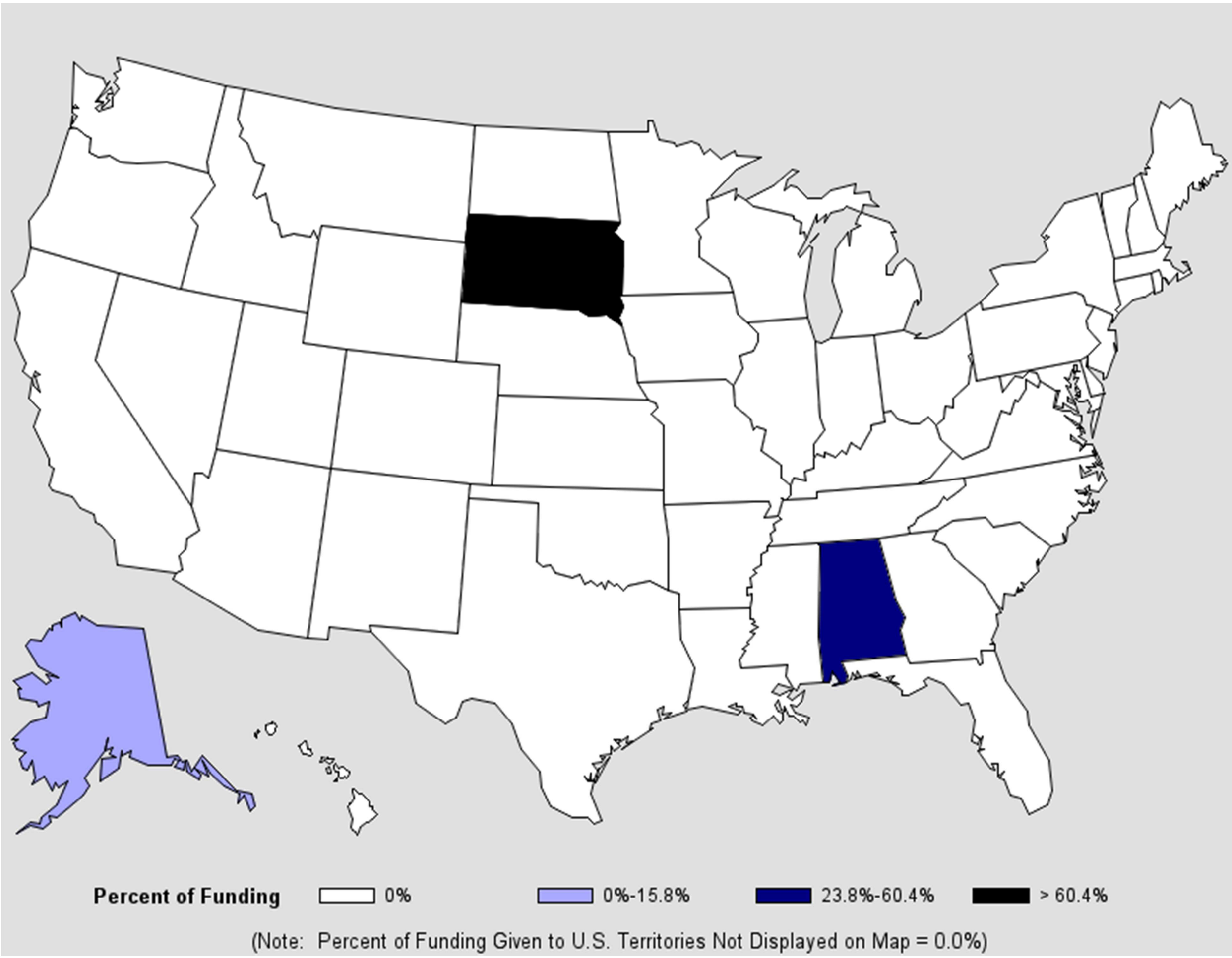

Figure 5: PY 2008 SEP, BPAC=Building Retrofits, Subcategory=Building Retrofits: Nonresidential, Percent of funding by state

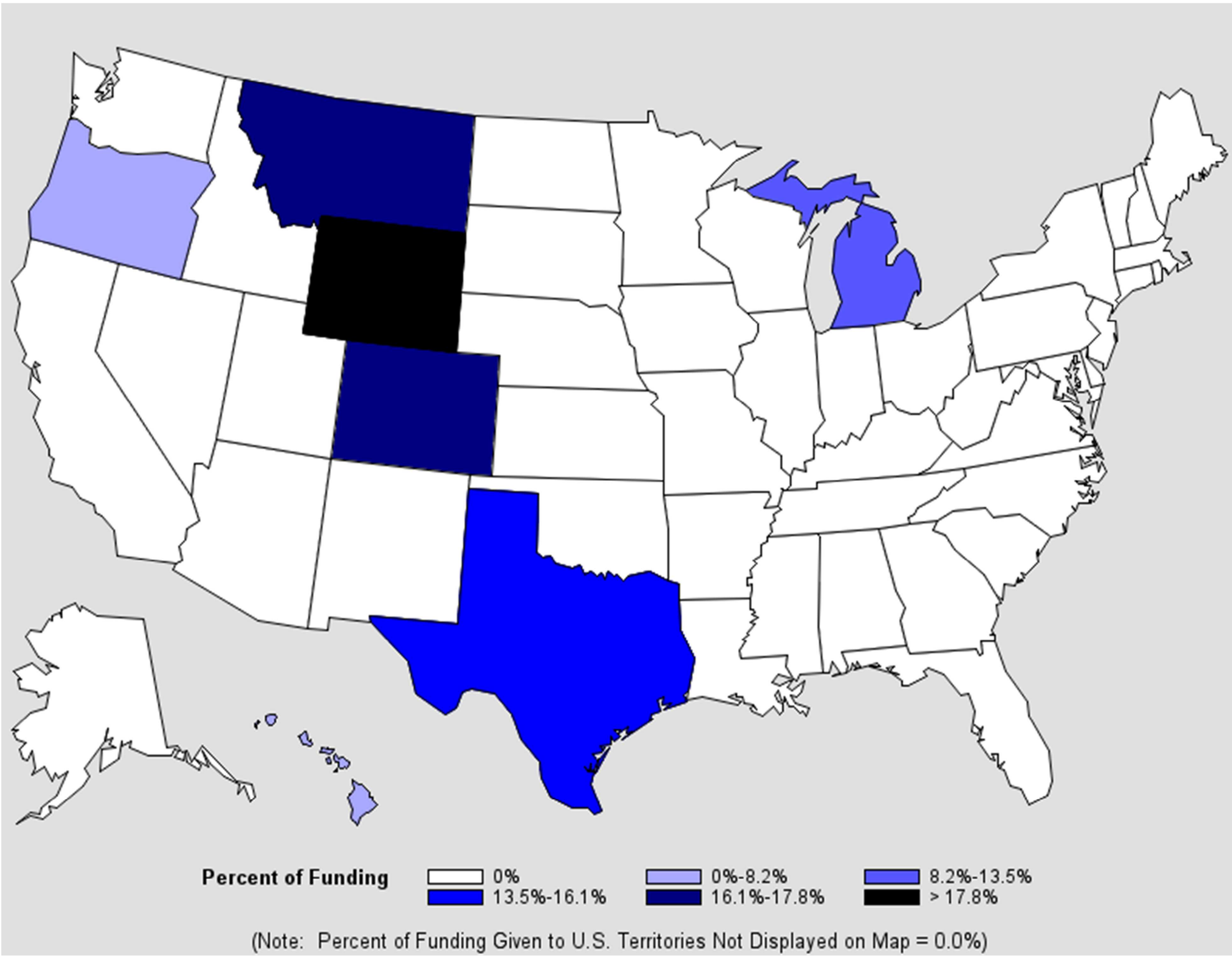

Figure 6: PY 2008 SEP, BPAC=Building Retrofits, Subcategory=Technical Assistance to Building Owners, Percent of funding by state

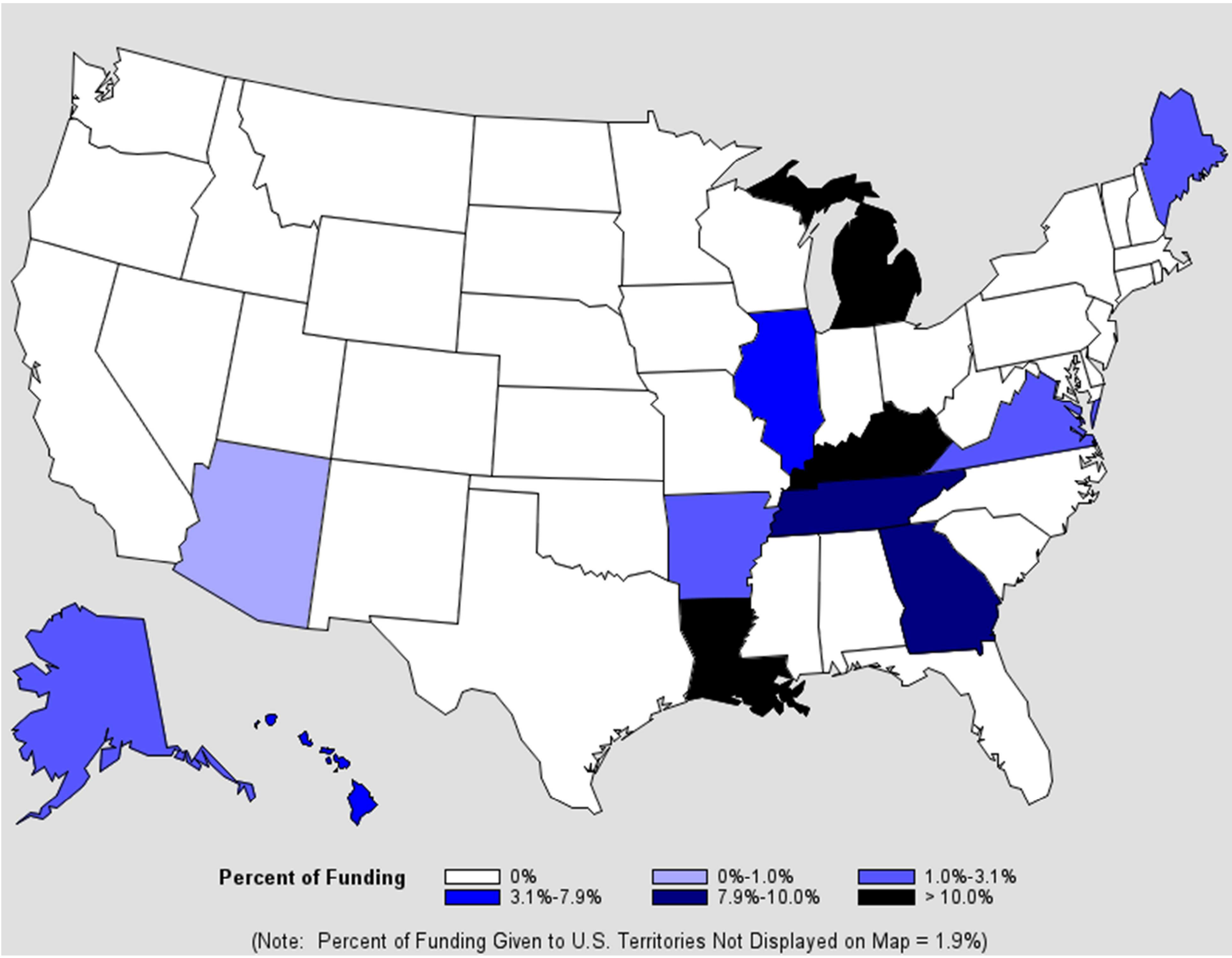

Figure 7: PY 2008 SEP, BPAC=Building Retrofits, Subcategory=Workshops and Training: Generalized Workshops and Demonstrations, Percent of funding by state

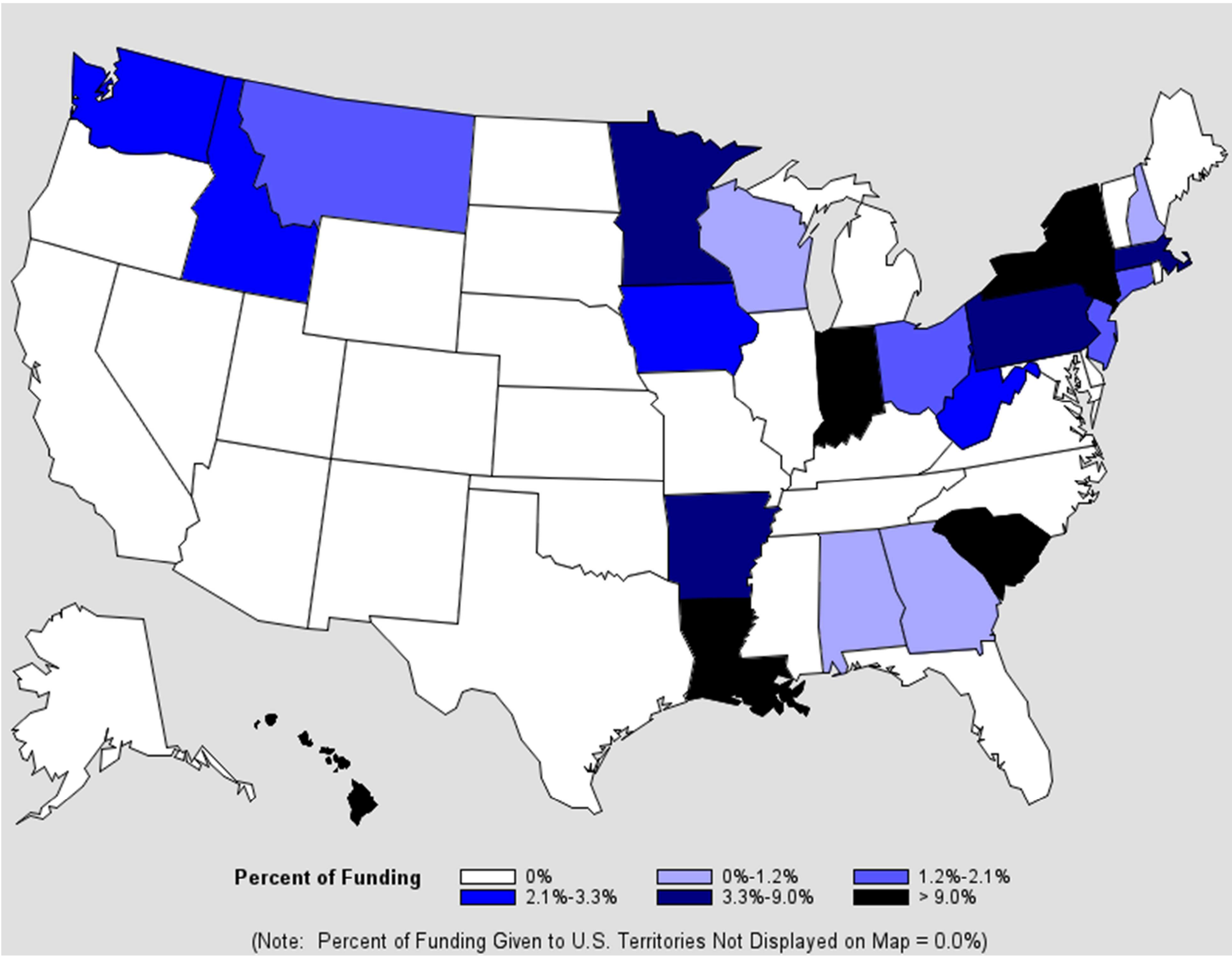

Figure 8: PY 2008 SEP, BPAC=Clean Energy Policy Support, Subcategory=Total, Percent of funding by state

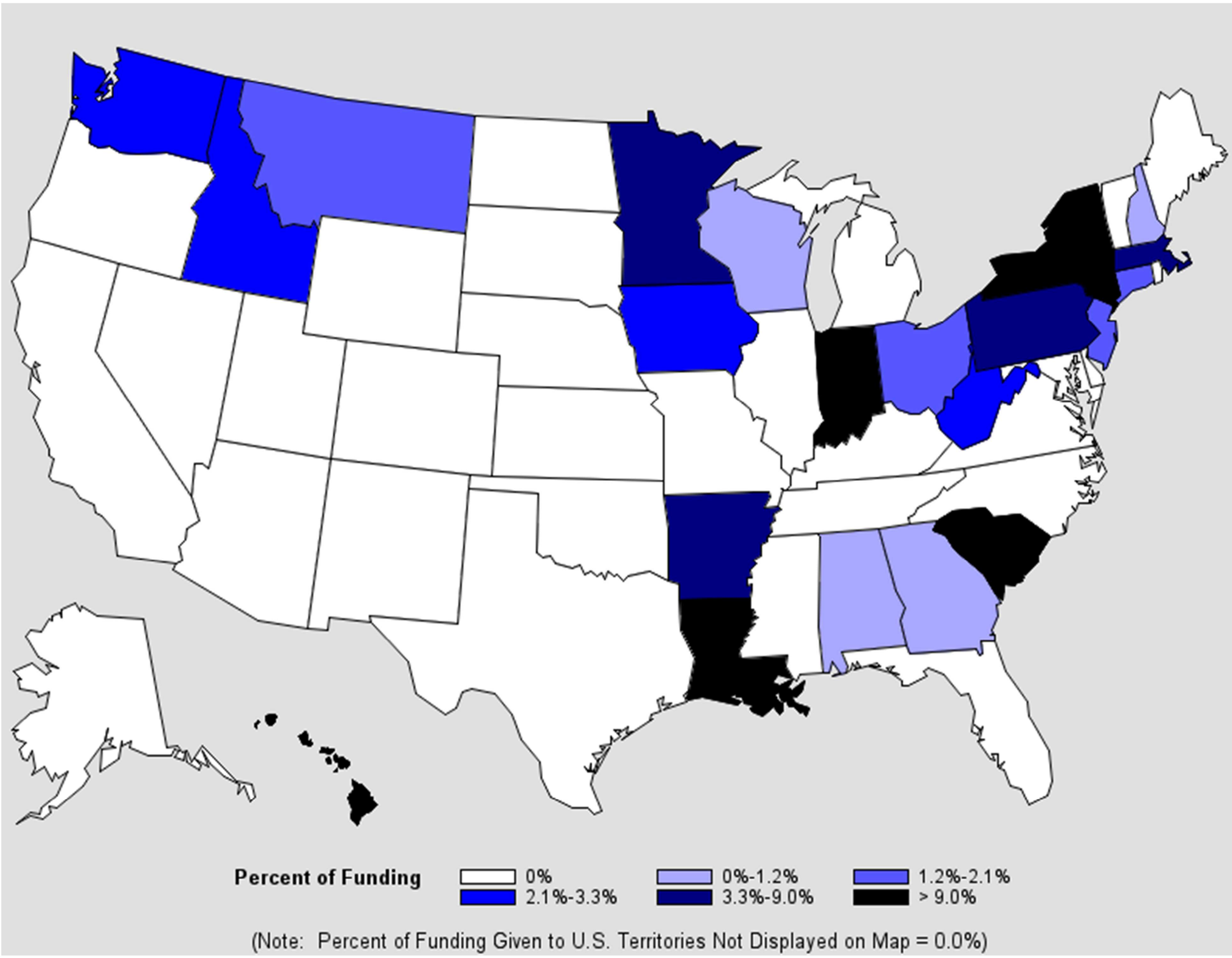

Figure 9: PY 2008 SEP, BPAC=Clean Energy Policy Support, Subcategory=Policy and Market Studies; Legislative Support, Percent of funding by state

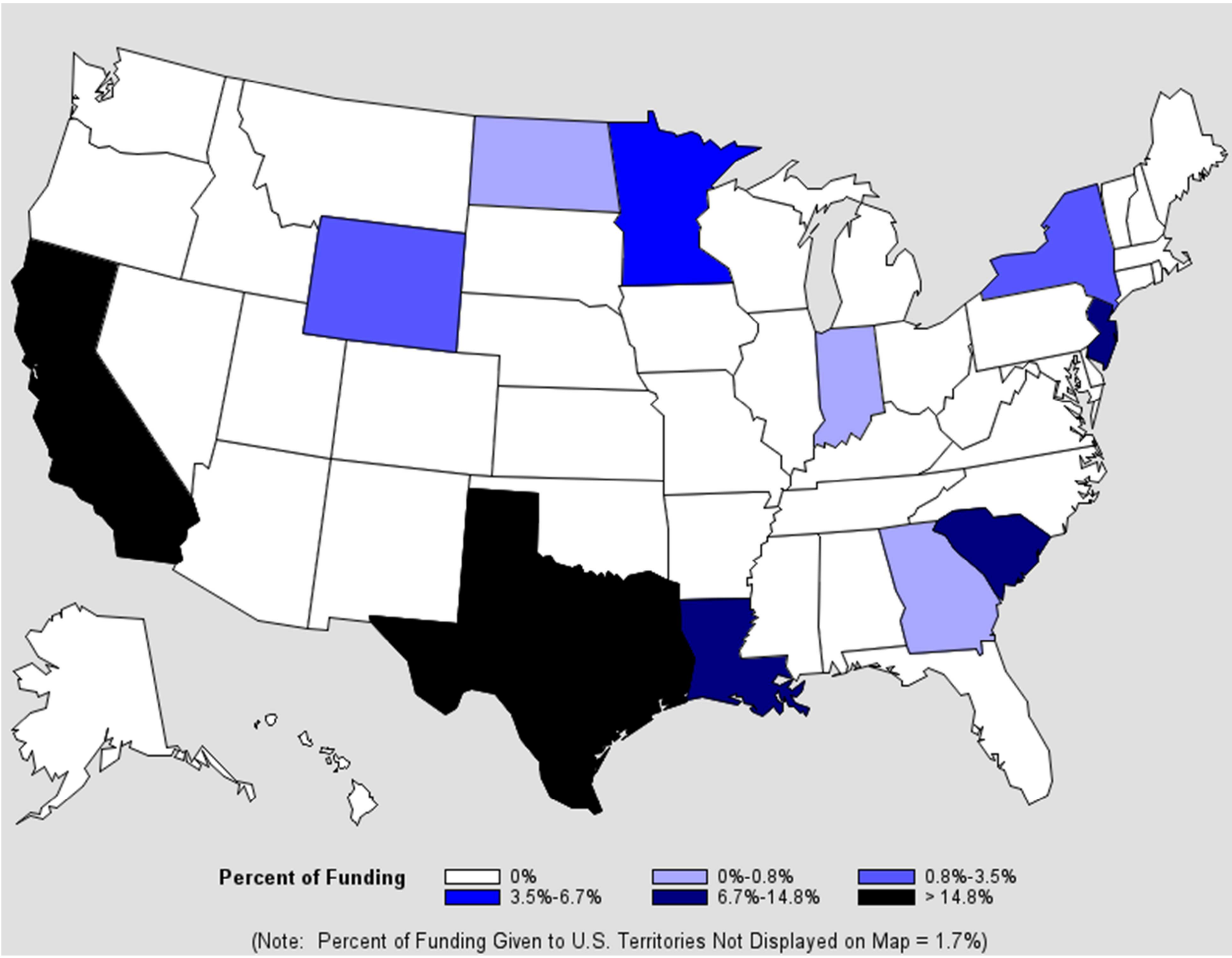

Figure 10: PY 2008 SEP, BPAC=Loans, Grants, and Incentives, Subcategory=Total, Percent of funding by state

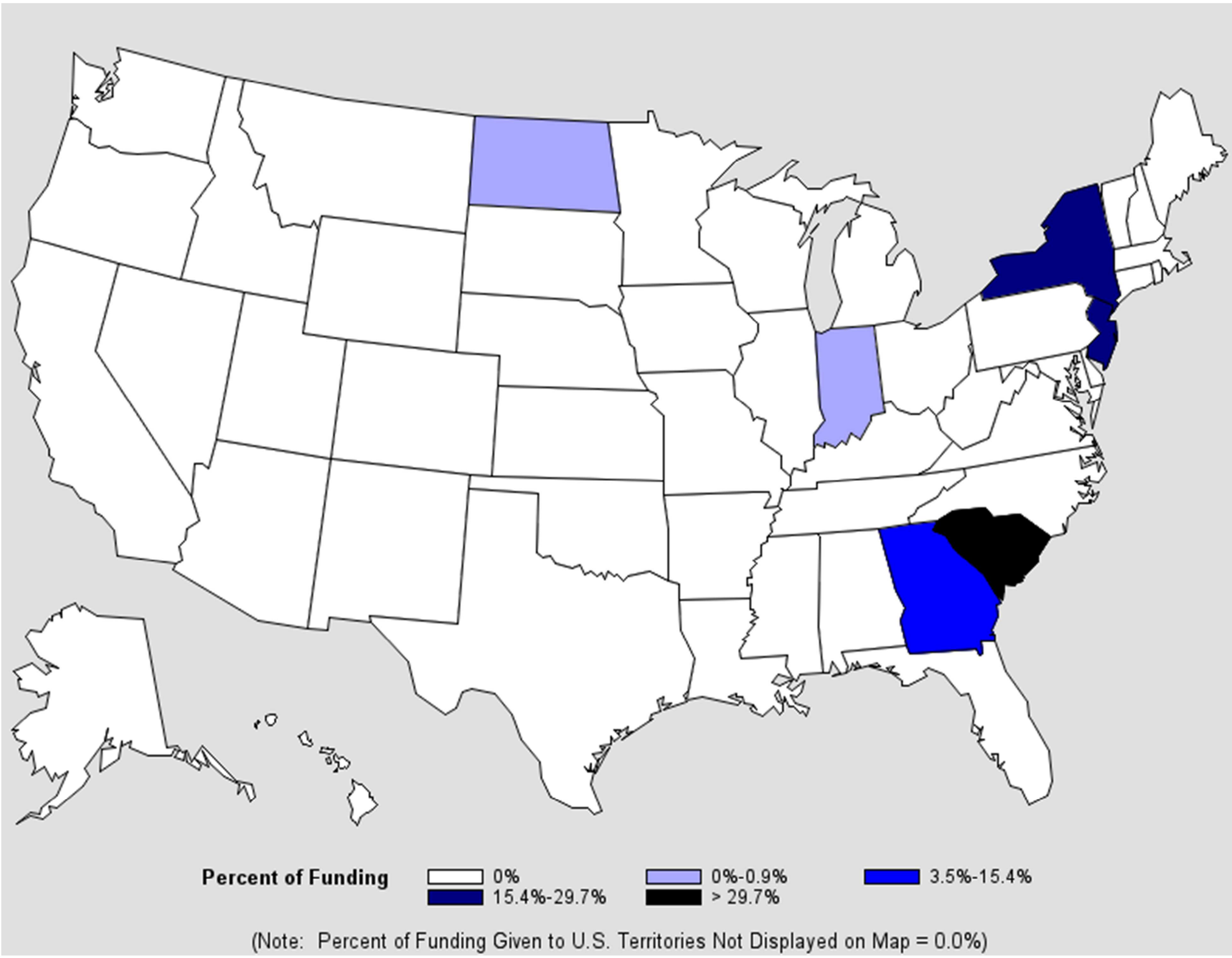

Figure 11: PY 2008 SEP, BPAC=Loans, Grants, and Incentives, Subcategory=Alternative Fuels, Ride Share and Traffic Optimization, Percent of funding by state

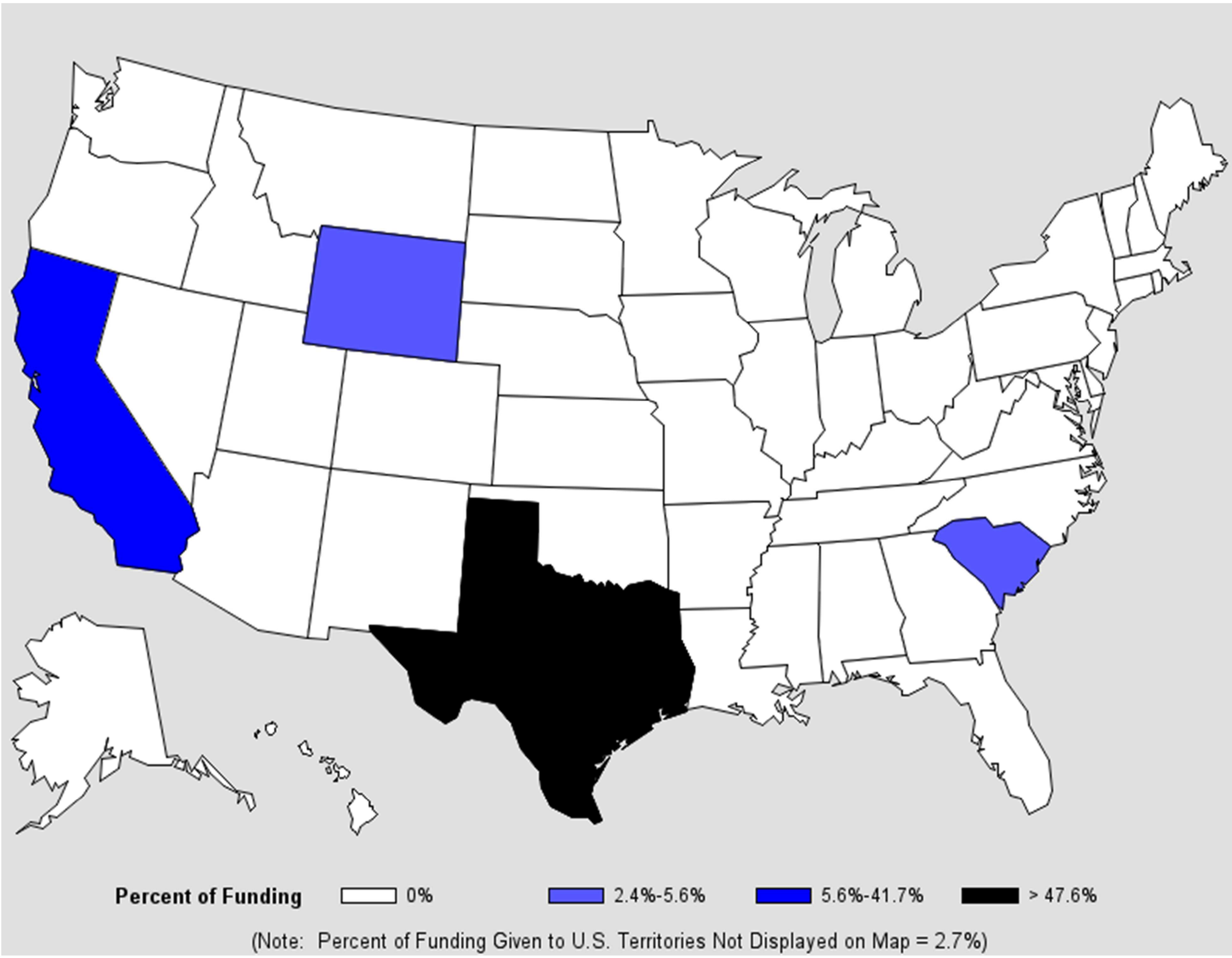

Figure 12: PY 2008 SEP, BPAC=Loans, Grants, and Incentives, Subcategory=Building Retrofits: Nonresidential, Percent of funding by state

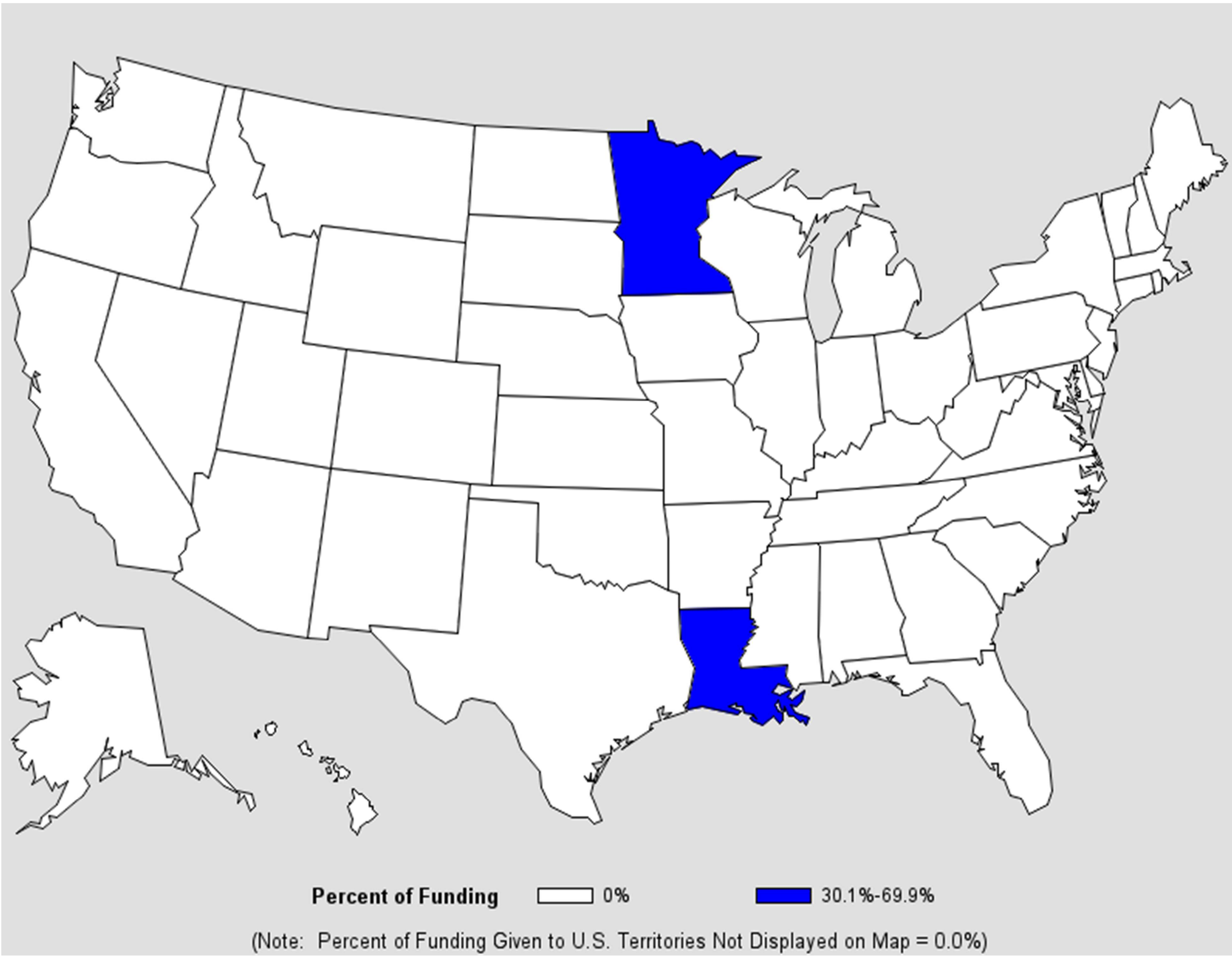

Figure 13: PY 2008 SEP, BPAC=Loans, Grants, and Incentives, Subcategory=Building Retrofits: Residential, Percent of funding by state

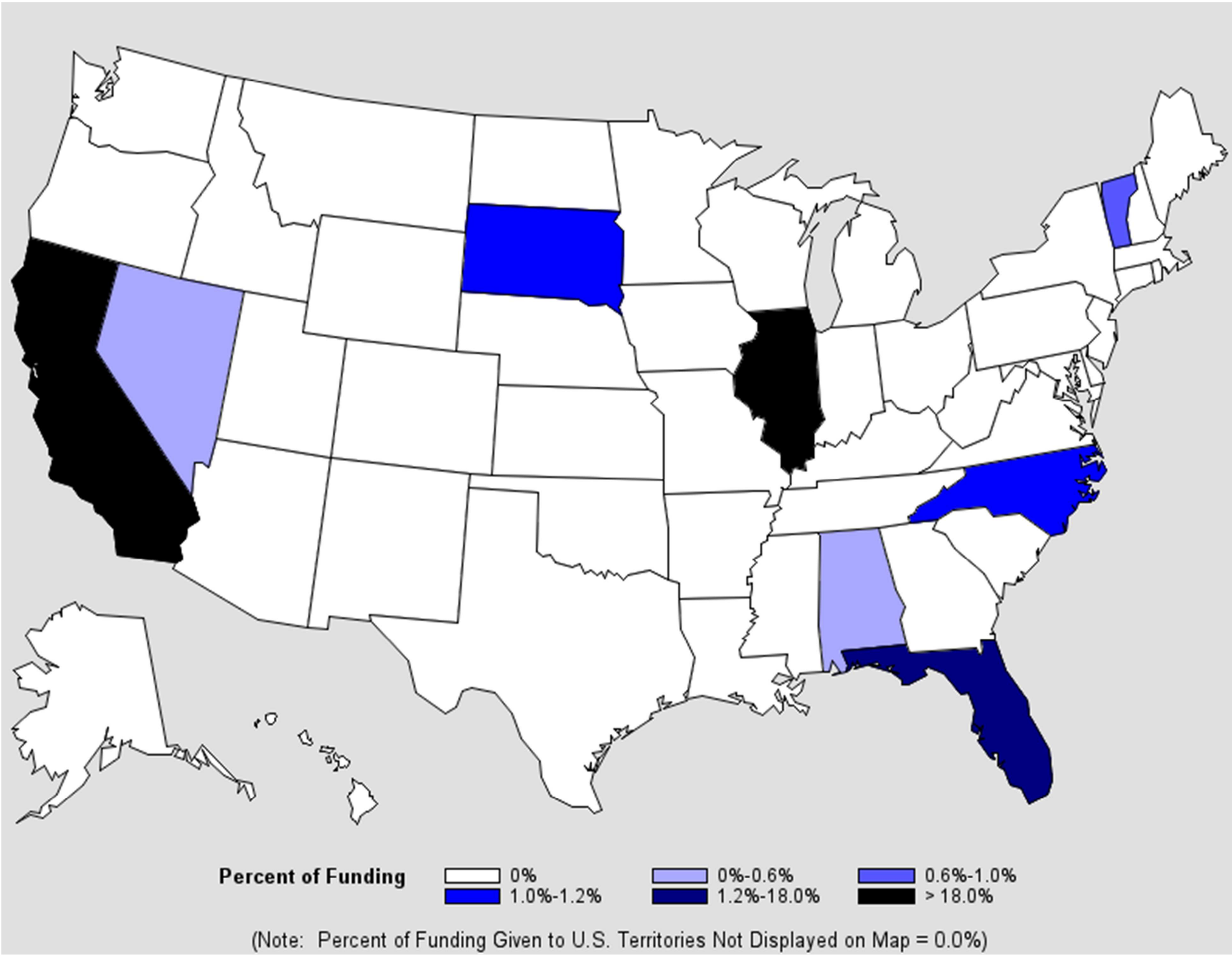

Figure 14: PY 2008 SEP, BPAC=Technical Assistance to Building Owners, Subcategory=Total, Percent of funding by state

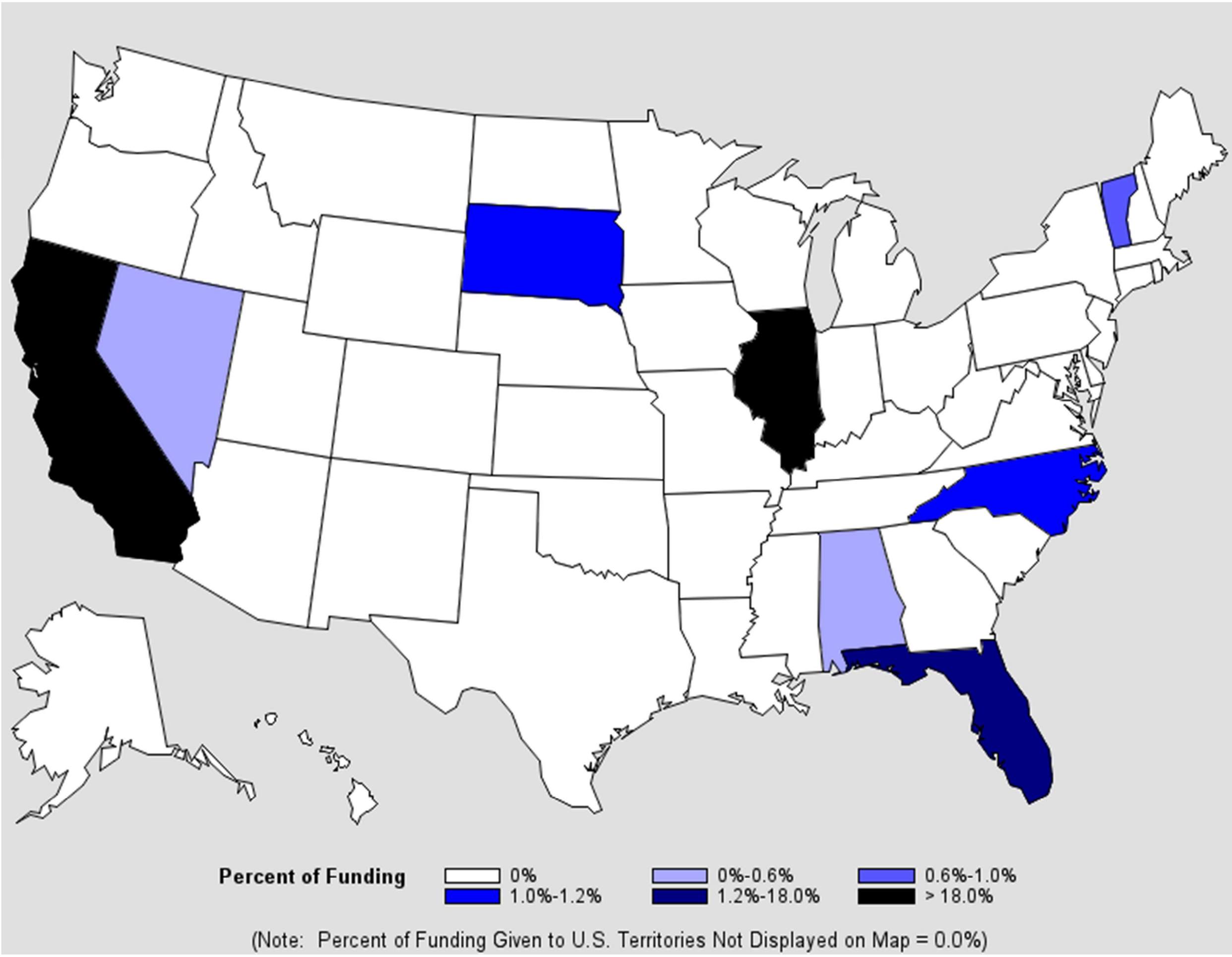

Figure 15: PY 2008 SEP, BPAC=Technical Assistance to Building Owners, Subcategory=Technical Assistance to Building Owners, Percent of funding by state

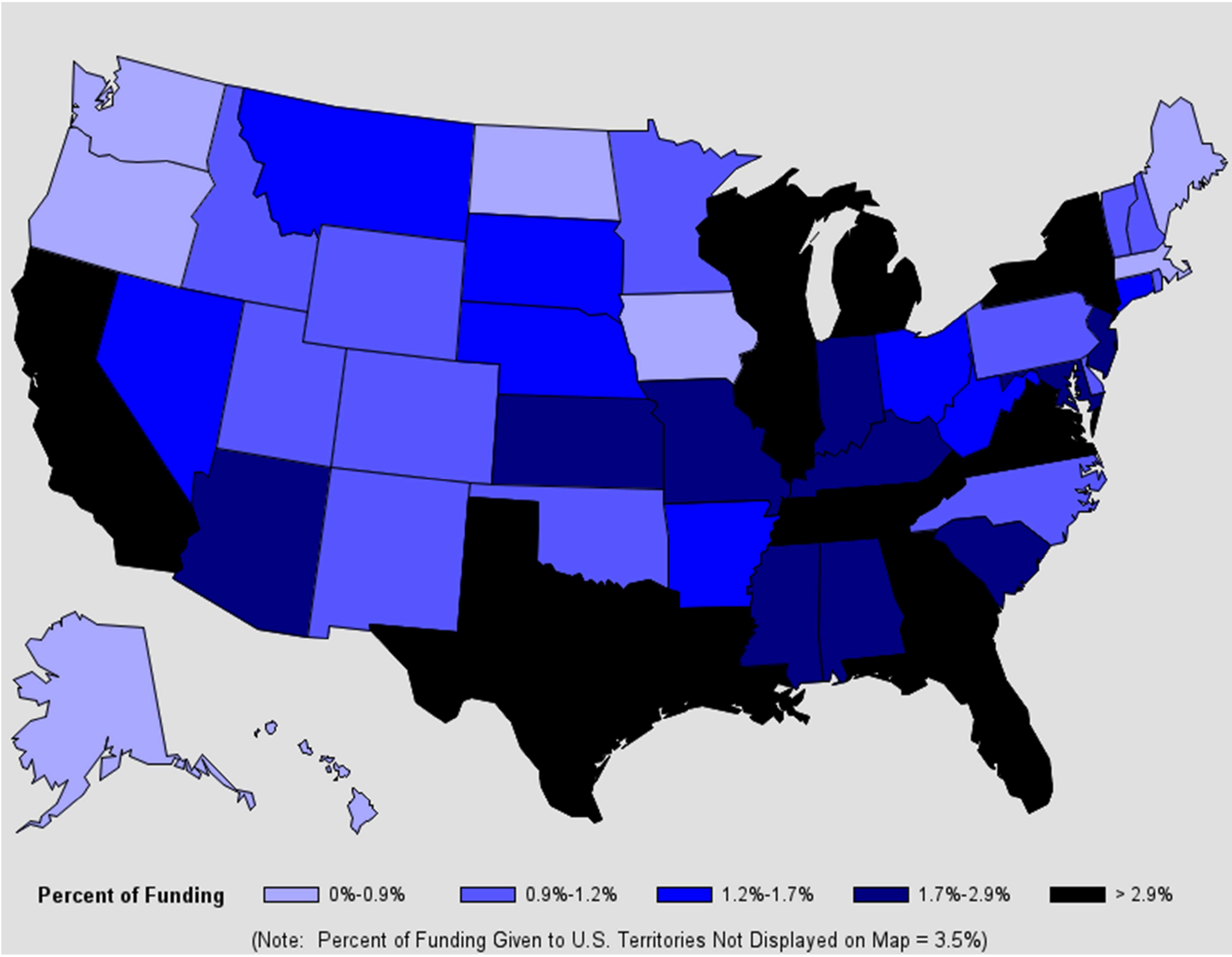

Figure 16: ARRA-period, BPAC=Total over all evaluated BPACs, Subcategory=Total, Percent of funding by state

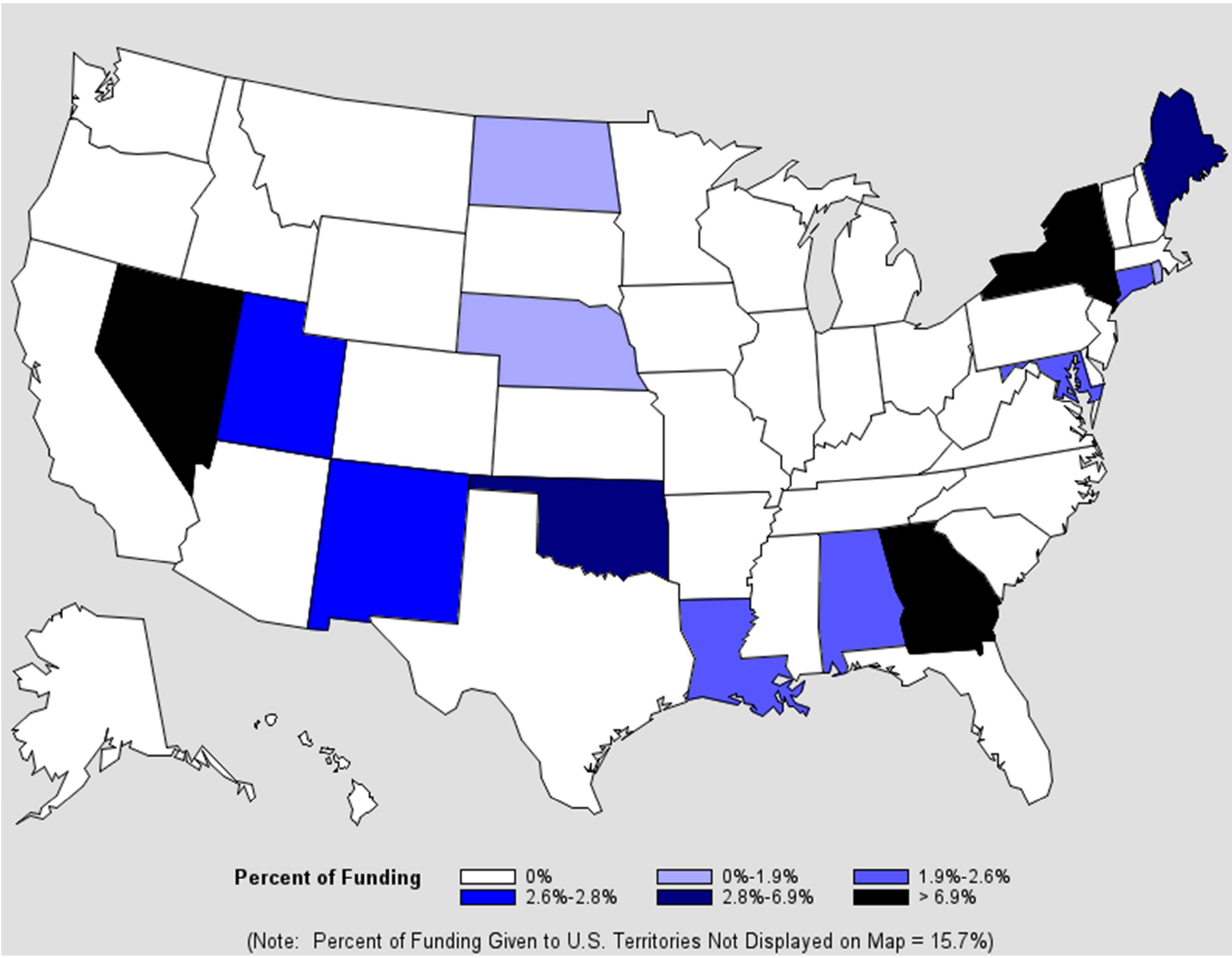

Figure 17: ARRA-period, BPAC=Building Codes and Standards, Subcategory=Total, Percent of funding by state

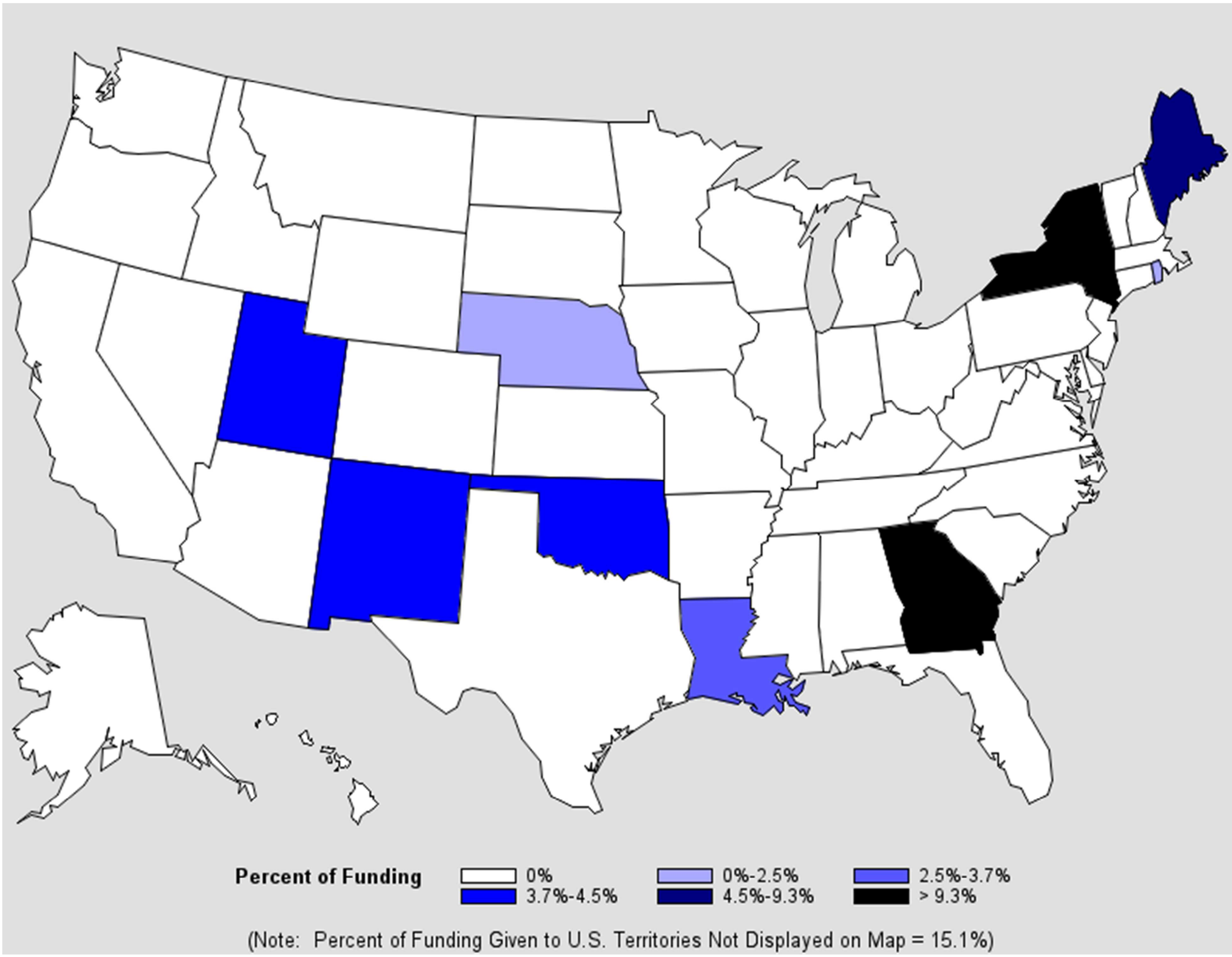

Figure 18: ARRA-period, BPAC=Building Codes and Standards, Subcategory=Building Code Development and Support, Percent of funding by state

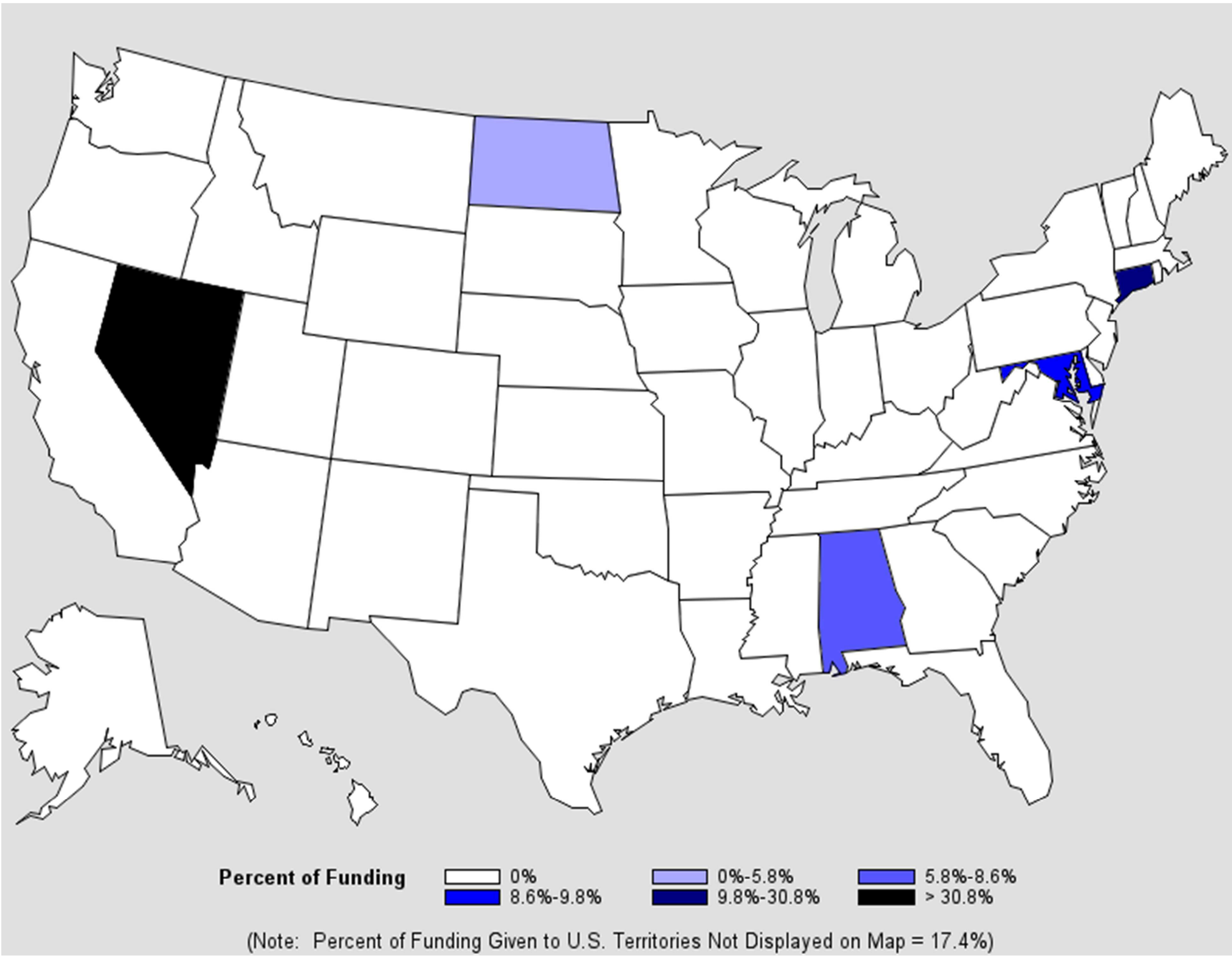

Figure 19: ARRA-period, BPAC=Building Codes and Standards, Subcategory=Workshops and Training: Targeted Training and/or Certification, Percent of funding by state

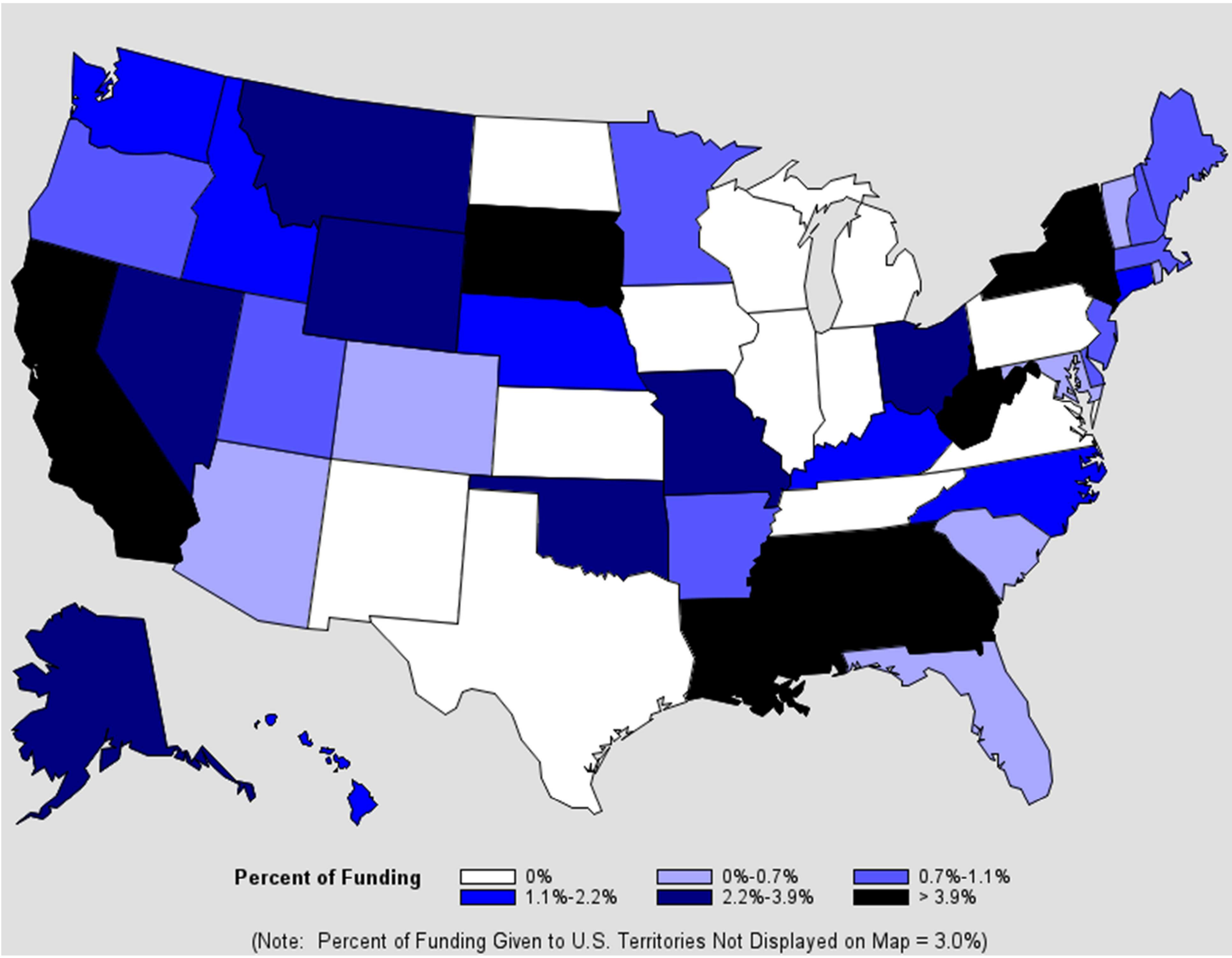

Figure 20: ARRA-period, BPAC=Building Retrofits, Subcategory=Total, Percent of funding by state

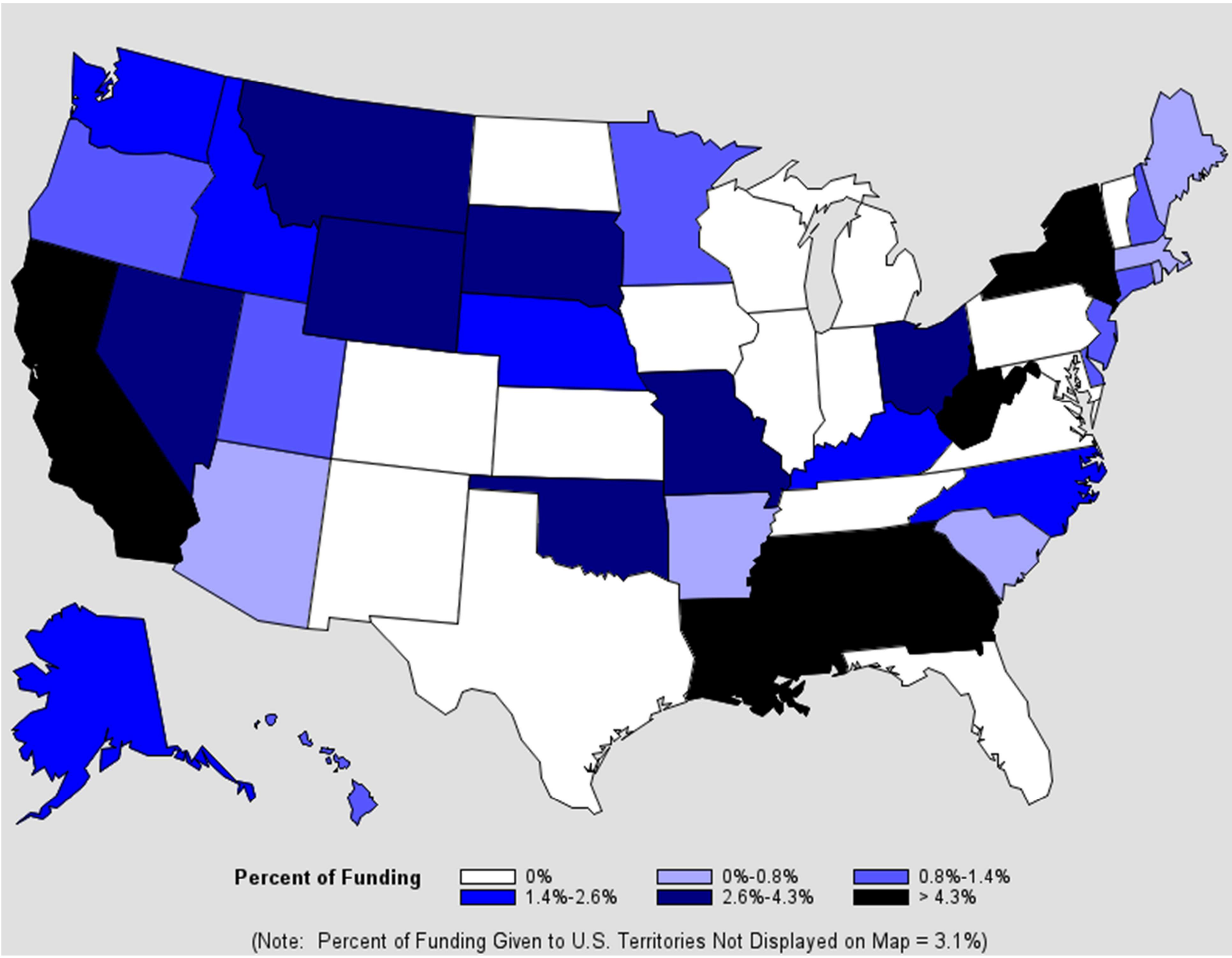

Figure 21: ARRA-period, BPAC=Building Retrofits, Subcategory=Building Retrofits: Nonresidential, Percent of funding by state

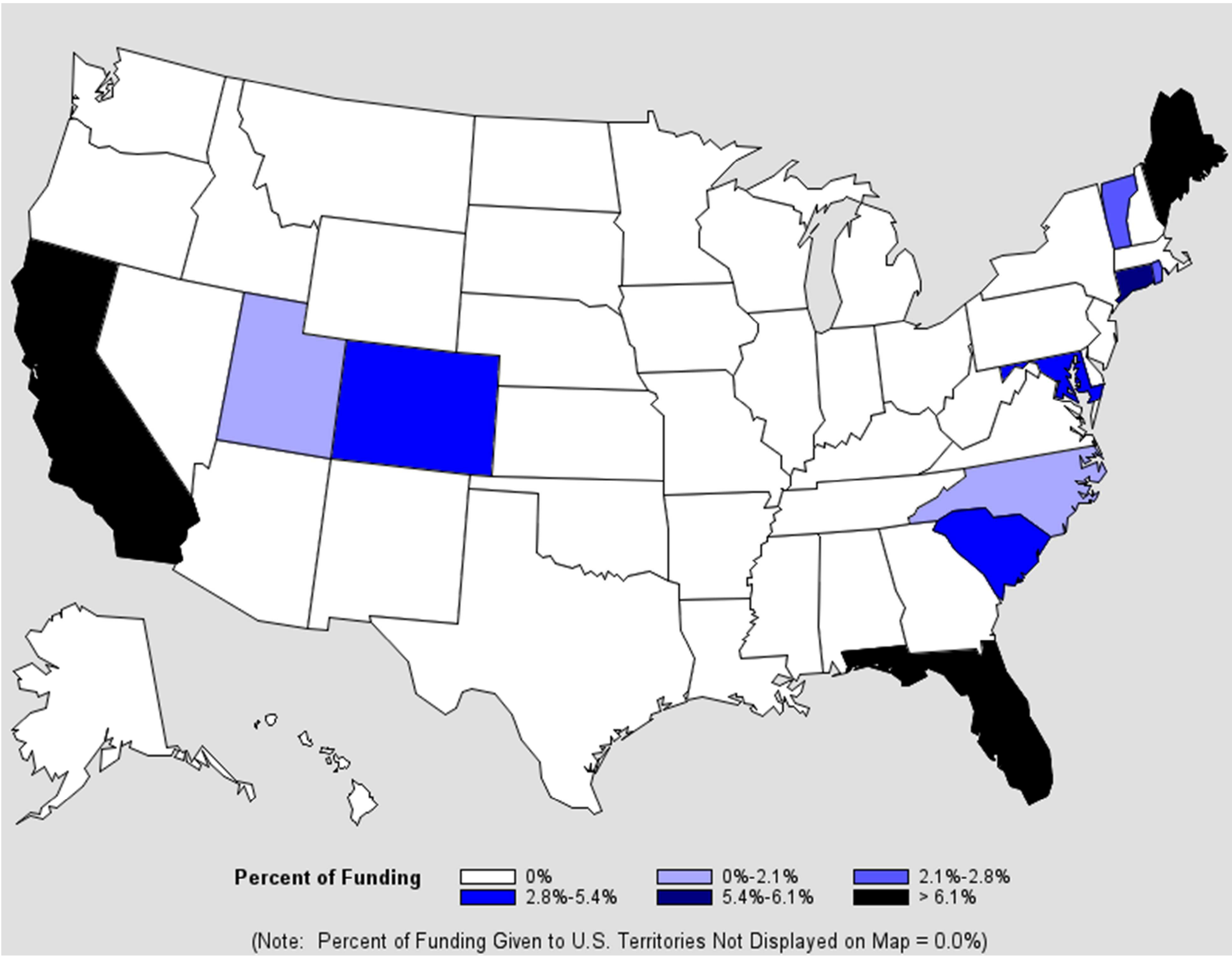

Figure 22: ARRA-period, BPAC=Building Retrofits, Subcategory=Building Retrofits: Residential, Percent of funding by state

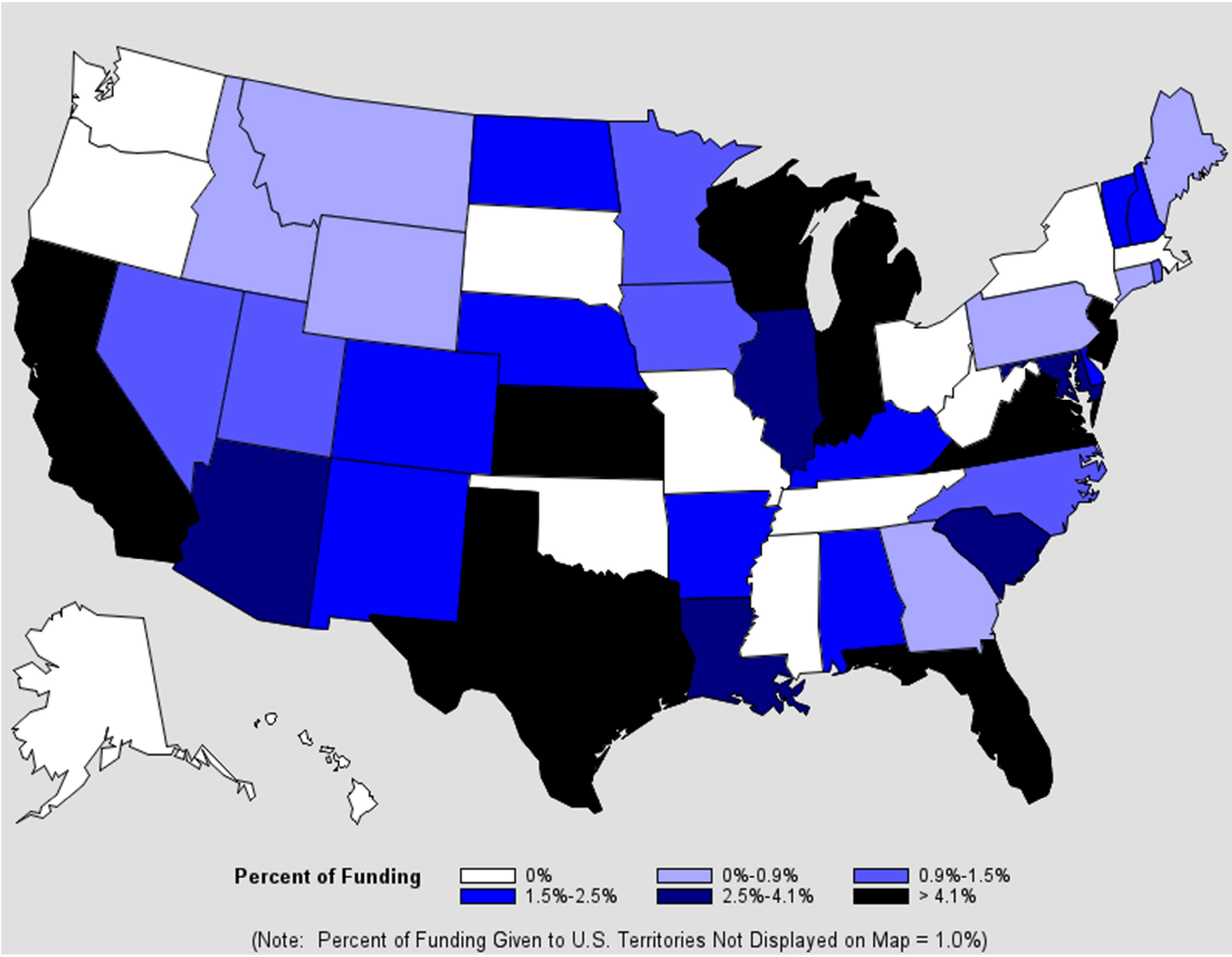

Figure 23: ARRA-period, BPAC=Loans, Grants, and Incentives, Subcategory=Total, Percent of funding by state

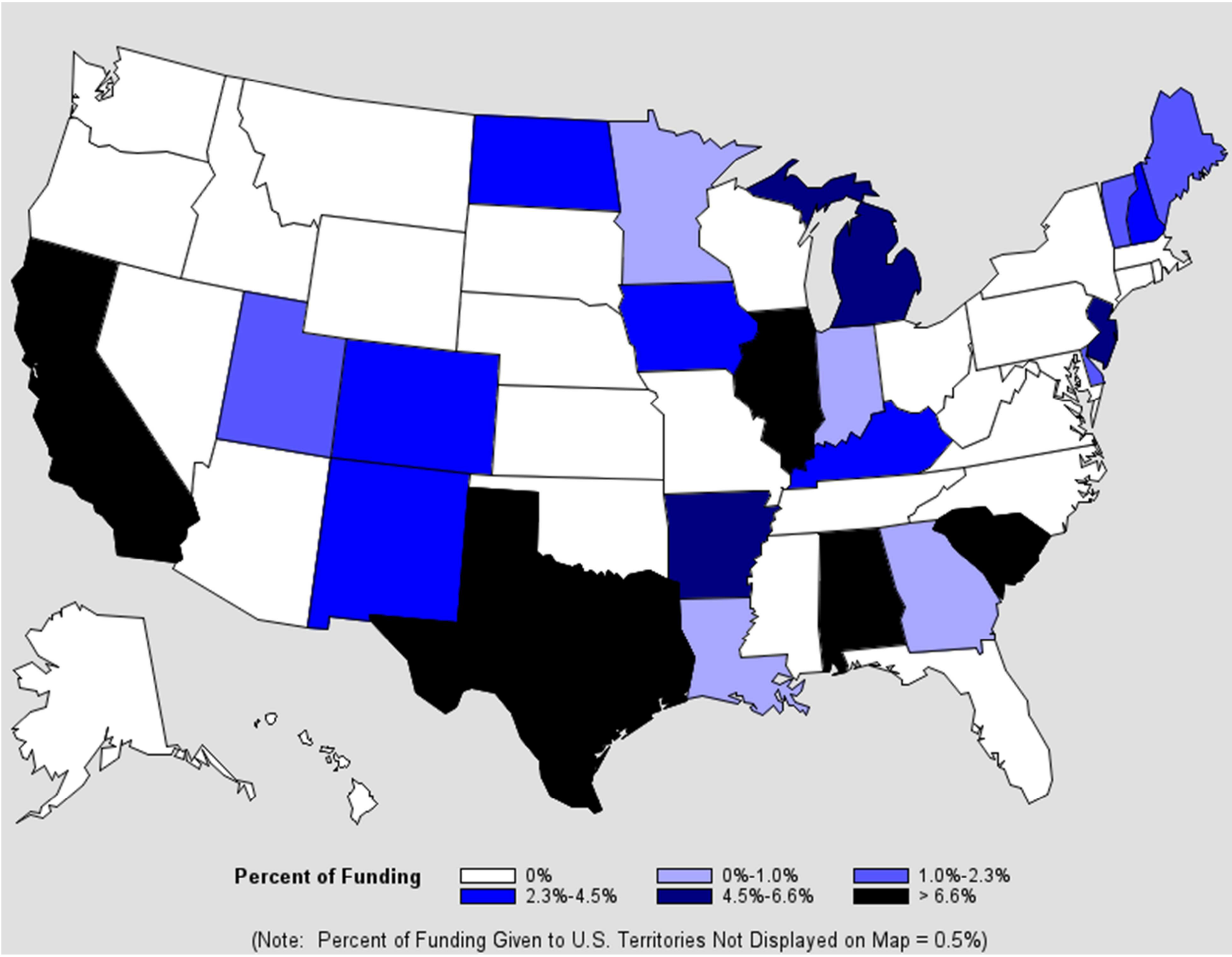

Figure 24: ARRA-period, BPAC=Loans, Grants, and Incentives, Subcategory=Building Retrofits: Nonresidential, Percent of funding by state

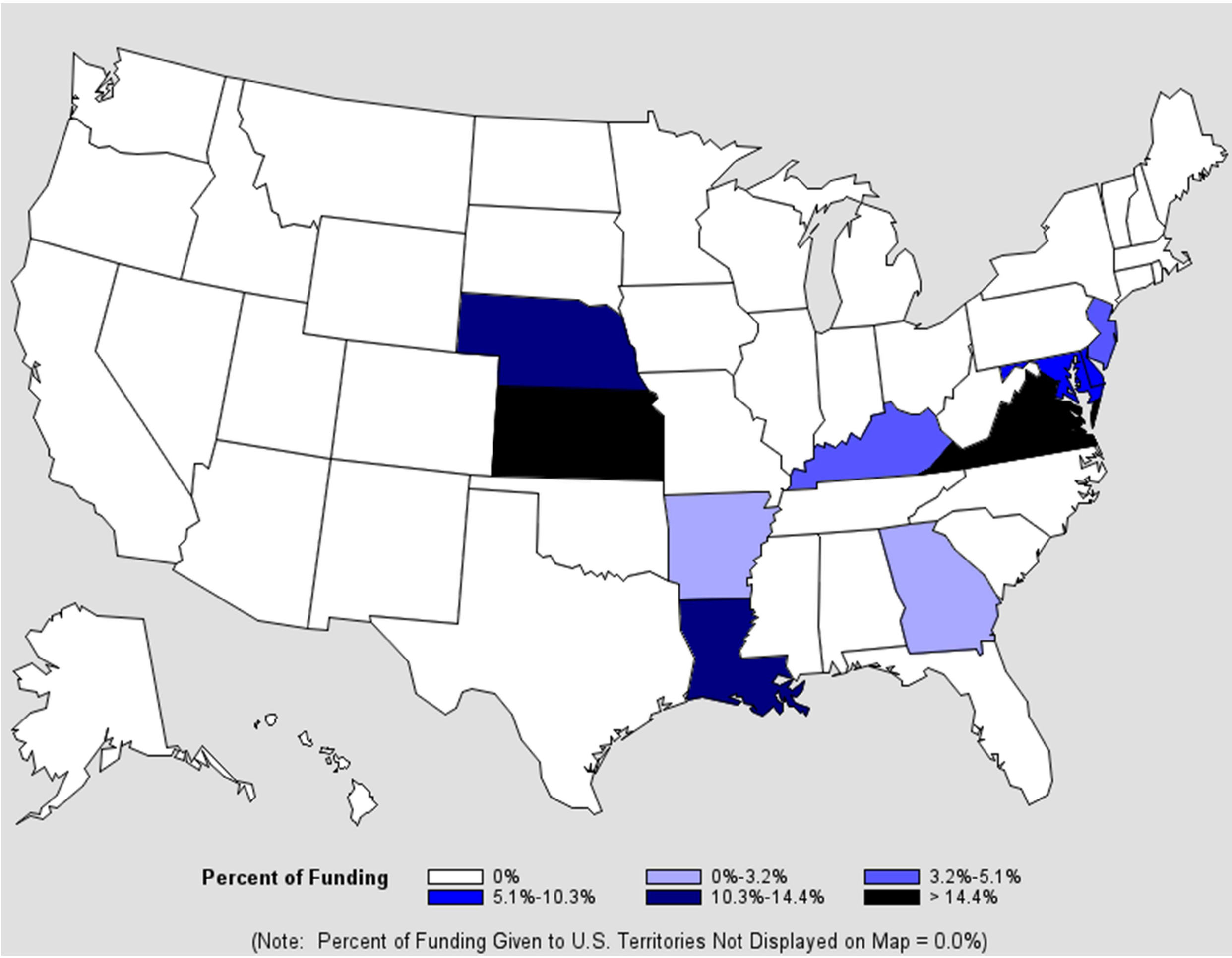

Figure 25: ARRA-period, BPAC=Loans, Grants, and Incentives, Subcategory=Building Retrofits: Residential, Percent of funding by state

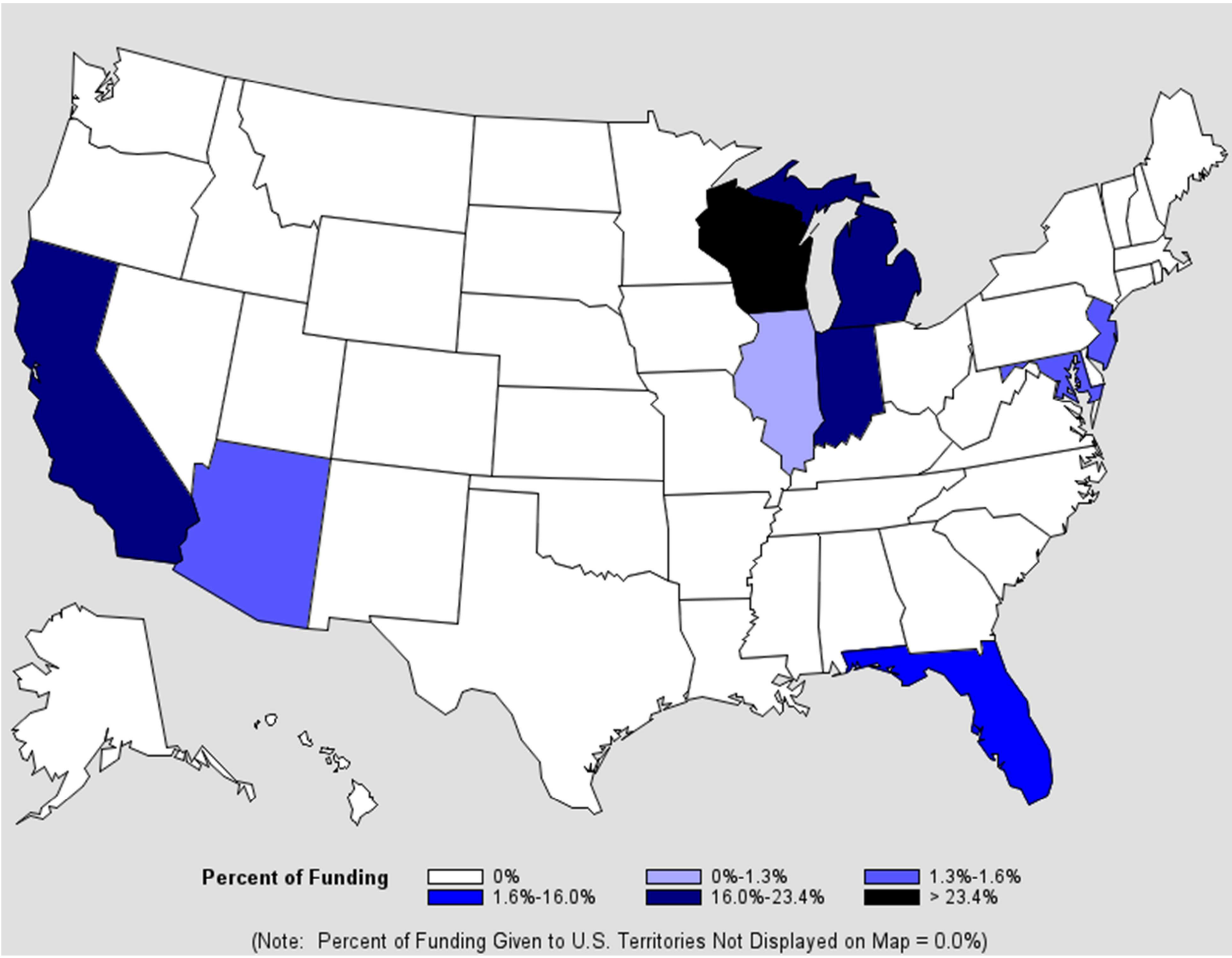

Figure 26: ARRA-period, BPAC=Loans, Grants, and Incentives, Subcategory=Renewable Energy Market Development: Manufacturing, Percent of funding by state

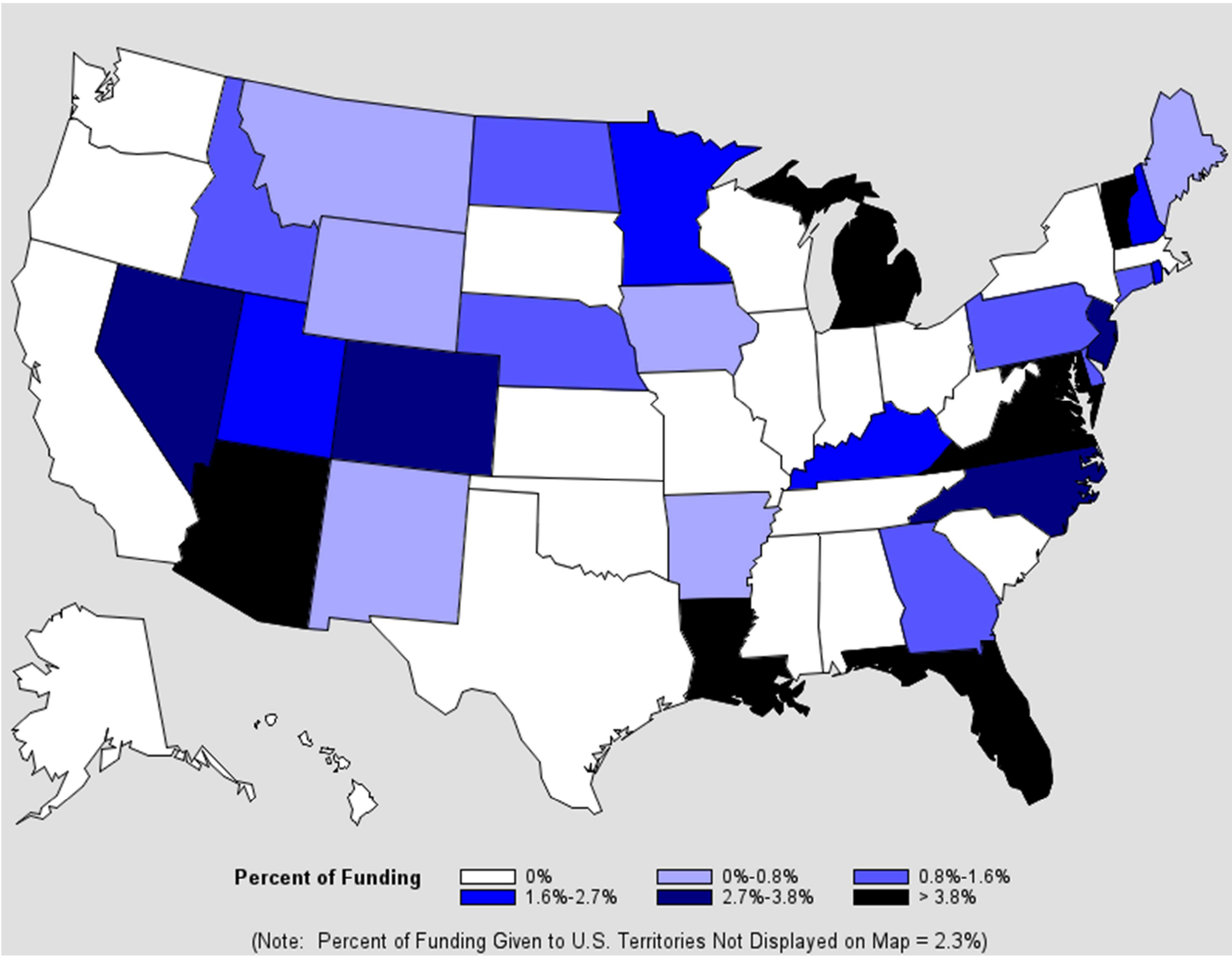

Figure 27: ARRA-period, BPAC=Loans, Grants, and Incentives, Subcategory=Renewable Energy Market Development: Projects, Percent of funding by state

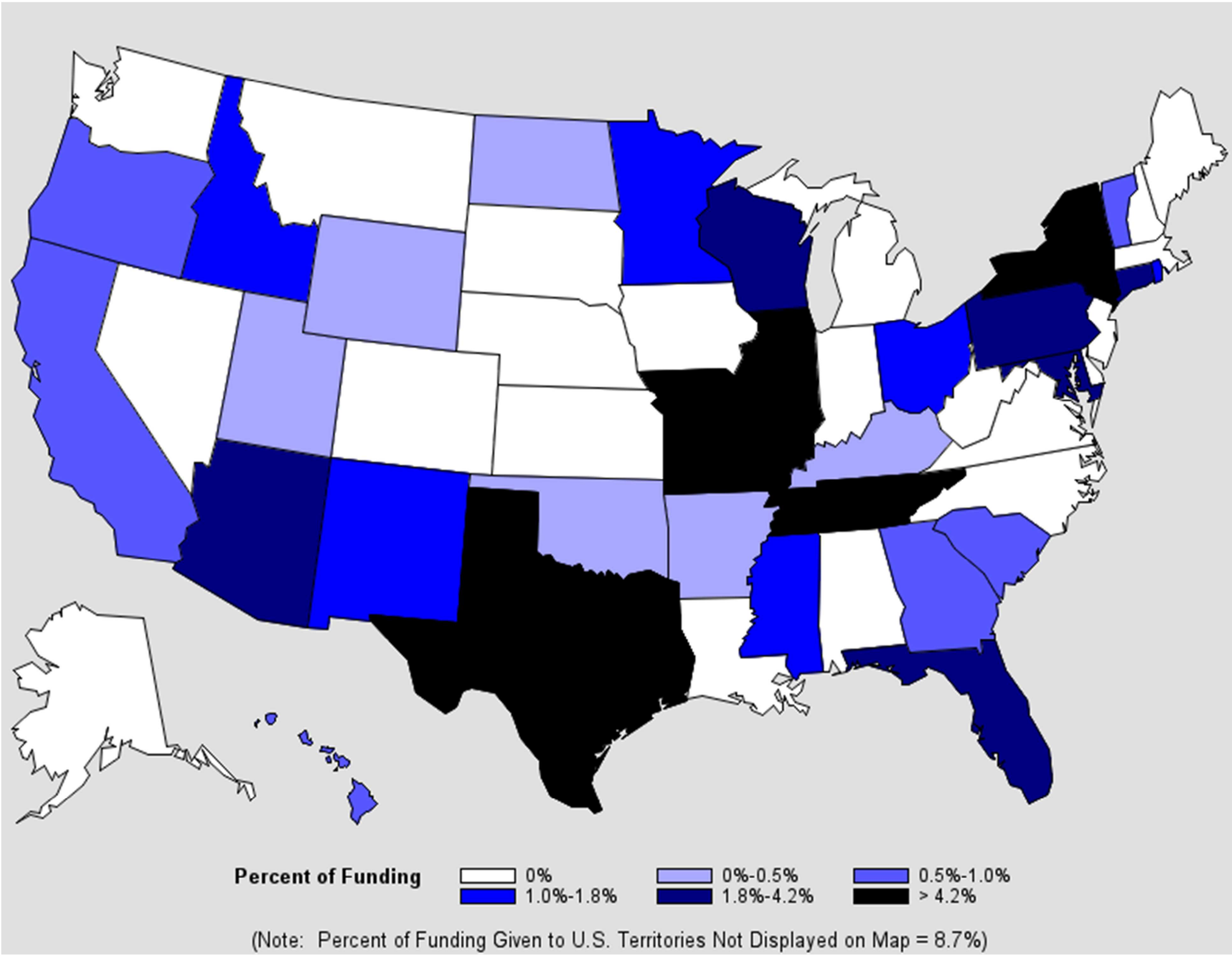

Figure 28: ARRA-period, BPAC=Renewable Energy Market Development, Subcategory=Total, Percent of funding by state

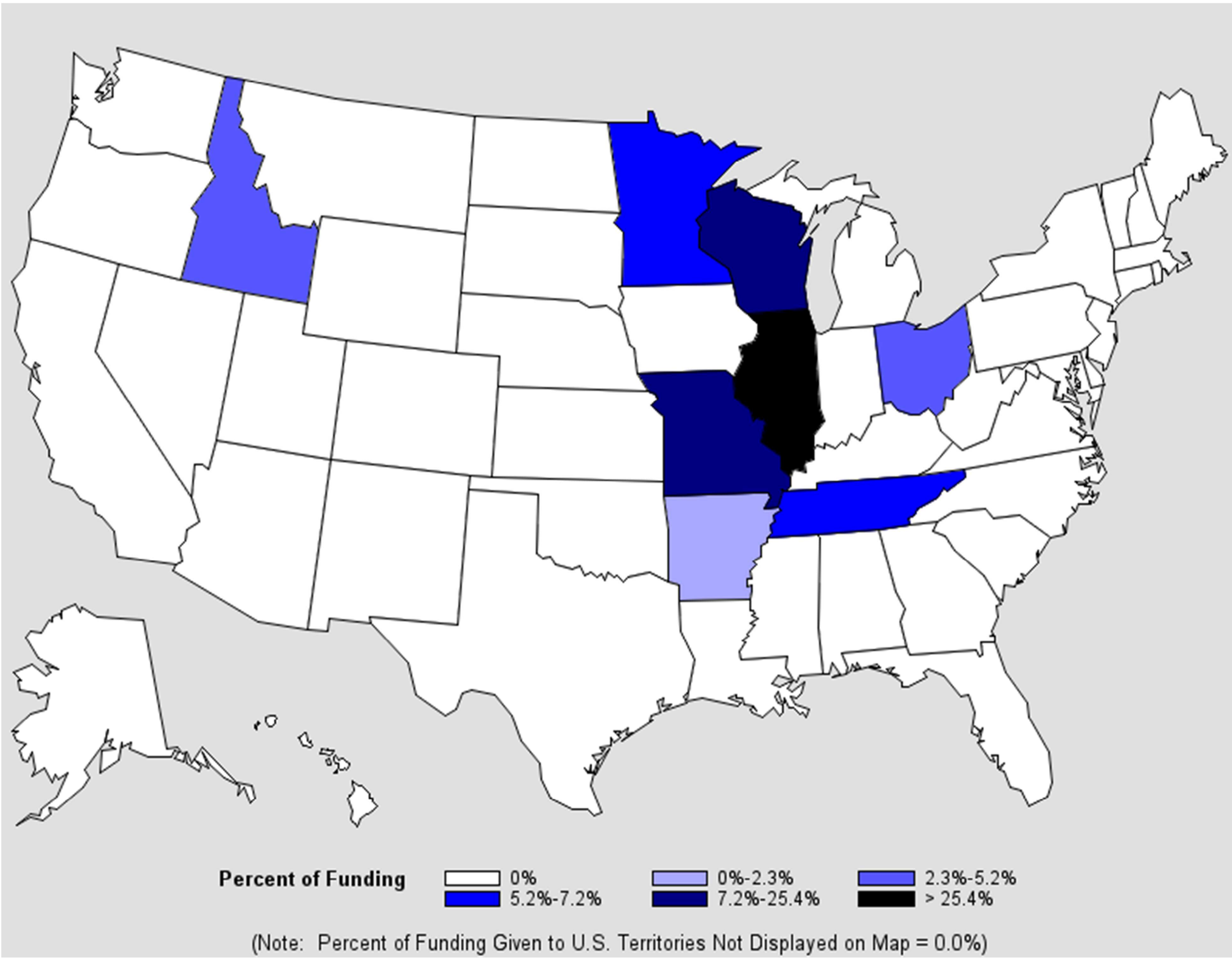

Figure 29: ARRA-period, BPAC=Renewable Energy Market Development, Subcategory=Renewable Energy Market Development: Manufacturing, Percent of funding by state

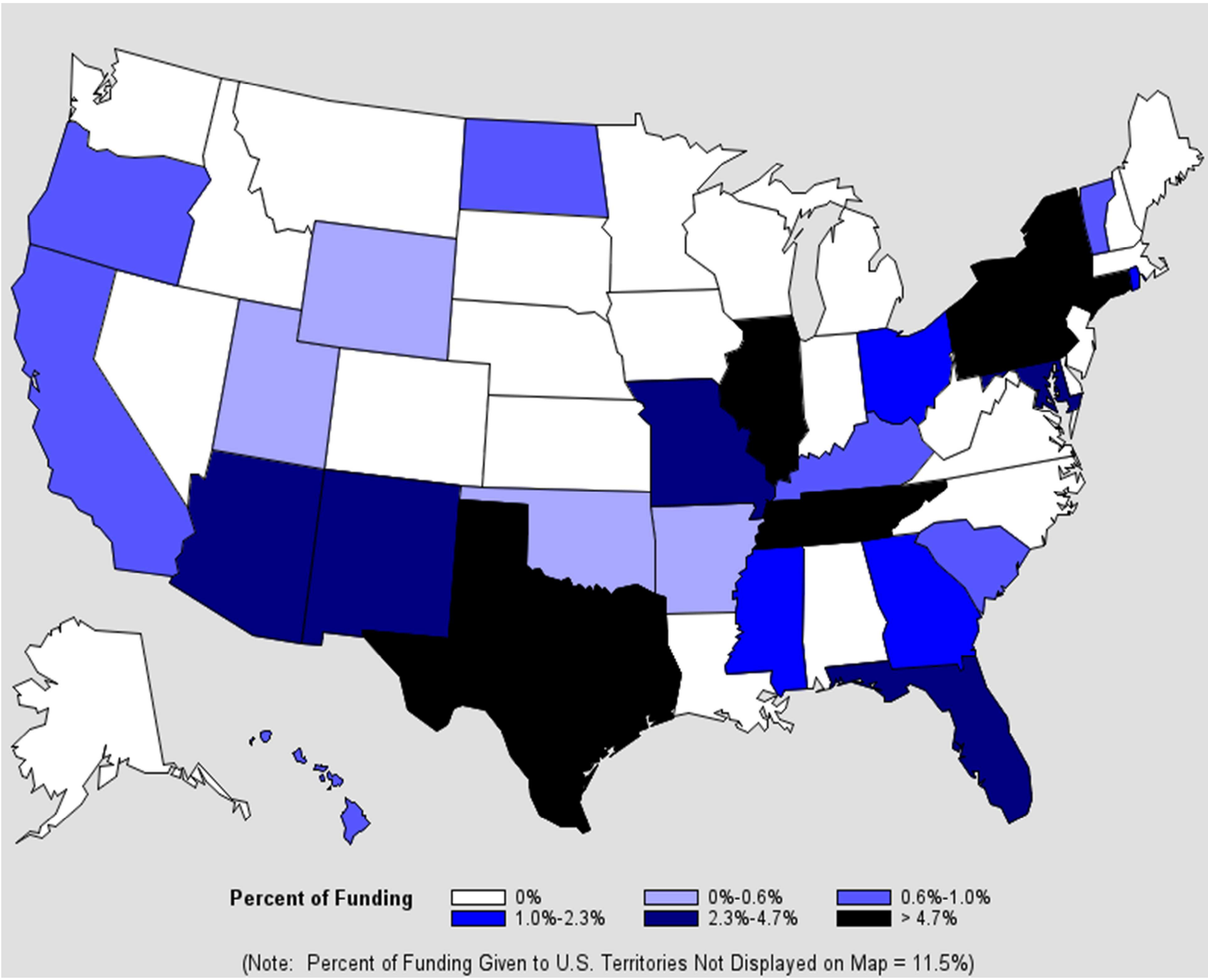

Figure 30: ARRA-period, BPAC=Renewable Energy Market Development, Subcategory=Renewable Energy Market Development: Projects, Percent of funding by state

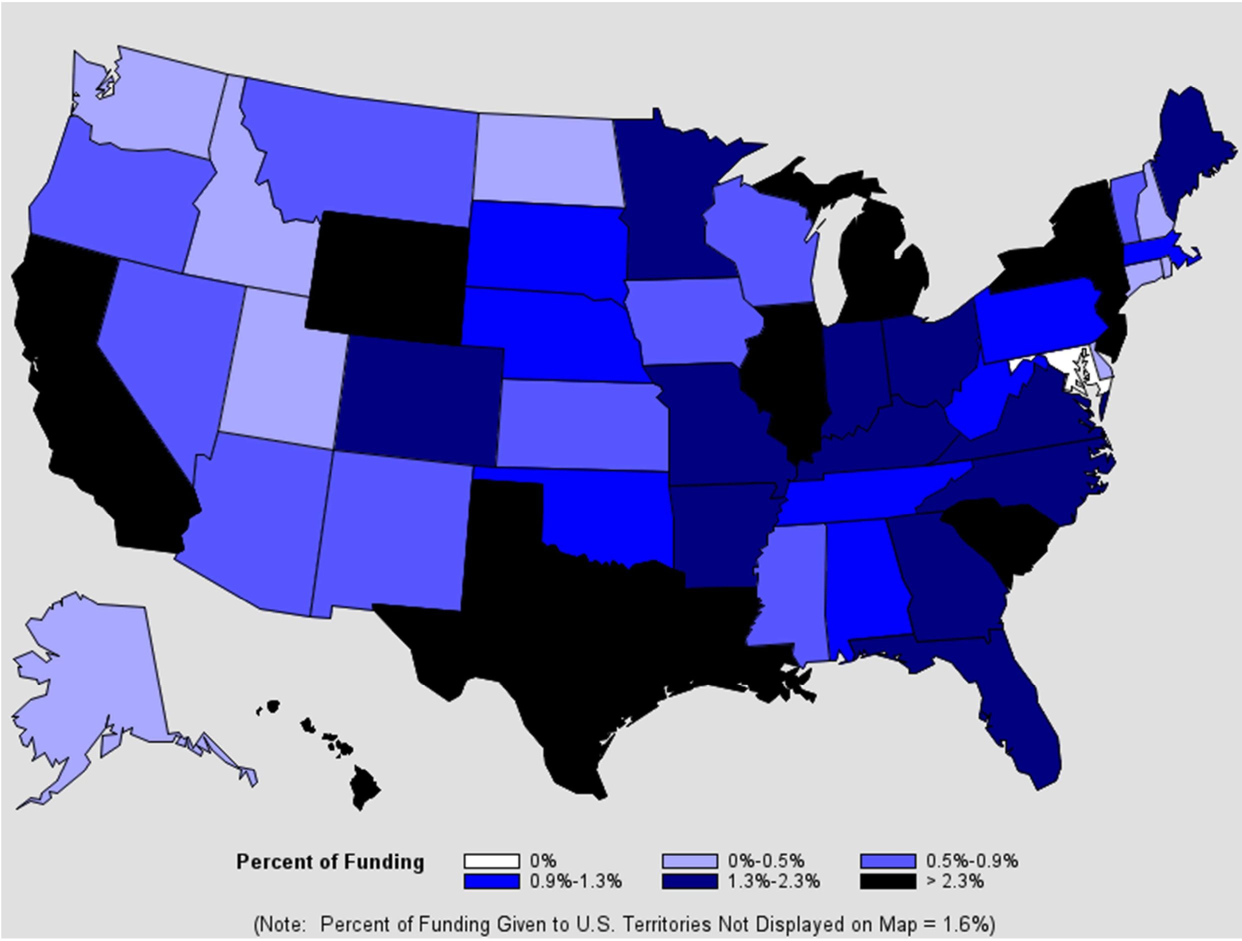

Figure 31: PY 2008 SEP, All BPACs and all Subcategories, Percent of funding by state from original universe file

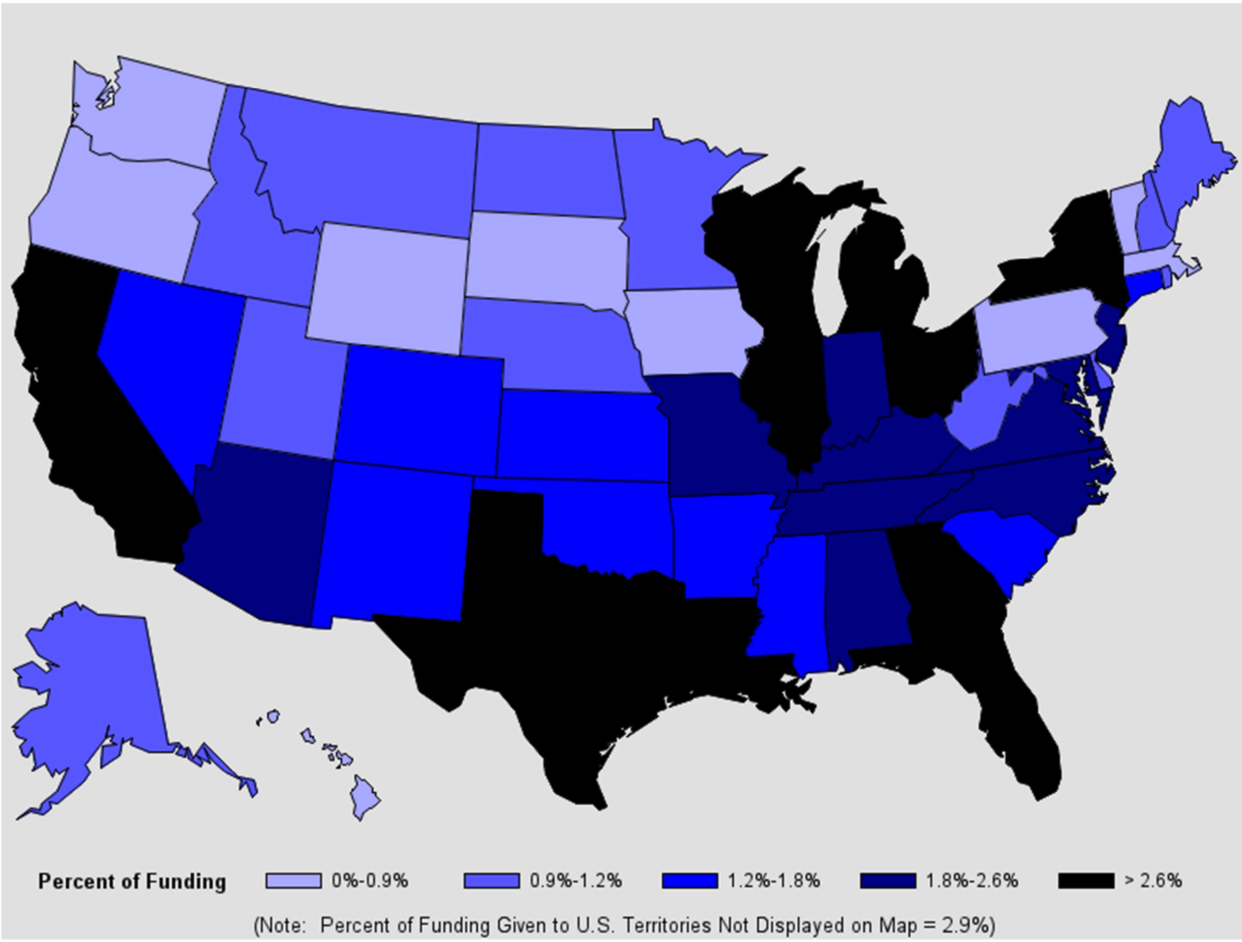

Figure 32: ARRA-period, All BPACs and all Subcategories, Percent of funding by state from original

F.5. REFERENCES

Binder, D.A. (1983). "On the variances of asymptotically normal estimators from complex surveys." International Statistical Review, 51, 279-292.

Tepping, B.J. (1968). "The estimation of variance in complex surveys." Proceedings of the Social Statistics Section of the American Statistical Society, pp 11-18.

Wolter, K.M. (1985). Introduction to Variance Estimation. New York: Springer-Verlag

APPENDIX G. DETAILED PA LEVEL ENERGY IMPACT ESTIMATION METHODOLOGY

G.1. OVERVIEW

This appendix details the methods used to estimate energy savings and renewable generation impacts for each of the PAs within the National SEP Evaluation. The energy impacts referred to in this section correspond with “gross savings,” as that term is commonly used in evaluation of rate payer-funded energy efficiency programs and refers to the overall savings achieved by programmatic activities and not just that portion attributable to SEP.

Section G.1 describes the general methods used for independent evaluation of PAs. Section G.3 then describes the standard attribution method used for determining the proportion of total PA impacts attributable to SEP funding. In this section, all discussion of impact calculations is for calculating the overall savings. The attribution factor is applied to overall savings to generate SEP-attributable savings.

The five Impact Method Groups shown in **Table 17** define standard data collection and impact estimation methods that apply to a particular group of PAs based on the Subcategory of the PA. The table also lists the rigor level designation applied to each Subcategory.[5]

Table 17: Impact method groups

Impact Method Group	Evaluation Rigor Level	Number of PAs in Group	Applicable Subcategory	Impact Calculation Method
Retrofits	High	23	Nonresidential Retrofits	Standard Calculation Tool (G.4)
	High	7	Residential Retrofits	
Renewables	Medium-High	14	Renewable Energy Projects	Standard Renewable Protocol (G.5)
	Medium-High	7	Renewable Energy Manufacturing	
Technical Assistance/ Training	Medium-High	4	Trainings and Workshops	Standard Calculation Tool (G.4) or Secondary Research
	Medium-High	7	Technical Assistance	
Codes and Standards	Medium-High	5	Building Code Development Support	Modified PNNL Tool (G.7)
Other	Medium-High	5	Alternative Fuels and Transportation	ANL GREET Model (0)
	Medium	9	Clean Energy Policy Support	Standard Calculation Tool (G.4), Standard Renewable Protocol (G.5), or Secondary Research
TOTAL		**81**		

5 As described in Section C.2, PAs were classified into a “High” rigor and “Medium-High” rigor level during the Stage 1 sample frame development process.

Each of the impact calculation methods shown in **Table 17** are outlined in Sections G.4 through G.8 of this Appendix. Section G.4 details the Standard Calculation Tool (SCT) used to calculate energy savings impacts from energy efficient equipment in Residential and Nonresidential Retrofits. Section G.5 outlines the renewable standard protocol used for calculating energy savings and generation from renewable energy technologies. Section G.6 describes the use of the Argonne National Laboratories GREET model for transportation impacts. Section G.7 describes the use of an adapted Pacific Northwest National Laboratory (PNNL) model for Codes and Standards Impacts. Section G.8 discusses the methods and assumptions made in estimating impacts from Clean Energy Policy Support PAs.

Finally, Section G.9 outlines the method used to calculate revolving loan impacts, which occurred for PAs across several of the impact method groups.

G.2. PRELIMINARY EVALUATION STEPS

Figure 33 outlines the PA level evaluation process flow for all of the savings method groups. The preliminary steps used in the evaluation of all program types are described in detail in Sections G.2.1 through G.2.3.

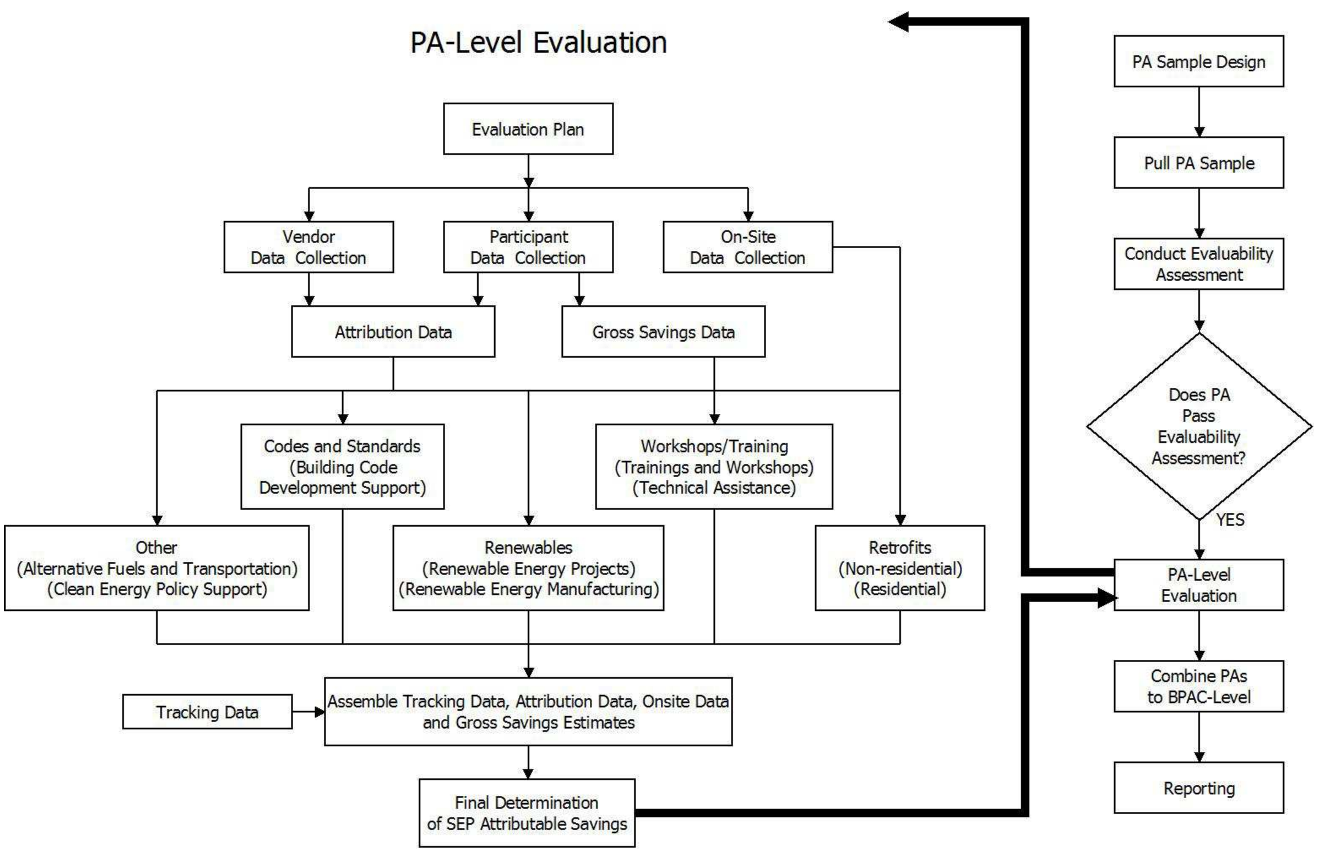

Figure 33: Process flow to estimate SEP-attributable savings

G.2.1. PA evaluability assessment

Following the Stage 1 PA sample selection procedure described in Section A.1, 143 sampled PAs were assessed for evaluability through interviews of program representatives at SEOs. As detailed in Appendix D, PA evaluability was judged based on funding thresholds for PY 2008 and ARRA-period programs, availability of tracking data for program activities, and availability of participant and other market actor contact information for further inquiry. Of the 143 PAs assessed for evaluability, 81 were confirmed as evaluable.

G.2.2. PA tracking data collection

Data collection for the 81 evaluable PAs began with obtaining and reviewing detailed program tracking data from the SEOs and DOE's PAGE information system. Where applicable, tracking data included definition of program activities, installed energy efficiency measures and/ or renewable equipment, funding information, participant contact information, vender information, energy savings or generation estimates, and other relevant data.

In many cases, PA evaluability assessment and PA tracking data collection occurred in tandem, in order to reduce the burden of effort on SEO representatives and to expeditiously review tracking data for assessment of evaluability.

G.2.3. Development of PA evaluation plans

The information gathered through SEO interviews and program tracking data was used to develop detailed PA evaluation plans. Evaluation plans take into account each sample PAs actual operations, scale, organization, roster of services provided, and level of documentation.

The evaluation plans for all PAs (both medium-high and high rigor) included the following elements:

- Verified funding amounts per BPAC and subactivity within the PA. Although PAs were classified into a single activity in one BPAC at the time the PA was sampled, the evaluation of the PA often revealed that the activities undertaken with the funding spanned several subactivities and several BPACs. One of the main purposes of the evaluation was to identify this distribution.
- Program logic models, wherein program inputs, activities, outputs, and outcomes were described to provide clarity on how a program functioned.
- Definition of available tracking data and intended use, as well as planned methods for resolving data gaps through data collection.
- Data collection plans based on impact method group and guidance from the SEP evaluation detailed study plan.
- Stage 2 sample design (described in Section C.4) for participant Computer Assisted Telephone Interviews (CATI) and/or In-Depth Interviews (IDIs).
- SEP attribution data collection plan, including Stage 2 sample design for vendor IDIs and interviews of other market actors, as necessary.
- Pre-evaluation review of other program influences.

In addition to the universal evaluation plan elements, high-rigor PAs also included plans for the collection of on-site verification data. Like both participant data-collection sample designs and vendor data-collection sample designs, on-site sample selection followed the standard Stage 2 survey sampling procedures described in Section C.4. However, OMB limits the number of on-site verification visits for the evaluation required that targeted buildings be strategically chosen for their ability to verify savings with the most impact per program. On-site visit counts were allocated across retrofit PAs based on funding size. Building selection for on-site visits within a PA was based on the tracking data quality, distribution of project funding sizes, distribution of ex ante energy savings across projects, and other determinants, in order to use on-site data quotas to improve the quality of verified savings estimates.

Attribution data were collected from participants and, where applicable, from equipment vendors, installers, and other market actors. Methods for collecting attribution data for groupings of similar program types are described in Section G.2.

Data collection procedures were based on the data requirements for calculation tools and methods used in each impact method group. These methods and tools are described in detail in sections G.4 through G.8.

G.3. STANDARD ATTRIBUTION METHODS

This section presents the standard SEP evaluation approach to assessing the extent to which sample PA estimated energy impacts can be attributed to the SEP.

The standard attribution methodology is based on addressing the following three fundamental research questions for each evaluated PA.

1. **Program effects on market actors.**

Question: What would the market actors targeted by the sample PA have done in regard to adopting the PA-supported technology or service in the absence of the program?

This question provides the framework for assessing the attribution of observed changes in key outcomes to the effects of the program. Market actors include energy users as well as firms and individuals in the supply chain for energy using equipment, renewable energy generating equipment, and design, installation, and maintenance services.

2. **Influence of SEP PAs on other program sponsors.**

In instances when two or more programs, including the SEP PA, target the same outcomes in the same domain,[6] to what extent are observed outcomes attributable to one program or another?

In many states, ratepayer funded programs with significantly greater resources targeted some of the same outcomes, particularly in PY 2008 but also in the ARRA-period. Additionally, to leverage its resources, SEP PAs often coordinate explicitly with programs offered by other sponsors that provide additional resources for efficiency and renewable measure adoption. This question takes into account the potential influence of

[6] By domain we mean the groups of market actors, regulators, government bodies and other institutions and their network of interactions in which the program operates and that it attempts to influence.

programs and policies other than the ones under evaluation on the outcomes of interest, such as the change in the pace of adoption of the targeted technology.

3. **Relative influence of other programs active in the sample PAs domain.**

To what extent have SEP PAs influenced the allocation and deployment of resources by other program sponsors in the relevant domains?

A number of studies of SEP activities,[7,8] have found that sponsors of ratepayer-funded programs collaborated closely with state energy offices to leverage their own resources, especially with the influx of ARRA funding. "In the absence of the program," means the array of resources available to market actors in the PA domain that would have been reduced not only by the absence of the SEP PA activities, but by a reduction in the level of resources available from other program sponsors. Thus, it was necessary to formulate and test hypotheses regarding the influence of SEP PA activities on the programming decisions of other sponsors in the domain.

In seeking to answer each of the fundamental attribution questions for each SEP PA, two SEP attribution method groups were shown to share similar methodological approaches and challenges. These are:

- **Group 1: Building Retrofit and Equipment Replacement, Renewable Energy Market Development — Projects, Information, and Training Programs.** Programs within this group focused on providing individual market actors with the information, tools, and incentives they may need to accelerate the adoption of targeted energy efficiency and renewable energy measures in specific projects. Assessment of attribution for these programs relied heavily on program participant direct reports, as these were the key decision makers. These data on participant perceptions of program influence were supplemented by information from vendors, program managers, and other market observers. Potential interviewees among other market actors were pre-screened to assure that they were aware of SEP-supported program activities (if not of the connection of those activities to SEP funding). Without such awareness, the market actors would be unlikely to be able to comment on the extent of the influence of SEP-supported activities.

  Market actors in Group 1 were asked a set of attribution questions directed at answering the question of how SEP influenced their behavior. The attribution battery sought to determine the answer to this question through three parameters: timing of participant behavior, quality of technology or service used by participant, and quantity of technology or service used by participant. These three factors, where appropriate, were the foundation for estimating a program's influence on a participant's or other market actor's behavior.

- **Group 2: Renewable Energy Market Development — Manufacturing, Clean Energy Policy Support, and Codes and Standards.** These programs do not address projects as individual transactions. Rather, they attempt to influence large classes of projects by establishing favorable

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7 TecMarket Works. The State Energy Program: Building Energy Efficiency and Renewable Energy Capacity in the States. Oak Ridge, TN: Oak Ridge National Laboratory. September 30, 2010.

8 Goldman, Charles A. et al. Interactions between Energy Efficiency Programs funded under the Recovery Act and Ratepayer-funded Energy Efficiency Programs (Draft). Berkeley CA: Lawrence Berkeley National Laboratory. January, 2011.

conditions for their implementation by improving the performance and cost-competitiveness of efficient technologies (manufacturing-oriented programs) or by removing barriers and creating incentives through regulatory and policy initiatives. Alternatively, they may oblige whole classes of customers to adopt efficient technologies through their incorporation into building codes and equipment standards.

For Group 2 PAs, the perceptions of individual facility owners provide little insight into attribution of observed savings. Rather, the attribution analyses for these programs relied on the collection, compilation, and interpretation of perceptions and opinions from knowledgeable supply side market participants and market observers, including regulators and code officials. Expert judgment information was often supplemented by research into secondary sources that trace the development of the relevant markets. These analyses structured case studies using logic models and other devices.

In summary, each Subcategory is listed in **Table 18** with the preferred (primary, secondary, and tertiary) attribution assessment method.

Table 18: Applications of attribution assessment methods to evaluation of PAs by BPAC Subcategories

Research Question/BPAC Subcategory	Participant Self-reports	Structured Expert Judging	Case Studies
Market Actor Response			
Building Retrofit (Residential and Nonresidential)	●		○
Renewable Energy Market Development – Projects	●		●
Renewable Energy Market Development – Manufacturing	●	●	●
Clean Energy Policy Support	●		●
Technical Assistance and Training (2 subcategories)	●		●
Codes & Standards		●	●
Influence of Other Programs			
Building Retrofit (Residential and Nonresidential)	●		○
Renewable Energy Market Development – Projects	●		●
Renewable Energy Market Development – Manufacturing	○	●	●
Clean Energy Policy Support		○	●
Technical Assistance and Training (2 subcategories)	●		●
Codes & Standards		●	●
SEP Influence on Other Programs			
All BPAC Subcategories	○		●

● = Primary Attribution Analysis Approach

○ = Secondary Attribution Analysis Approach

G.4. THE STANDARD CALCULATION TOOL'S ENERGY SAVINGS IMPACT METHODS

The Standard Calculation Tool (SCT) was developed to support the National SEP and Energy Efficiency Community Block Grant (EECBG) evaluations for ORNL. The SCT was used to calculate savings for several Subcategories including Building Retrofits: Residential; Building Retrofits: Nonresidential; Technical Assistance; and Workshops, Education, and Training. A few PAs in the Clean Energy Policy Support

Subcategory also used the SCT. All PAs in other Subcategories went through alternate savings impact methods discussed in Sections G.5 through G.8. Section G.4.1 describes the general functionality of the SCT. Section G.4.2 describes the selection of calculation algorithms from publicly available sources. Section G.4.3 presents the methodology for defining the appropriate baseline for each technology. Finally, Section G.4.4 describes the effect of State and National Codes and associated general assumptions made in development of the tool.

G.4.1. Description of the SCT

The SCT was developed to ensure consistency of calculation methods across multiple evaluations through transparent procedures, replicable results, and an auditable trail for quality control. The tool is a collection of engineering-based methods that allows the user to estimate energy savings for 19 residential and 11 nonresidential energy efficient measures.

DNV GL assembled the measures into a software application that prompts the user for the inputs necessary to complete calculations. The user can then estimate energy savings for measures located anywhere in the country and based on input data that can vary greatly in terms of content and quality. For example, in the absence of detailed equipment quantity, sizing, or efficiency information, the tool can estimate savings for many measures based only on the square footage of the space affected. The SCT makes the best use of available local data while making the most reasonable use of assumptions given the nature of the local program, measures, and operating environment.

Each of the 30 measures included in the SCT had individual specifications developed for them; however, they all follow consistent general principles, which include:

- Algorithms and assumptions based on industry standards. Existing technical resource manuals (TRMs) served as the source of the calculation algorithms and some default assumptions for the SCT.
- Life-cycle savings estimate. DNV GL calculated life-cycle energy savings or the energy savings over the life of the installed measure.
- Dual baseline. A dual baseline allowed the team to estimate savings for accelerated measures, or measure that were installed earlier than they would have been without the program. A dual baseline calculation uses the efficiency of the existing (replaced) equipment as the baseline during the acceleration period and standard efficiency as the baseline during the remainder of the installed equipment life.
- Retrofit and new construction measures. The developed algorithms are capable of addressing both retrofit and new construction measures.
- Local and regional characteristics. Where practical, the effects of local and regional differences were included in the calculation. The major differences included:
    - Weather. Population-weighted, normalized weather data allowed production of state-level estimates for heating degree days, cooling degree days, and average outdoor temperature.
    - Energy Intensity. The SCT uses energy intensity information to estimate energy savings if the equipment capacity was missing. This information was determined for each census

region using the U.S. Energy Information Administration (EIA) Commercial Building Energy Consumption Survey (CBEC) data.

- Model energy codes. State energy code served as the baseline in some situations, adjusted to consider noncompliance and, for accelerated and add-on measures, equipment degradation. The actual values will come from the model energy code on which the state code is based.

Table 19 shows the measures programmed in the SCT by sector. **Table 20** shows the prescriptive non-SCT measures, which are measures that have predetermined calculation methods and assumptions, but were not programmed into the SCT tool. Most of the measures reference a standard, one-for-one equipment replacement. The SCT is not equipped to handle most fuel switching calculations.

When energy efficiency measures installed through the SEP could not be calculated with one of the SCT or prescriptive non-SCT calculation modules, custom calculation methods were developed and independently documented. Custom calculation documentation included the input values, algorithms, assumptions, and clear justification for the recommended approach.

Table 19: Measures programmed in the SCT

Residential		Nonresidential	
Boiler	Furnace	Boiler	Lighting
Windows	Insulation	Chillers	Heat Pumps
Lighting	Refrigerators	Windows	Insulation
Dishwashers	Clothes Washers		
Freezers			

Table 20: Prescriptive non-SCT measures

Residential		Nonresidential	
Doors	Central AC	Doors	Furnace
Heat Pumps	Programmable Thermostat	Programmable Thermostat	Packaged and Split AC
Water Heater	Room/Window AC	Package Terminal Air Conditioner (PTAC) and Package Terminal Heat Pump (PTHP)	
Low-Flow Showerhead	Low Flow Aerator		
Turn-Down Water Heater Temperature	Pipe Insulation		

G.4.2. Calculation algorithm selection

We reviewed 22 national, regional, and state-level TRMs to identify the best sources as judged on transparency and national applicability of source information, nationally relevant or modifiable algorithms, and range of measures per sector. Based on these selection criteria, nine TRMs were designated as preferred sources, including: ENERGY STAR, Regional Technical Forum (RTF) in the Pacific Northwest, Mid-Atlantic, Pennsylvania, Ohio, Wisconsin (nonresidential), New York, TVA, and Texas (residential).

One nonresidential and eight residential calculations were built using nationally applicable ENERGY STAR calculators. The New York TRM contributed to four measures, Pennsylvania to three measures, Wisconsin to three measures, Ohio to three measures, Mid-Atlantic to two measures, and TVA to one measure. We did not rely on RTF or Texas for any measure calculations.

In addition to the preferred TRMs, the SCT also uses the Indiana TRM for two measures, Arkansas for one measure, and Vermont for most space heating and cooling measures. Alternative TRMs were used when the preferred TRMs did not contain a calculation for the measures addressed, such as low-flow showerheads or faucet aerators. Vermont was used as an alternative calculation for building load (using square footage) when the equipment capacity was not available. Finally, DNV GL used an original calculation to estimate savings for window replacements, as none of the reviewed TRMs had a standard calculation for this measure.

G.4.3. Determining the appropriate baseline

The baselines used in the SCT correspond to the baselines referenced in the survey instrument in order to produce appropriate impact results. The baselines depend on measure category and timing effect.

The measure categories are:

- Add-on measures: These are equipment or practices that can be combined with existing equipment or structures. Examples include variable speed drives (VSDs) and controls. These measures do not have a range of efficiency levels, but represent efficiency improvements by themselves. The savings from add-on measures are the difference in usage for the site with versus without the measure in place. If the add-on measure is added without changing other equipment, the baseline condition is the prior equipment without the add-on measure. If the add-on measure is added in conjunction with replacement equipment, the baseline condition for the add-on measure is the new equipment without the add-on measure.
- Incremental efficiency measures: These are higher-efficiency versions of equipment that could be installed at a lower efficiency level. The savings from incremental efficiency measures are the difference in usage for the site with the (high-efficiency) equipment installed under the program compared with the lower efficiency equipment that would otherwise be in place.

The timing effects are:

- Early replacement: This references replacement of existing equipment with new, higher efficiency equipment, much sooner than the equipment replacement would have occurred absent the program. For retrofit conditions, the savings are the difference in consumption between the site with the old equipment in place versus with the new equipment in place. The baseline is the usage with the old equipment in place.
- Natural replacement: This references replacement of equipment at the same time as it would have been replaced absent the program. For natural replacement, the baseline is the usage with standard efficiency new equipment in place.
- Accelerated replacement: This references replacement of existing equipment with new equipment, sooner than the equipment replacement would have occurred absent the program. For accelerated

replacement, the baseline condition is the old equipment for the acceleration period, and standard efficiency new equipment from the end of the acceleration period to the end of the measure life[9]. If the old equipment would have stayed in place indefinitely, the acceleration period is the full measure life, and the baseline is the old equipment for the full measure life.

- New construction: This references the installation of new equipment or structure for a new premise or a portion of a premise. The baseline condition is the facility with standard equipment or construction.

Table 21 shows the baseline definitions by measure category and timing effect.

Table 21: Baseline definitions by measure category and timing effect

Timing Effect		Incremental Efficiency Measures*	Add-on Measures*
Natural Replacement		Federal standards Standard alternative	Federal standards, D% Standard alternative State energy code, DR%, D%
New Construction		State energy code, DR%	State energy code, DR%
Accelerated Replacement	Acceleration Period	Federal standards, D% Standard alternative State energy code, DR%, D%	Federal standards, D% Standard alternative State energy code, DR%, D%
	Remainder of effective useful lifetime (EUL)	Federal standards Standard alternative	Federal standards, D% Standard alternative State energy code, DR%, D%

*D% refers to degradation adjustment; DR% refers to adjustment factor related to compliance

To apply the above definitions, we needed a basis for specifying standard and existing equipment. In most cases we did not have an opportunity to observe actual equipment prior to measure installation, and we did not have local information on standard practice for new equipment. We used the following to specify standard and prior equipment baselines.

The timing effect was based on responses to the surveys. The participant questionnaires asked if the measure would have been installed earlier, later, or at the same time absent the program, and if later how much later. We used the following classification based on the timing response:

- Would otherwise have been installed at the same time or earlier: Natural replacement.
- Would otherwise have been installed four or more years later: Early replacement.
- Would otherwise have been installed x months later, up to 47 months: Accelerated replacement with x/12 years of acceleration.

[9] The effective useful life (EUL) and measure life are considered equivalent metrics for this study. EUL is defined as the number of years over which the new (efficient) equipment is expected to be maintained at the efficient condition for which it was intended. Energy savings from efficient equipment is zero after the end of the EUL.

- Don’t know: Early replacement.

Section G.4.4 discusses federal standards and state energy codes, including the degradation adjustment and adjustment factor related to compliance.

“Standard alternative” refers to standard baseline assumptions used by energy efficiency professionals for measures that do not have an efficiency standard or may not have been covered by the state energy code. Examples include most lighting and water reduction measures. These assumptions represent the typical non-energy efficient equipment replaced by the qualifying equipment, or the typical non-energy-efficient equipment improved by the add-on measure. Examples include 400 W metal-halide bulbs as the baseline for 6-lamp T8 high-bay fixtures or incandescent bulbs as the baseline for residential CFLs. We used common industry practice and guidance from the source TRMs to determine the standard practice.

G.4.4. SCT application of standards and codes

“State energy code” refers to the primary energy code in effect at the time and in the state in which a particular building was built. State energy codes have currently been adopted in all states and territories but 10. “Federal standards” refers to equipment efficiency standards mandated by the federal government. Such standards have been created for many types of equipment, including furnaces, air conditioners, household appliances, and electronics, and can change over time. Standards are created through legislation or DOE rulemakings, and require all affected appliances manufactured after a certain date to conform to the standard.

Federal standards and model energy codes were served as the input for baseline information in the following ways. In all cases, we felt that these definitions of standard efficiency would correspond to what our survey respondents were likely to have in mind when they answered attribution sequences.

- **Standard efficiency for current new construction measures.** For new construction measures, the baseline efficiency was equal to the energy code requirement in the state in which the building was built. An adjustment factor was applied to help address noncompliance based on publically available studies and professional judgment. We feel that this definition of standard efficiency corresponded to what our survey respondents were likely to have in mind when they answered attribution sequences.
- **Standard efficiency for natural and accelerated replacement.** For natural and accelerated (remainder of EUL) replacement measures, the baseline efficiency was equal to the federal standard for the minimum required equipment efficiency the year before the project was installed. More discussion on the lag year is found in the following paragraphs.
- **Federal standards: Actual/prior efficiency for accelerated replacement and add-on measures.** For accelerated replacement (acceleration period) and add-on measures where federal standards were applicable, the baseline efficiency was equal to the minimum required equipment

efficiency the year before the actual/prior piece of equipment was purchased.[10] More discussion on the lag year is found in the following paragraphs. An adjustment factor of 10% over the life of the equipment was applied to HVAC equipment to account for efficiency degradation, based on professional judgment. If the respondent could not provide an accurate estimate of the actual/prior equipment age, we assumed the maximum EUL for that piece of equipment.

- **Energy code: Actual/prior efficiency for accelerated replacement and add-on measures.** For accelerated replacement and add-on measures where federal standards were not applicable, the baseline efficiency was equal to the energy code requirement in effect in the state at the time the retrofit building was built, adjusted to consider noncompliance and efficiency degradation based on age. If the actual age of the building was not known, we assumed the maximum EUL for that piece of equipment and used the code value in effect at that time with the adjustment and degradation assumption.

The federal standard was applied one year after it was adopted. This simplification allowed us to address two issues across all measures:

- **Effective standard date.** Federal standards do not always begin on January 1 of the year in which they go into effect. We assigned a single federal standard to the entire year based on the standard that was in effect for the majority of that year. We did not use standard-specific change dates.
- **Adoption lag from storage.** Federal standards address the efficiency of the equipment manufactured, not the equipment sold. There is a lag in actual market adoption of the new equipment standard as the stored, less efficient equipment is sold in the market. The actual lag time likely differs by region and type of equipment, but there was no systematic way to determine what it should have been for each technology. To account for the storage lag, we applied a one-year lag period, based on professional judgment, before applying the change in standard.

For state energy codes, the contractor team used the values from the model energy code on which the state code was based. We made the following assumptions for simplification purposes:

- The appropriate model energy code was applied at the state level, using information from the DOE Building Energy Codes Program. State-level assignments were important because the energy programs were designed to provide incremental efficiency above state codes, not a national average.
- We used the model energy code as written, without applicable state-specific amendments.
- We assigned a single-model energy code to the entire year, based on the code that was in effect for the majority of that year. We did not use state-specific change dates.
- We assumed a lag in code adoption to account for the amount of time it takes to complete the construction of a building. The lag was one year for residential buildings and two years for

[10] For add-on measures (measures that consist of equipment or practices that can be combined with existing equipment or structures and represent efficiency improvements by themselves, such as VSDs or controls), the baseline was the prior equipment without the add-on measure.

nonresidential buildings. Our assumptions were based on professional judgment because there was no systematic way to determine what the lag should be for each technology.

- Adjusted baselines were developed as follows:
    - We developed an adjustment factor that helps to address the percentage of buildings that are noncompliant based on publically-available studies. The adjustment factor helps to account for noncompliance but is not a noncompliance factor.[11] The adjustment factors are 16% for commercial buildings and 33% for residential buildings.
    - We weight the efficiency level from the previous applicable code by the adjustment factor. We weight the efficiency level from the current applicable code by the complement of the adjustment factor.
    - We calculated a weighted average efficiency level based on the two efficiency levels (current and previous code) and the adjustment factor.
- The baseline used for commercial buildings was ASHRAE 90.1-1989 and for residential buildings was Model Energy Code 1993 because our research showed that these were the first widely adopted model energy codes.

These simplifications will not likely result in a great loss of accuracy but will result in significant development cost savings.

G.5. RENEWABLE GENERATION IMPACT METHODS

Standard calculation methods were used for estimating all electrical or thermal energy generation and/or savings associated with renewable energy systems installed through the SEP.

Thermal energy savings were calculated for biomass, biogas, and solar water-heating systems used to improve energy efficiency of existing hot water or space heating systems. Electrical and thermal energy generation was calculated for photovoltaic, wind, biomass, and biogas systems that displace fossil fuel use in the generation of electricity. Displaced fuels and displaced grid electricity were tracked with generation for use in the carbon model described in Appendix I.

Calculation methods are provided for biomass combustion systems (G.5.1), photovoltaic systems (G.5.2), solar water heating (G.5.3), and wind systems (G.5.4). Each section includes a description of the chosen calculation algorithm or tool and enlists input parameters, sources, and assumptions.

Some evaluated energy systems, such as demonstration projects, were not consistent with the renewable energy systems presented in these standard calculations. For those systems, custom calculation methods were developed and independently documented. Custom calculation documentation included the input values, equations, assumptions, and clear justification for the recommended approach.

[11] The limited number of noncompliance studies, variations in methodology, and wide range of results prevents us from determining an actual noncompliance adjustment factor.

G.5.1. Biomass combustion system energy impacts

A variety of biomass, electrical, and thermal energy generation technologies were installed through the SEP in the evaluated period.

A few biomass systems installed through the SEP were unique to a particular program and thus required a custom calculation. In these cases, calculation of the electricity generation and thermal energy generation of the systems relied upon guidance and documentation from the U.S. Department of Agriculture, U.S. Environmental Protection Agency (EPA), and DOE's National Renewable Energy Laboratory (NREL) and National Energy Technology Laboratory.

A few general assumptions were made for all biomass systems when data were not available. These general assumptions are listed in **Table 22**.

Table 22: General biomass energy-calculation default assumptions

Calculation Parameter	Default Assumption, if missing
Displaced energy source	Regional grid electricity mix
New Equipment Installation Year ($Y_{install}$)	Program year
System Lifetime	Manufacturer warranty or 20 years
Capacity Factor	0.85

Standard calculations for biogas production through anaerobic digestion are provided in Section G.5.1.1. Section G.5.1.2 estimates the electricity production of an engine-generator using the calculated estimate of biogas production. Section G.5.1.3 estimates thermal energy savings from biogas generator sets (genset) waste heat utilization.

G.5.1.1 Biogas production

Biogas production from anaerobic digestion was estimated using the chemical oxygen destruction (COD) method. The COD method uses a standard rate of methane production in cubic feet per pound of COD, which allows for a standard calculation of methane production regardless of digester inputs. This makes the COD method applicable to agricultural systems as well as industrial processes, such as food waste processing, landfill gas, and wastewater treatment. An alternative method uses volatile solids (VS) to estimate biogas production, but this method is less versatile than the COD approach (and is most easily applied to agricultural biogas applications).

Methane gas production from the digestion process is based on farm type or industrial process using the following equations:

Equation 1: Annual biogas production based on farm processes

$$AnnualBiogas_{Farm}\,(ft^3/year) = \frac{A \times B \times C \times D \times E \times 365 days/year}{F}$$

Equation 2: Annual biogas production based on industrial processes

$$AnnualBiogas_{Industrial}(ft^3/year) = \frac{A \times B \times D \times E \times 365 days/year}{F}$$

A = Number of animals (agricultural) or gallons of influent/day (industrial).

B = Pounds of COD/animal/day (agricultural) or pounds of COD/gal (industrial).

C = Manure collected in influent (percent expressed as a decimal), 0.95–1.0 range (not used for industrial digester).

D = Digester efficiency (percent expressed as a decimal), 0.1–0.9 range based on influent type and digester efficiency. Digester efficiencies have been shown to range from 0.1 to 0.5 at dairy installations and from 0.3 to 0.7 at swine installations.[12]

E = COD to methane conversion factor. Use 8.3 ft^3/lb at 95° F and 760 mm Hg.[13] At other temperatures and pressures adjust volume using the General Gas Law.[14]

F = Percent methane in biogas (percent expressed as a decimal), 0.55 to 0.80 range depending on digester type and influent source. Average biogas contains 65 percent methane.[15]

Where the COD content of the manure for a particular project is not available, the COD content is estimated based on the VS content of manure by animal type based on industry guidance.[16] These estimates do not include additional VS or COD content available from bedding or other substrates added to the waste stream.

G.5.1.2 Electricity Generation from Biogas Combustion

The annual electricity generated by a biogas combustion system is calculated from the quantity of methane delivered to the engine, heating value, capacity factor, and the thermal conversion efficiency.[17]

Equation 3: Biogas annual energy generation

$$Annual\,kWh/year = \frac{G \times H \times I \times J}{3{,}413\,Btu/kWh} - Load_{Parasitic}$$

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12 "An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities," Technical Note No. 1, USDA, NRCS, October 2007.

13 Burke, Dnnis A., P.E. "Dairy Waste Anaerobic Digestion Handbook." Page 38. Environmental Energy Company, 6007 Hill Street, Olympia, WA 98516. June 2001.

14 The General Gas Law is expressed by the equation: $V_2 = V_1 \times (T_2/T_1) \times (P_1/P_2)$
Where: V_1 = gas volume (m^3) at temperature T_1 (°K) and pressure P_1 (mm Hg)
V_2 = gas volume (m^3) at temperature T_2 (°K) and pressure P_2 (mm Hg).

15 NRCS, October 2007 op. cit.

14 American Society of Agriculture and Biological Engineers, ASAE D384.2: Manure production and characteristics, The Society for Engineering in Agriculture, Food and Biological System, St. Joseph, MI, 2005.

17 John H. Martin, *A Protocol for Quantifying and Reporting the Performance of Anaerobic Digestion Systems for Livestock Manures*, ASERTI, USDA – Rural Development and EPA AgStar, (www.epa.gov/agstar/pdf/protocol.pdf), January 2007.

G = Annual cubic feet of biogas delivered to the generator set (genset) engine (Equation 1 and

Equation 2 above). This quantity is the annual biogas produced minus biogas flared, sold, or used for heating.

H = Thermal conversion efficiency (percent expressed as a decimal), 0.22–0.25 for older, naturally aspirated gensets, 0.29–0.31 for lean-burn gensets, and ≤0.38 for larger (>1 MW) lean-burn gensets.

I = Lower heating value of biogas (Btu/ft^3) – (corrected for temperature and pressure of methane production); the value ranges from 500 to 800 Btu/ft^3; average biogas is approximately 600 Btu/ft^3.

J = Engine-generator capacity factor, 0.85 (average for a mature, well-operated system). [18]

The anticipated methane production of the farm or industrial process is typically used to determine the genset size. The above equation assumes there is no over-production of biogas relative to the size of the generator set that is flared. Under-production of biogas for the specified genset (e.g., in anticipation of later expansion) is assumed not to occur unless otherwise specified through data collection. Because some gensets (especially older models) decline in electric production efficiency at partial loading, care is taken in estimation of system efficiency when partial loading is demonstrated by collected data.

Finally, parasitic electrical load is the energy required to operate the renewable energy system that would otherwise not be required. In this case, it includes the energy consumed by pumps, fans, and motors that are necessary to operate the digester energy system. Total parasitic electrical energy is the sum of annual energy in kWh for all parasitic loads.

G.5.1.3 Thermal energy savings from biogas genset waste heat utilization

Thermal energy savings are calculated for applications that utilize biogas on-site to fuel a boiler or furnace. Equation 4 calculates the thermal energy saved through utilization of waste heat from the engine-generator.

Equation 4: Biogas annual Therms saved from waste heat utilization

$$Annual\ Therm\ Savings(Therms/year) = \frac{K \times L \times M \times hrs - N}{P}$$

K = Engine-generator capacity factor, 0.85 (assumes this value as the average for a mature well operated system).

L = Heat generation of engine (Therms/hour). Obtained from manufacturer. Specific information about the installation may indicate that the heat generation of the engine may represent the heat recovery from the water jacket, the exhaust manifold or both.

M = Heat exchanger efficiency (percent expressed as a decimal). Obtained from manufacturer.

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[18] The capacity factor derates the projected output for factors such as generator downtime, maintenance, and other practical considerations affecting generation. Based on engineer experience, existing installations have an average capacity factor of 0.85.

N = Average waste heat supplied to the biodigester (Therms). This estimate depends on the digester type and design, the type and collection method of influent, and many other factors.

P = Average efficiency of a gas boiler percent expressed as a decimal). If unknown, the efficiency is assumed to be 0.80 (average efficiency of a natural gas fired boiler heating system).

hrs = The annual hours of operation for the engine-generator. The value is 8760 hours/year for systems that operate constantly, but this can vary depending on a specific location's operating hours.

Because the system provides natural gas savings for heating, the estimate is divided by the average efficiency of a natural gas fired boiler. The heat generation of the engine-generator and the efficiency of the heat exchanger will depend on the type and operating power of the engine. Finally, the average waste heat supplied to the biodigester must be subtracted from the available waste heat. The heat supplied to the biodigester will be unavailable to offset existing heating loads. These values and assumptions are documented for each project.

This calculation assumes that all waste heat produced can be utilized. When the waste heat available exceeds the waste heat utilized, the waste heat utilization equals the waste heat demand. The evaluation tracked only the waste heat that will be utilized.

G.5.2. Photovoltaic (solar electric) energy impacts

Estimates of solar energy (kWh) generated by photovoltaic (PV) systems are performed using PVWatts, an online software package provided by the NREL.[19] This tool was chosen based on the public availability of both the tool and of supporting solar resource data provided through the DOE.

Calculation documentation for PV systems includes, but is not limited to, the information listed in **Table 23**. These data points are required entries in the model and appear in the output.

Table 23: Solar photovoltaic calculation default assumptions

Calculation parameter	Default assumption, if missing
Displaced energy source	Regional grid electricity mix
New Equipment Installation Year ($Y_{install}$)	Program year
System Lifetime	Manufacturer warranty; 20 years
Array Type	• Commercial building: rack mounted. • Residential building: rooftop mounted.
Panel Tilt (degrees from horizontal)	• If rooftop mounted, use rooftop incline. • If not rooftop mounted, tilt based on latitude.
Rooftop Incline	30 degrees
Panel Orientation (degrees from north)	South facing
AC to DC Derate Factor (0.0 to 1.0)	0.77 (PVWatts default value)
System Lifetime	25 years (Average Manufacturer Warranty Lifetime)
Degradation Factor (0.0 to 1.0)	0.5% per year (NREL)[20]

[19] *PVWatts version 1. A Performance Calculator for Grid-Connected PV Systems.* NREL. http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/ (accessed June 17, 2013).

In addition to the required inputs, additional information was asked of program funding recipients to determine the percent shading during a part of the day from surrounding objects, or part of the year from snow. In instances where arrays of panels at a site are at different tilt angles, orientations, or have different shading, the PVWatts calculations are performed separately for each array.

G.5.3. Solar water heating energy impacts

Energy savings from solar water heating was calculated using RETScreen v4,[21] a tool developed by Natural Resources Canada for predictive modeling. This tool was chosen for its larger scope of program specific input parameters than other considered tools. It includes regional weather data, information on the specific system used, application, and replaced system information.

The RETScreen model requires various operational parameters of the solar water heater installation and of the load. Examples of these parameters include climate data, system design specifications, and the quantity of water heated. The model then calculates the estimated energy savings due to the installation of solar water heating systems for service hot water with storage, service hot water without storage, and swimming pools, as applied to residential, commercial, and industrial applications. The RETScreen model provides algorithms and recommendations for default input parameters for use when program data were not available. **Table 24** lists modeling assumptions made in addition to RETScreen default input parameters.

Table 24: Solar water heater calculation default assumptions

Calculation Parameter	Default Assumption, if missing
Energy Savings Fuel Source	Regional grid electricity mix
New Equipment Installation Year ($Y_{install}$)	Program year
System Lifetime	Manufacturer warranty; 20 years[22]
Panel Orientation (degrees from north)	South facing
Type of collector (unglazed, glazed, evacuated)	• Pool heating or aquaculture: unglazed • All others: glazed
Total capacity [Number of tanks & capacity of each (gal)]	• Residential: daily water usage = tank capacity • Nonresidential: Use square footage of facility & facility type to estimate hot water usage
[Residential Only] Number of people in home	Average persons/household for State per 2010 census data[23]

20 Dirk Jordan and Sarah Kurtz. Photovoltaic Degradation Rates – an Analytical Review. National Renewable Energy Laboratory (NREL). http://www.nrel.gov/docs/fy12osti/51664.pdf

21 RETScreen International. Natural Resources Canada. www.retScreen.net (accessed October 7, 2013)

22 *Save Money and More with Energy Star Qualified Solar Water Heaters.* http://www.energystar.gov/index.cfm?c=solar_wheat.pr_savings_benefits ; The Cadmus Group, Inc. Overview of Solar Water Heating Inputs and Results. October, 2012. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2013IRP/PAC%202013IRP_SWH%20Memo_10-05-12.pdf

23 http://quickfacts.census.gov/qfd/index.html

RETScreen also estimates the parasitic energy used by the solar water heating circulation pump. The model estimates an annual electricity usage (MWh) for the pump based on an input value for pump power per unit area of solar panel (W/ft^2). RETScreen will calculate the MWh used by the pump by dividing the pump power by the solar collector area. The user subtracts the parasitic energy usage from total production when electric energy is displaced.

RETScreen calculates the parasitic load based on user inputs regarding storage capacity, heat exchangers, miscellaneous losses and pump power per solar collector area. RETScreen provides recommendations in the help section for pump sizing and power ranges per collector aperture area. For residential systems, the value will be small, but not insignificant, if an electric pump is used. For industrial operations, the value can be sizeable. These loads were neglected for:[24]

- Thermosiphon systems, as a circulation pump is not required.
- Systems with photovoltaic-powered pumps, as the required electric energy is produced by photovoltaic panels.
- Outdoor swimming pool systems when the filtration system pump can be used for the solar loop; if the solar loop requires a high head (e.g., collectors placed too high above pool level, a booster pump may be required) then include the pump as parasitic load.
- Industrial systems where water is diverted through the collectors before being delivered to the load.

G.5.4. Wind energy impacts

The NREL Wind Energy Payback Period Workbook version 1.0 (NREL model)[25] was chosen for calculation of wind energy impacts for the SEP evaluation. The model is similar to other publicly available models, such as the Idaho National Laboratories (INL) wind model, in that it bases its kWh production estimates from a Weibull probability distribution function. The differentiating factor that makes the NREL model preferable is that it provides default assumptions for some of the inputs, and corrects for air density and derate factors[26] when calculating contribution to average wind turbine power (kW).

The model uses project site information such as wind speed, elevation, and density to estimate the wind profile. Physical characteristics of the turbine, including rated capacity, hub height, and power curve (power production at different wind speeds) can also be input to the model. Finally, miscellaneous factors such as turbine maintenance and weather can be input to better define the capacity factor, which is the amount of time available for electricity production at the site.

The NREL model uses the Weibull function formula to create a probability distribution of wind speeds at the specific site and percent of the time during the year the wind speed will be at projected levels.

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[24] RETScreen Software Online User Manual, Solar Water Heating Model. RETScreen® International. www.retscreen.net.

[25] Wind Energy Payback Period Worksheet version 1.0. NREL http://www.nrel.gov/wind/docs/spread_sheet_Final.xls (accessed October 9, 2013)

[26] A derate factor is a number which values the proportion of electricity that is retained by the system after taking into account electricity loss throughout a system, which could be caused by inverters, lack of maintenance, or external conditions (e.g., weather).

A range of average annual wind speeds are taken from an NREL geographic information system (GIS) wind speed map for the particular location being studied. The site evaluator selects an average annual wind speed from the range using his or her best assessment of the site's characteristics. For a selected turbine hub height a value for the annual average wind speed is estimated using the Power Law equation:

Equation 5: Average wind speed

$$Hub\ Height\ Average\ Wind\ Speed\ (AWS) = A \times \left(\frac{G}{B}\right)^{\alpha}$$

A = Average wind speed

G = Rotor hub height

B = Anemometer height

α = Wind shear exponent, see **Table 25.**

With these inputs, the model yields an expected kW rating on a yearly basis at each of the different wind speeds at the turbine site. The model then sums the expected yearly kW at all the different wind speeds to get a total kW estimate at the site. This number is then multiplied by 8,760 hours/year to obtain the annual energy production (kWh/year).

Table 25 lists the inputs used for the model, and defaults that can be assumed in the absence of respondent data.

Table 25: Solar photovoltaic calculation default assumptions

Calculation parameter	Default assumption, if missing
Displaced energy source	Regional grid electricity mix
New Equipment Installation Year ($Y_{install}$)	Program year
System Lifetime	Manufacturer warranty; 20 years
Wind Shear Estimate[27]	• 0.10 inches – very smooth terrain or open water use • 1/7 inches – smooth terrain • 0.20 inches – flat terrain with some surface roughness (the Great Plains)
Weibull k	• k = 2 – inland sites • k = 3 – coastal sites • k = 4 – island sites and trade wind regimes
Turbine hub height (m)	80 feet (AWEA)[28]
Anemometer Height (meters)	10 meters
Availability (%)	95 - 98 %
Performance Margin	• 0.0 (0%) –grid-connected applications • 0.05 (5%) – remote homes and village power sites with back-up power • 0.15 (15%) - 0.25 (25%) – telecommunication applications with back-up power • 0.2 (20%) - 0.4 (40%) – high-priority loads at sites without back-up power (should have solar component).
Performance Derating	10%

G.6. TRANSPORTATION ENERGY IMPACT METHODS

The impacts of Alternative Fuels and Transportation PAs were based on Argonne National Lab's Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model, specifically the Fleet Footprint Calculator.[29] The calculations also relied on research from NREL and EIA (specific sources listed below).

The contractor team modeled the fuel usage of an existing baseline vehicle and compared it to that of a more efficient SEP-funded vehicle over the expected useful life of the efficient vehicle. Calculation of vehicle fuel use for both the existing and efficient vehicle was based on the GREET model's transportation fuel energy density[30,31] and vehicle emissions (CO2e) data.[32] User inputs to the calculation included baseline

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[27] M. L. Ray, A.l. Rogers, and J.G. McGowan, *Analysis of Wind Shear Models and Trends in Different Terrains*, AWEA Wind Power 2005 Conference, Pittsburgh, PA, June 2006.

[28] *Frequently Asked Questions*. American Wind Energy Association. http://www.awea.org/Issues/Content.aspx?ItemNumber=4638&navItemNumber=727 (accessed October 9, 2013)

[29] *GREET Fleet – Carbon and Petroleum Footprint Calculator*. Argonne National Laboratory. https://greet.es.anl.gov/fleet_footprint_calculator (accessed on March 10, 2013)

[30] Pump-to-wheel 'BTUs per one unit of fuel, GREET model, Argonne National Labs (http://greet.es.anl.gov/)

vehicle fuel economy (based on Corporate Average Fuel Economy (CAFE) Standards),[33] efficient vehicle fuel economy (based on NREL data)[34] and annual miles driven (per participant interview).

The impact method for transportation also incorporated a dual baseline for cases when the baseline vehicle effective useful life[35] ended prior to that of the efficient vehicle. The secondary baseline vehicle was defined with higher efficiency standards using CAFÉ standards for the year of replacement.

Table 26: Transportation impacts calculation default assumptions

Calculation parameter	Default assumption, if missing
Baseline - Fuel Type	Gasoline
Baseline - Fuel Economy	2008 CAFE standard for light-weight vehicle (car)
Baseline - Total Miles Driven (miles/yr)	Average of other vehicles in evaluation of program. If not available, average across Subcat for similar type of vehicle.
Baseline - Quantity of Vehicles	One
Years before Baseline vehicle would have been replaced	Average of other vehicles in evaluation of program. If not available, average across Subcat for similar type of vehicle
SEP - Fuel Type	Gasoline Hybrid
SEP - Fuel Economy	2008 Toyota Prius
SEP - Total Miles Driven (miles/yr)	Equal to baseline vehicle
SEP - Quantity of Vehicles	Equal to baseline vehicle
Years before SEP vehicle would have been replaced	10 years

G.7. CODES AND STANDARDS IMPACT METHODS

Codes and Standards PA savings impacts were determined using a custom tool built on key components of a similar tool developed by Pacific Northwest National Laboratory (PNNL).[36,37] The approaches of both models are based on the following basic formula:

$$\text{Total Savings} = (\text{Old Code EUI} - \text{New Code EUI}) \times (\text{Program Compliance} - \text{Baseline Compliance}) \times \text{Construction Activity}$$

31 Grams of CO_2e per BTU of fuel (Power plant combustion), EPA (http://www.eia.gov/oiaf/1605/coefficients.html)

32 Grams of CO_2e per BTU of fuel (Pump-To-Wheel), GREET model, Argonne National Labs (http://greet.es.anl.gov/)

33 CAFE standards from National Highway Traffic Safety Administration. "2017-2025 Model Year Light-Duty Vehicle GHG Emissions and CAFE Standards: Supplemental" (http://www.gpo.gov/fdsys/granule/FR-2011-08-09/2011-19905/content-detail.html)

34 Fuel economy for PHEV based on 2009 NREL study "Deriving In-Use PHEV Fuel Economy Predictions from Standardized Test Cycle Results" (http://www.nrel.gov/docs/fy09osti/46251.pdf) and a 2009 Argonne study "Well-to-Wheels Energy Use and Greenhouse Gas Emissions Analysis of Plug-in Hybrid Electric Vehicles" (http://www.transportation.anl.gov/pdfs/TA/559.pdf)

35 The effective useful life is defined as the number of years over which the new (efficient) equipment is expected to be maintained at the efficient condition for which it was intended. Energy savings from efficient equipment is zero after the end of the EUL.

36 PNNL. Commercial Compliance using COMcheck. http://www.energycodes.gov/comcheck

37 PNNL. Residential Compliance using REScheck. http://www.energycodes.gov/rescheck

Where EUI = Energy Use Intensity (savings per square foot)

Using this formula, savings are assigned from both improving compliance levels and acceleration of code adoption. Each component of the impact analysis method is described in detail below.

Code EUIs were first sourced from the PNNL tool. The tool provides an EUI for each code version (e.g., International Energy Conservation Code (IECC) 2009) for each state. These EUI estimates are climate-specific and are broken into components. For residential, the components are electric and fuel heating, electric and fuel cooling, and electric and fuel other (6 total) and are provided on a per-housing unit basis. For commercial, the components are electric and fuel HVAC and electric and fuel other (4 total) and are provided on a per-square foot basis. Through expert interviews and through a review of historical documentation, we determined the baseline code (e.g., IECC 2003) and the code that was adopted because of the program.

The PNNL EUIs do not reflect adjustments for amendments. As such, we determined through expert interviews and through a review of historical documentation which amendments had been attached to the model codes. Engineering judgment was then used to estimate the impact that the amendments would have.

Code adoption and compliance are treated dynamically because they change over time. We determined the year of code adoption in reality by observing the historical record and verifying it with interviewees. To determine the counterfactual, baseline year of adoption (i.e., the year the code would have been adopted in the absence of the program), interviewees were asked to describe the political climate in the state and estimate explicitly the year that the code would have been adopted without the program.

Compliance values were estimated using interview data. Interviewees were asked to estimate the percentage of projects in the state that adhered to the adopted code prior to it being adopted and again how many were adhering to it in current practices. This was done on the measure level for a set of prescriptive practices outlined in the code. The former question established a baseline level of compliance: the naturally occurring market adoption (NOMAD) of technologies and measures in the code. The latter question showed how compliance improved following the adoption of the code and the provision of program training. Interviewees were also given a chance to revise their estimates as part of a Delphi process.

A single weighted-energy compliance (WEC) value was estimated by taking the measure-specific compliance estimates and weighting them by the relative importance of each measure. We used a modified weighting system based on PNNL's Score + Store compliance tracking system.

Each respondent's pre- and post-WEC was weighted by the credibility (on a scale of 1 to 3 where 1 is low credibility and 3 is high credibility) of their responses overall. Credibility was judged on the stature of the respondent, the completeness of their responses, the reasonableness of their justifications, the internal consistency of their responses, and the consistency of their responses with other experts. If a respondent declined to respond regarding a particular measure, average compliance values were assumed for those holes in their responses. Individual responses and credibility weightings can be seen in the "Pre-WEC" and "Post-WEC" tabs of the analysis spreadsheets.

The pre- and post-WEC values established two anchor points by which to determine the trajectory of compliance over time in the program-induced scenario and the counterfactual baseline scenario.

For the program-induced scenario (reality), the pre-WEC was assumed to have been achieved simultaneous to the code adoption year. The post-WEC was assumed to align to the period of questioning (late 2013) and is thus reflected in the 2014 savings analysis. Compliance prior to the pre-WEC anchor is estimated to reduce linearly by 2.5% per year as you go back in time; this represents the learning rate for NOMAD of a less-informed populace per the PNNL tool's assumption. Compliance between the anchor points is assumed as follows: half of the difference between the pre- and post-WEC is achieved immediately as a consequence of a change in code requirements and the remaining half is achieved linearly over the period of years between the two anchors as a consequence of training and learning. Compliance following the post-WEC is estimated to grow at 1.5% per year as you go forward in time; this represents the learning rate of a more-informed populace per the PNNL tool's assumption (more people educated about compliance leave less opportunity for learning).

For the counterfactual baseline scenario, the pre-WEC was assumed in the same year as above. Compliance in the years before the counterfactual year of code adoption was determined using the 2.5% NOMAD growth rate and the pre-WEC anchor. In the counterfactual year of adoption, the compliance level was assumed to jump an amount equal to that in the program-induced scenario (i.e., nominally half of the difference between pre- and post-WEC values). In the years following adoption, the compliance rate was assumed to grow at a rate of 2.5% (since fewer people understand the code than in the program-induced scenario) until it reaches the level of compliance observed in the program-induced scenario, at which point it matches the program-induced growth rate (i.e., 1.5%). This allowed the two lines to converge over time, demonstrating that the program's effect on code outcomes will diminish over time.

An additional compliance trajectory was also required to estimate the split in savings between accelerated code adoption and the training component of the program. This compliance trajectory reflects the estimated WEC for a scenario including accelerated code adoption, but excluding training. It follows the program-induced trajectory through the year of code adoption, but following that year it simply grows at the 2.5% learning rate until it catches up to the program-induced scenario.

All non-compliance (i.e., 100% WEC) was assumed to imply consumption at the old-code EUI level. All compliance was assumed to imply consumption at the new-code EUI level. Thus, savings is the difference in WEC between the program-induced scenario and the counterfactual baseline multiplied by the difference in EUI between those two codes multiplied again by construction volumes (i.e., the original formula above). Construction volumes were a combination of census data for historic volumes and PNNL projections.

Savings were calculated yearly, thus implying a stream of savings per year. Moreover, the savings of a single building were assumed to last for 20 years, reflecting the fact that these measures affect core building systems (mostly envelope) and will have long lifetimes.

Overall savings were split by fuel type using DOE Commercial Building Energy Consumption Survey and Residential Energy Consumption Survey (RECS) data. Non-electric savings were divided by fuel type according to their aggregated usage.

G.8. CLEAN ENERGY POLICY SUPPORT IMPACT METHODS

The Clean Energy Policy Support portion of the study represents state efforts to develop or support policies that facilitate the adoption and use of energy efficiency and clean energy technologies. Within the broad area of policy support programs, the PAs within this Subcategory represent three key subareas:

- Program design and pilot implementation of state policies to increase the efficiency of its municipal building stock or to advance the market for renewable technologies.
- Assessments of renewable technologies (e.g., hydrogen, biomass, etc.) for inclusion in state renewable portfolio standards.
- Legal and regulatory support to facilitate increased usage of energy-efficient and renewable energy resources and associated portfolio standards.

The general impact analysis methods used for Clean Energy Policy Support compared the downstream impacts of the policy to a baseline developed for each PA. Each of the three subareas had a different approach, as well as standard calculation methodology for determining the SEP-attributable impacts:

- **Program design and pilot implementation of state policies to increase the efficiency of its municipal building stock or to advance the market for renewable technologies.** For PAs in the pilot design/implementation support subarea, we used previously defined engineering methods (including the SCT) as well as specific data on all measures/technologies installed to estimate savings and generation. The extent of the energy impacts for PAs in this subarea directly related to the measure lives of the technologies installed.
- **Assessments of renewable technologies (e.g., hydrogen, biomass, etc.) for inclusion in states' renewable portfolio standards.** For renewable technology assessments, we used data to create two streams of renewable energy generation: one from facilities that existed or were on track to be developed prior to the policy change, and one from the facilities that were initiated after the policy change. The difference between these two streams of generation was the overall impact associated with the policy change. We assumed the lifetime impact of the policy changes was equal to the lifetime of the generation units affected by the policy. For any renewable technology that was a part of the Clean Energy Policy Support programs evaluation, we used the appropriate renewables standard calculation methods described in Section G.5 to calculate the impact of the technology.
- **Legal and regulatory support to facilitate increased usage of energy-efficient and renewable energy resources and associated portfolio standards.** For legal or regulatory support, we calculated overall impacts as the difference between the program impacts from the policy changes (the downstream impact) and the forecasts based on historical program results for the previous policy that was in effect for each individual PA. The policies that we evaluated in this subarea did not include sunset clauses, so we assumed that the savings associated with the PA included those that had already occurred as well as those that were already planned to occur. For example, in one state where the policy supported the creation of triennial savings plans, we only evaluated the savings associated with the triennial plans currently in place and not future triennial plans we expected would occur.

G.9. REVOLVING LOAN IMPACT METHODS

This section outlines the default assumptions used in calculation of energy impacts from the effect of revolving loan repayment streams. In a revolving loan fund arrangement, loans are awarded to projects through a central fund. Program participant payments to the fund are then redistributed to new projects, extending the impact per dollar of initially awarded funding. Revolving loan repayment streams affect the energy impact, cost-effectiveness, labor, and carbon impacts of a PA.

The contractor team calculated revolving loan impacts through the application of several common assumptions. These assumptions are intended to capture the benefits and costs of revolving funds in addition to their full employment and economic impacts while still making the analysis as reasonable and accessible as possible. The method for calculation of revolving loan impacts involves the following steps:

- Disburse the full loan pool amounts over one program year unless detailed documentation is available. For PY 2008 PAs, loans are disbursed in that year. For the ARRA-period, disbursement is in the year 2011. The years 2009 and 2010 are considered as ramp-up for the loan programs and 2012 begins program closing and reporting.
- Start repayment of principal and interest (P+i) in the year following disbursement and run it through the full term of the loan. This step assumes that there are no early repayments and no defaults.
- Assign all cash flows at the end of each year.
- Attribute repayment of P+i on an annual basis rather than monthly.[38]
- Assume the borrower collects P+i for one year and then reloans the full amount repaid minus funds used for administrative expenses (typically equal to the interest rate charged on the loan). In other words, the loans "revolve" once per year.
- Assume the new portfolio of loans has the same interest rate, loan duration, repayment risk profile and energy savings potential as the initial round of loans.[39]
- The assessment is no longer than 20 years such that no loans are made after 20 years from the final year of the program. For example, if an ARRA-period program starts loaning funds in 2010 and the last loan made from the original funding is in 2012, the revolving loan schedule for 2012 continues no longer than 2032.
- Exclude income and sales tax rates from the calculations.
- Assume the impacts of the revolved loans follow the same pattern of the initial loans, only at a reduced proportion on account of defaults and the repayment rate never fully replenishes the original loan fund. This proportion is determined by the ratio of new loaned dollars to original loaned dollars. It should also be noted that the number of years in which the streams occur is the same. So, for example, if the initial loan had 10 years of energy savings, then a revolved loan will also have 10 years of savings, just at a smaller proportion.

The treatment of revolving loans affects each criterion for cost-effectiveness (SEP-RAC and present value) in a different way, as outlined in **Table 27**. Where the loan interest rate is different from the discount rate, the

[38] Technically, discounting is applied to periods rather than years. Given that the discount and inflation rates from OMB are provided on an annual basis, a period is defined here as one year.

[39] The risk profile of the borrower can be considered constant due to the same application requirements and interest rate assignment (an indicator of risk). However, this does not imply that all borrowers will adjust to changing market conditions in the same way.

present value loan analysis produces residual dollars (i.e., net present value is not zero). When positive, these amounts represent a benefit to the borrower because, in present value terms, the borrower is paying back fewer dollars than they borrowed. A positive balance also implies a cost to the lender because they are receiving fewer dollars than they loaned out in present value terms.

Table 27: Effects of revolving loans on cost-effectiveness calculations

Criteria	Initial Loan Disbursement	Loan Repayment
SEP-RAC	Increases program expenditures (cost)	No Impact
Present Value Ratio	Increases present value of program expenditure (cost)	Reduces present value of program expenditure (cost) by offsetting some – but not all – of the loan disbursement amount Reduces present value of participant bill savings (benefit) since free cash flow from bills savings is reduced by the amount of loan payments Increases program expenditures (cost) when present value dollars paid back are less than present value dollars borrowed

Because revolving loans have annual impacts reported as a percentage change from a baseline forecast, they have associated employment and economic impacts. Changes in economic activity from short-term and long-term spending influence the degree of change in employment. The timing of initial loan disbursements and the repayment terms of these loans determine the level of cash flow (and therefore spending) of borrows. This spending drives changes in economic activity as detailed in **Table 28**.

Table 28: Effects of revolving loans on employment impacts

Employment	Initial Loan Disbursement	Loan Repayment
Direct **Indirect**	Increase current period employment No impact on future period employment	No Impact on current period employment Dampens impact on future spending/reinvestment (and employment) until loan is paid off

G.10. REFERENCES

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APPENDIX H. DETAILED LABOR IMPACT METHODOLOGY

H.1. INTRODUCTION

The purpose of this section is to describe how employment impacts evolve from (1) direct spending from PY 2008 or ARRA-period activities nationwide and, (2) the direct energy saving outcomes from those completed PY 2008 or ARRA-period projects net of participants' project-related costs (up-front or loan repayment costs).

Employment impacts reflect jobs created or retained. A multi-regional macroeconomic impact forecasting model of the U.S., called the REMI model,[40] was used to gauge the annual job changes based on (i) initial SEP spending that is domestically supplied, and (ii) the effects from net energy bill savings within different customer segments*.* Spending consists of program administration costs and costs tied to the *incremental costs for equipment* above the base case technology in place. For household (and institutional public) participants, the savings after paying any costs related to their energy improvements (net savings) will drive more household (public sector) spending. For all other types of participants, the net savings are a reduction in the *cost-of-doing-business*. The latter exerts a unique response (specific to each NAICS code activity) on the ability of businesses to expand their sales into domestic and foreign markets.

Within the REMI model, the resultant impacts from (i) and (ii) not only reflect a "direct" job equivalent but also jobs from the *multiplier effect* on direct jobs and the consequences of energy savings moving through the economy. Hence, the nature of the annual job change is a *total* impact comprised of a direct element and a non-direct element. The latter represent two types of employment: the *indirect* (the local supply chain reaction that is initiated by the direct spending that is locally fulfilled) and the *induced* economic transactions (initial "after-tax" wages driving consumer purchases).

Job impacts were measured for two regimes:

- Without ARRA – this is indicative of the 2008 program year
- With ARRA – funding that supplements 2009 through 2013 SEP budgets.

The impact modeling exercise of the PY 2008 SEP activities were interpreted as the portion of the existing REMI base-case economic projection that was attributable to SEP. The SEP ARRA-period modeling exercise was interpreted as the change relative to the REMI base case economic projection in any particular year where the base case already captured PY 2008 SEP spending.

Findings are presented by BPAC and study period. Key impact metrics from this analysis are as follows:

- **Direct jobs and job-years produced** – These are the short-term jobs that represent the number of people whose work is directly billed to a PY 2008 or ARRA-period construction project. These jobs may be part-time or full-time but for each year they are reported against a non-ARRA-period baseline. In other words, they are not intended to be cumulative.

[40] Produced by Regional Economic Models, Inc. (REMI), of Amherst, MA. (www.remi.com)

- **Total employment over the life of the program's impacts** – This metric represents direct jobs and employees working for producers of materials, equipment, and services that are used on the SEP-supported construction project, such as steel producers or producers of accounting services. It also includes those jobs created when employees (working on SEP-funded construction projects) spend their increased incomes on consumer goods and services.
- **Incremental employment impact by sector** – This metric shows the composition of total employment created by SEP spending in PY 2008 or the ARRA-period. For example, short-term employment tends to be concentrated in the construction sector as projects are being implemented. Later, spending and employment moves to other sectors as the initial project spending moves through the economy.

H.2. METHODS

The jobs analysis presented in this report was determined by the nature of SEP-related spending and subsequent changes in costs through more efficient consumption of energy products, (the how much, by whom, spent on what, and who fulfills that expenditure). Consequently, we followed the Renewable Energy Efficiency Mapping (REEM) framework developed by the Economic Development Research Group to translate the ways in which SEP dollars are injected into the economy and how they influence economic outcomes in different market segments.[41]

REEM is used with information and assumptions from the contractor team as a preprocessor to ensure that data reflecting energy policy and program implementation activities are characterized thoroughly and properly. While REEM can perform key allocation mapping, many of the REEM inputs and industrial sector mappings were developed by the contractor team as part of the SEP program evaluation and cost-effectiveness analysis. Sectors receiving funding were known, and project cost allocations between labor and equipment were assigned based on factors developed from each PA.

The resulting expenditure allocations were inputs for the REMI model to explore their short-term direct and subsequent multiplier effects on each of the regional economies. The REMI model is capable of capturing how cost changes in either the short-term or the longer-term among the commercial (here we include the private Institutional as well) and industrial customer segments affects their ability to sell more which impacts their jobs and multiplier jobs.

For example, a commercial or industrial customer with a lower energy bill has lower costs of doing business in their region and, as a result, is more competitive within local markets or domestic and international 'extra-regional' markets where the customer competes for business. This cost-competitiveness response, unique to each NAICS code of the Commercial or Industrial energy customer, grows sales, along with jobs,

[41] Economic Development Research Group. Renewables & Energy Efficiency Impact Model. http://www.edrgroup.com/tools/reem-renewables-energy-efficiency-impact-model/

labor income, and value-added product. In addition, households have more disposable income to spend on other goods and services when they are able to lower their energy consumption.[42]

In addition, this activity may reduce energy generation that would have implicitly sent some dollars out of the nation for fuel imports.[43] Domestic displacement that results along the energy generation supply-chain and the foregone foreign fuel imports are replaced in part with locally provided services (to install and maintain lower energy using dwellings or facilities), and some locally sourced equipment, components, and installation services. In **Figure 34**, the left portion of the diagram portrays the set of direct effects that are possible with a broad range of energy-related investments and objectives. This analysis, however, focuses on program administration in addition to household, business, and institutional spending and energy savings.

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[42] A large part of the model's econometric equation structure is defined at the industry-level to forecast or predict impacts in annual dollars of Output (production), annual dollars of value-added on that production, the annual employment needed, and the annual labor income generated. Apart from what the model structure can account for, if there are effects from emerging technology the model does not internally account for this. As such, the REMI model should never be construed as an 'expert system' of microeconomics for any single industry (e.g., it is not a load-dispatch model determining prices and labor requirements with the electric utility generation and transmission distribution sector).

[43] Unless new export demand can be identified to absorb that generation.

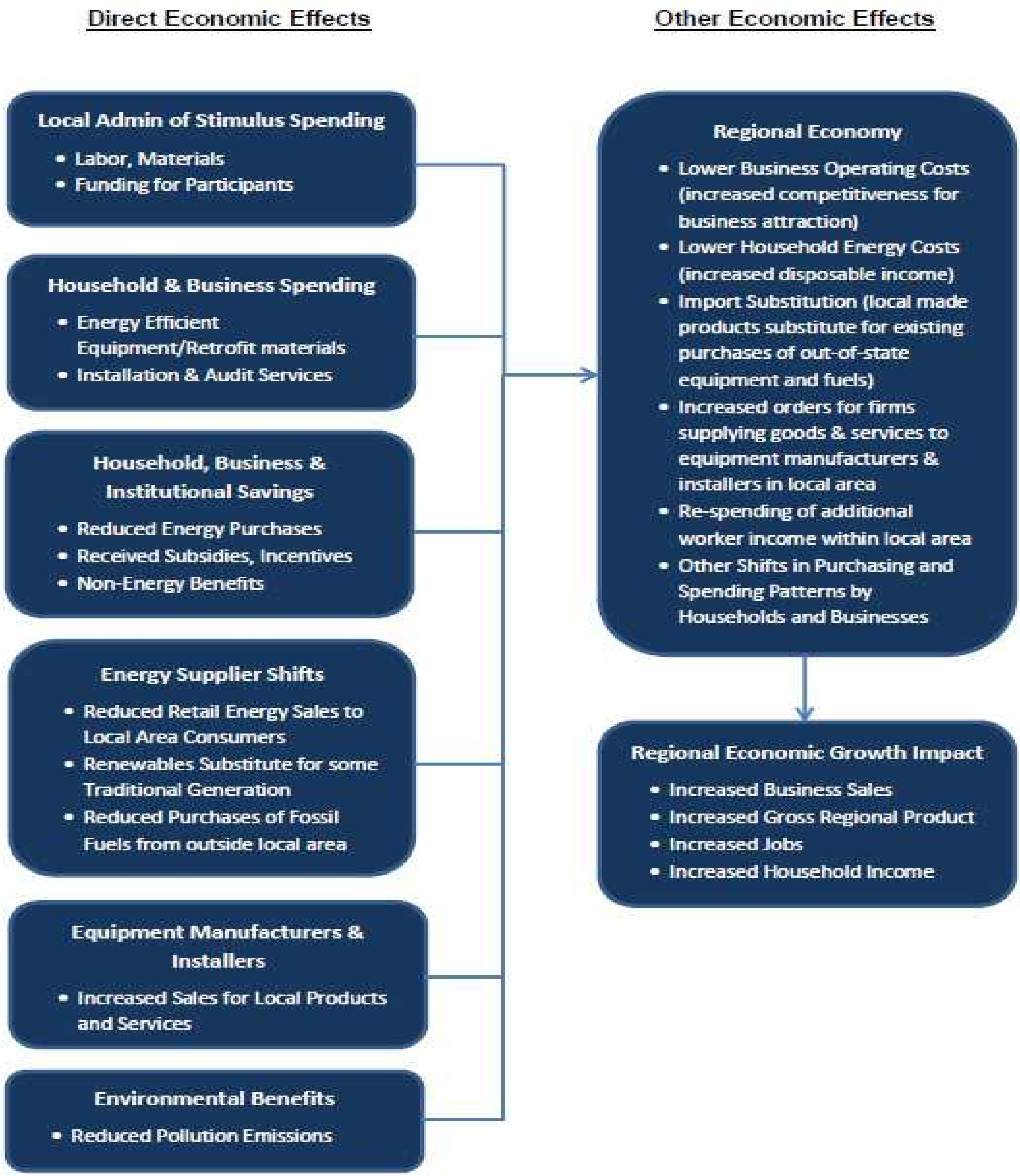

Figure 34: REEM framework for energy impact analysis

Source: ©2005-2014 Economic Development Research Group, Inc.

H.2.1. Energy investments and macroeconomic responses

The four major categories of direct effects associated with energy policies or investments and their potential to initiate macroeconomic responses are described in this section. In addition, the analysis requires tracking these activities by the geographic regions where the expenditures occurred and by the type of activity (e.g., energy audits/assessments, energy efficiency upgrades, or on-site renewable electricity generation). The four categories are described below.

H.2.1.1 Local administration of stimulus spending

These dollars are spent to operate the SEP programs. This spending includes incentives and loans disbursed to business and household participants, as well as expenditures for program management, marketing and participant information, workforce development and training, and quality assurance and control.

H.2.1.2 Household, business, and institutional energy bill savings

These savings include estimated energy bill savings by commercial or industrial businesses, agencies, and households from reductions in energy consumption and on-site generation capacity realized as a result of the SEP-funded projects. The estimated dollar savings for a participant are the recurring energy bill savings minus the out-of-pocket expenditure (explained next) for the energy upgrade project. Changes in net energy savings create changes in discretionary funds available for households to spend on additional goods and services in current and future periods. For participating commercial or industrial facilities, the estimated net energy bill savings lower operating costs. For participating government facilities, the net energy bill savings augment public spending.

H.2.1.3 Household and business expenses

Participating households and businesses incur additional expenses related to making improvements. These expenses, net of rebates and incentives, are associated with the incremental cost of purchasing and installing energy retrofits and upgrades, including efficient equipment or on-site renewable electricity generation. Participant’s net expenses alter current spending behavior of households and profitability of businesses.

For example, if a project has an incremental cost of $100,000, this is the level of expenditure (demand) introduced into the regional economy. However, the participant’s cost is $100,000 minus SEP ARRA-period payments ($50,000), minus leveraged rebates attributed to the program ($40,000). The resulting participant’s out-of-pocket expense would be $10,000.

H.2.1.4 Equipment manufacturers and installers

The dollars of new demand (referenced in 2.1.3) for energy efficient components reflects projects’ incremental cost (before incentives and rebates). Some portion of the new demand of equipment will be fulfilled locally through either local manufacturing or through a local wholesale (and possibly retail) distributor channel if components are manufactured out of region.

Items that are locally transacted in the model trigger a particular set of economic linkages associated with energy upgrade products purchased from a wholesale distributor or manufacturer located within one of the eight regions defined in the model. Regions are multi-state aggregate economies and therefore exhibit diverse economic activity. So for most energy upgrades, the purchase region is the same as the region where the upgrades were installed. The next decision is whether the local purchase is supported by a manufacturer or a distributor.

Items that are locally manufactured in the model trigger a different set of economic linkages associated with equipment manufactured in various regions. This is because each region has its own level and mix of manufacturing. Most U.S. manufacturing for energy efficiency and generation occurs in regions 3, 4, and 5 (Great Lakes, Plains, and Southeast).[44,45] One example is Trane in Wisconsin (region 3). Examples of manufacturing outside these regions are heating and cooling equipment manufactured by Goodman in Texas (region 6), and by Carrier in New York (region 2). REMI model data inputs for equipment investments are described as follows:

- Labor cost by type (e.g., auditor or construction laborer) will be sourced entirely within each region where the labor demand increases.
- "Locally manufactured or procured" building equipment (e.g., windows, insulation, HVAC, and motors) or production system components (e.g., solar panel assembly tables, injection molding and cutting machines, chemical baths, and furnaces).
- Equipment investment associated with Institutional Public sites will use manufactured components that reflect 97% American manufacturing (the remaining 3% is assumed to be imported) as a result of the *Buy American* policy that was put in place at the start of the ARRA-period.[46]
- Equipment investment associated with all other customer segments will reflect U.S. content of 70% (based on the REMI model's U.S. manufacturing regional purchase coefficient averaged between 2009 and 2013).
- Based on the contractor team's research on the U.S. manufacturing landscape for energy efficient devices and renewable system components, the U.S. orders arising from the SEP equipment demand are allocated across the eight sub-regions as follows:

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[44] U.S. Census Bureau, series 12s1012, https://www.census.gov/compendia/statab/cats/manufactures/manufactures--establishments_shipments_employees_payroll.html

[45] Helper, Susan, Timothy Krueger, Howard Wail, "Locating American Manufacturing: Trends in the Geography of Production", Brookings Institute, April 2012 http://www.brookings.edu/research/interactives/manufacturing-interactive

[46] Email correspondence between Joseph Schilling, US DOE and Martin Schweitzer, ORNL, February 24, 2014.

Table 29: Percent of U.S. orders by region

Region	Percent U.S. Orders
New England	4%
Mideast	11%
Great lakes	21%
Plains	9%
Southeast	25%
Southwest	14%
Rocky Mountain	3%
Far West	14%

Source: U.S. Census of manufacturing value for NAICS 331-335

H.2.2. Modeling approach

The model used for this analysis was the REMI Policy Insights Plus (PI+).[47] It depicts an eight-region model of the national economy with detail to address impacts on the residential household sector and 23 additional sectors (17 private-sector non-farm NAICS, a farm sector, two Federal government sectors, and a combined state/local government sector).

The model integrates input-output, computable general equilibrium, econometric, and economic geography methodologies[48] into an annual forecasting system capable of doing analysis through 2060. Results are reported for the U.S. as a whole through 2050, but the model includes the ability to adjust a full range of variables to introduce direct elements of a policy change and assess economic impacts for a targeted region.

The analysis models two cases: one for PY 2008 and one for the ARRA-period. In both cases the model uses inputs specified by the user to make an alternative forecast to the baseline. For the ARRA-period, the baseline is the status quo (i.e., SEP before ARRA supplementation). PY 2008 is treated similarly to the ARRA-period but is a historical event in the ARRA-period dataset. The interpretation of PY 2008 output is discussed later in this section.

The model generates a default baseline level of economic activity based on regional industry and labor market interactions, and relative prices. When model inputs are changed, for example, a change to participant energy-bill savings, the model recalculates economic flows and presents results in terms of change from the baseline. The steps are listed here:

1. Define the desired set of direct project effects for analysis.
2. Develop macroeconomic model with required responses. REMI calibrates these by region and by industry, and the output becomes the baseline scenario forecast.

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[47] Amherst, Massachusetts. www.remi.com

[48] REMI PI+ V1.6 model equations, 2014 Regional Economic Models, Inc., http://www.remi.com/products/pi

3. Map region specific, project direct effects into economic changes for the model to understand.
4. Adjust the model to reflect these program-related economic changes, and rerun the model.
5. Extract the resulting regional annual total employment impacts (total equals direct plus indirect plus induced impact cycles) and sum for the national level result.

To estimate employment effects and other macroeconomic changes from SEP spending, key information was assembled from the BPAC impact estimation process. For example, estimated energy bill savings, incremental project costs, and direct expenditures for program operations and support services were used as key input data to the macroeconomic analysis.

Changes in the model output from the baseline represented the change caused by the introduction of the additional ARRA-period spending and the ensuing cycle of net energy savings by different customer segments. The impact is the resulting estimated annual change in employment from what it would have been without the policy change. The change can be shown as a difference from the baseline or as a percentage change. **Figure 35** depicts this sequence of analysis.

In a multiregional REMI model, an economic event in one region will have varying spillover effects on surrounding regions. Triggered by the policy or investment, these effects result from preexisting patterns of labor flows, interregional business transactions, and changes in relative competitiveness.

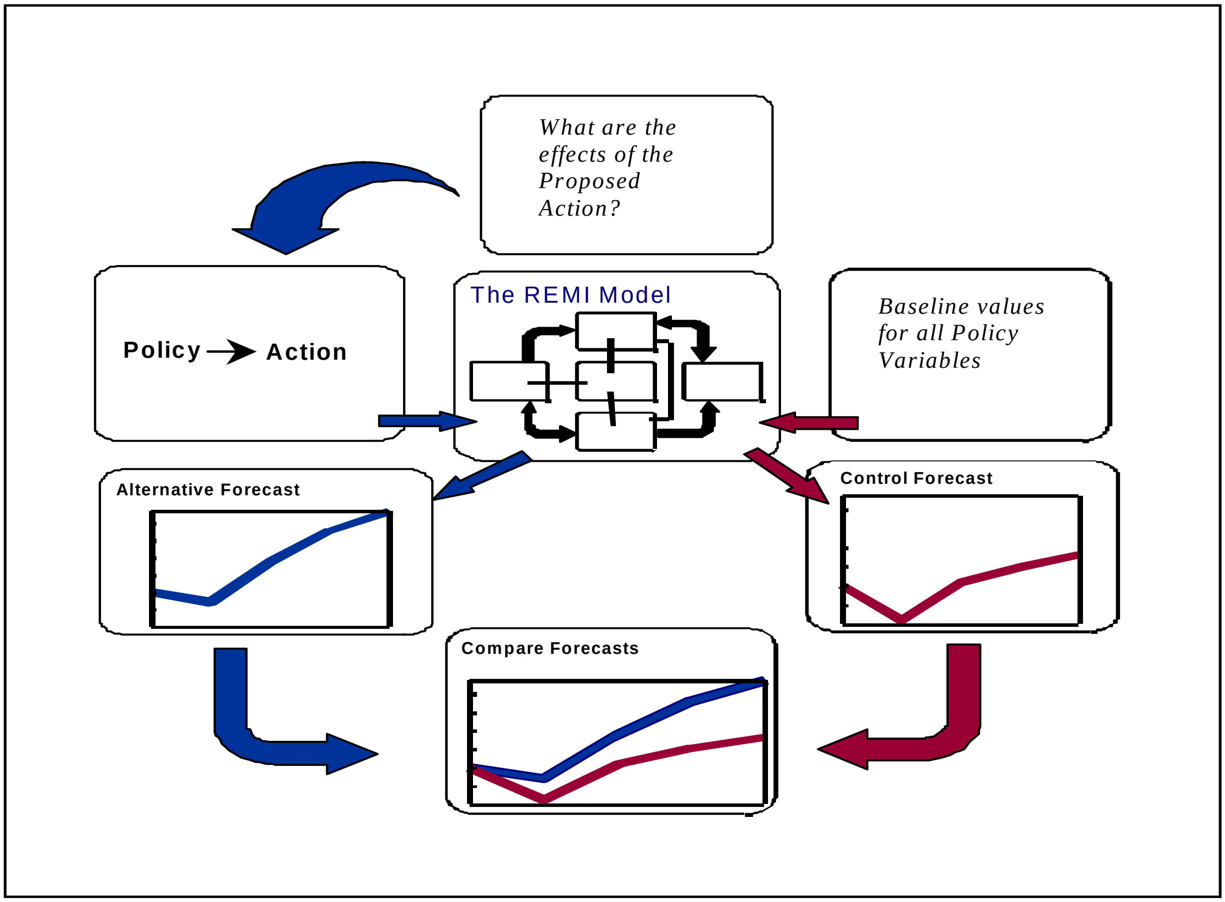

Figure 35: Identifying annual economic impacts with a REMI model

Due to the timing of this analysis, the REMI economic baseline dataset already includes spending effects on employment from SEP in PY 2008. SEP spending in PY 2008 is extremely small relative to the size of the total U.S. economy. To determine the macroeconomic activity of SEP PY 2008 from REMI's existing base-case economic projection, we used the model inputs from the PY 2008 evaluation dataset. However, these data were inserted into the REMI model as though repeating the investment and ensuing net energy savings. The change in the output represents the increment due to SEP PY 2008 activity. Unlike the ARRA-period, this output was not added back into the national economy because it represents a portion of the existing baseline and not an overall incremental change.

H.2.2.1 Analytical process

The SEP contractor team developed a series of BPAC expenditures and bill savings representing a time series (for the interval 2008, or 2009 through 2050) for each of the PY 2008 and ARRA-period BPACs. To support the macroeconomic analysis, program activities were divided into customer segments (residential, commercial, industrial, public institutional, and private institutional) and then by region. A high-level flowchart of this process is shown in **Figure 36**.

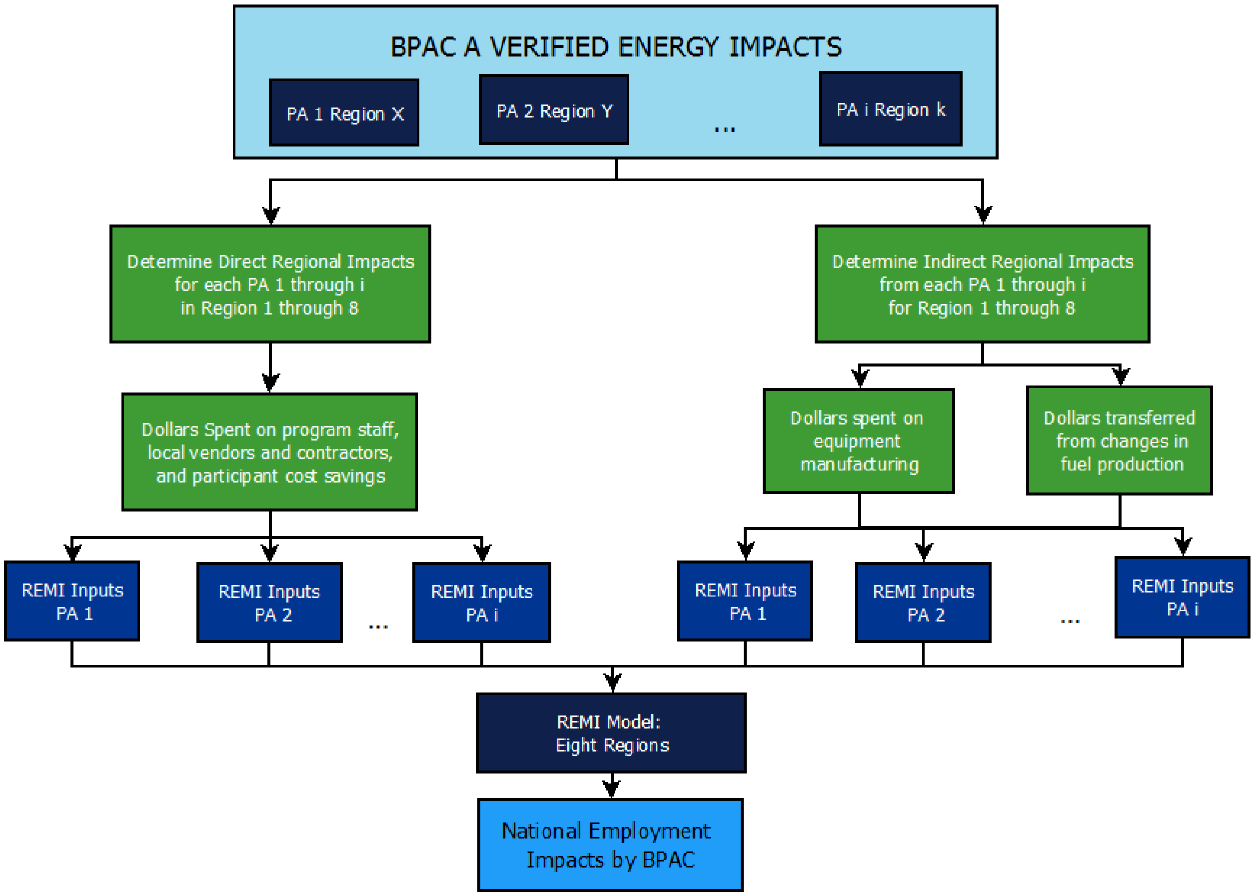

Figure 36: PA level data to national employment impacts

The dataset for each BPAC has administrative costs, incentive/rebate costs, incremental project costs, loan costs, and estimated energy bill savings from reduced electricity, natural gas, or other fuel consumption. Incremental project costs were broken out by BPAC Subcategory for labor and purchases.

Given that the sampling plan has posed challenges to extrapolating to 51 states, the contractor team used an eight-region model rather than a 51-state model. Using an eight-region model reduced the challenges associated with expanding sample-derived PA-specific impacts into workable economic regions for the macroeconomic impact analysis. Instead of looking at out-of-state impacts at the individual state level, we look at impacts by major economic regions defined by the U.S. Bureau of Economic Analysis. These regions are broken up into groups of states that are geographically and economically similar. The contractor team assigned labor and equipment costs and the effects of fuel displacement as “within region” or to one of the remaining seven economic regions.

Applying a set of assumptions to the steps in Section H.2.2 make it possible to map or translate these concepts into a set of interactions initiated by the program activities that alters the baseline macroeconomic trajectory across each region.

H.2.2.2 Modeling PY 2008 and ARRA-period activities in REMI

To create an alternative macroeconomic forecast across the eight sub-national regions, costs and economic benefits were entered into the REMI analysis model for each BPAC as described:

- Labor dollars for the installation of any project were considered local labor compensation payments by sector (defined at the two-digit NAICS code level). The projects supported under SEP rely on labor-intensive activities such as retrofits and retrofit-related BPACs, construction labor (23), and professional and technical services (54).
- "Equipment" dollars represented the energy upgrade measures installed through the SEP program. U.S.-made equipment is procured across the eight model regions' manufacturing sectors according to allocations presented above.
- Incentives and rebate dollars were applied to project costs to reduce the cost of projects to participants.
- Financing cost payment flows were determined using program-specific interest rates and loan durations. Energy savings associated with future loans were dollar constant based on initial program loan dollar to energy savings ratios.
- Financing cost flows were deducted from estimated energy bill reductions to determine net energy-bill dollar flows, which affect changes in the cost of living in the residential segment and the cost of doing business in the commercial, industrial, and institutional private customer segments.
- Incremental projects costs were restated as net project costs by deducting incentives and rebates.
- Program operations spending (apart from incentives and financing) included state government employee compensation for day-to-day program activities.
- Renewable manufacturing labor costs resulting from expanded operations were treated as wages rather than participant costs.

H.3. ASSUMPTIONS

Key assumptions in the analysis of labor impacts using the REMI model are listed below:

- All analyses were standardized on and reported as 2009 dollars.
- Revolving loan program interest rates and terms varied across regions according to program documentation. The "re-loan" period was standardized at 1-year. Principal and interest collected was "re-loaned" each year for the same term and interest rate. In addition, energy savings remained at the same loan dollar to energy savings ratio as the original loan. Loan repayment begins one year after loan disbursement.
- Gross project cost was the basis for creating the "demands" allocated between energy-efficient (or renewables) equipment and labor for installation/inspection/audit activities.
- Each region contained an allocation of EE manufacturing activity for sourcing equipment as explained in Section 1.1.1.4.

- Program-administration costs (net of the incentive and financing budgets) were modeled as labor payments for state and local government employees to run day-to-day aspects of the program.
- The participant's estimated net energy bill savings were specified after considering any future stream of loan repayment cost. Loan repayments began one year following disbursement of funds.
- Net energy-bill savings streams for programs were estimated over the period of analysis, which for most programs is consistent with the program's savings-weighted average measure life.
- Bill savings were calculated using actual and EIA forecast state-average retail rates by sector and fuel type.
- Direct expenditures on project labor occurred in the region where the project was implemented. The contractor team developed these allocations by BPAC and sector as inputs to the REMI modeling process. Data sources included; the DEER database, prior DNV GL research reports, expert interviews, NREL reports, and PNNL models. The final allocations are shown in **Table 30**.

Table 30: Equipment and labor cost allocations

BPAC	Subcategory	Sector	Equipment	Labor
CEPS_08	Policy and market studies	RES	TBD by PA	TBD by PA
CEPS_08	Policy and market studies	COM	TBD by PA	TBD by PA
CEPS_08	Policy and market studies	IND	TBD by PA	TBD by PA
CEPS_08	Policy and market studies	INT_PB	TBD by PA	TBD by PA
CEPS_08	Policy and market studies	INT_PR	TBD by PA	TBD by PA
TA_08	Generalized workshops and demonstrations	All	0.65	0.35
TA_08	Target training / certification	All	0.65	0.35
TA_08	TA to Building owners	All	0.65	0.35
LGI_08	Alternate fuels, Ride shares and traffic opt	All	0.36	0.64
LGI_08	Generalized workshops and demonstrations	All	0.65	0.35
LGI_08	TA to Building owners	All	0.65	0.35
LGI_08	BR: Res	RES	0.65	0.35
BR_08	BR: Res	RES	0.65	0.35
BR_08	BR: Nonres	All	0.65	0.35
BR_08	Generalized workshops and demonstrations	All	0.65	0.35
BR_08	Target training / certification	All	0.65	0.35
BR_08	TA to Building owners	All	0.65	0.35
CS_ARRA	Building Codes and Standards: Codes	All	0.80	0.20
CS_ARRA	Generalized workshops and demonstrations	All	0.65	0.35
CS_ARRA	Target training / certification	All	0.65	0.35
BR_ARRA	BR: Res	RES	0.65	0.35
BR_ARRA	BR: Nonres	All	0.65	0.35
BR_ARRA	Generalized workshops and demonstrations	All	0.65	0.35
BR_ARRA	Target training / certification	ALL	0.65	0.35
LGI_ARRA	Generalized workshops and demonstrations	ALL	0.65	0.35
LGI_ARRA	Renewable Energy Market Development: Mfg	IND	0.65	0.35
LGI_ARRA	Target training / certification	ALL	0.65	0.35
LGI_ARRA	BR: Res	RES	0.65	0.35
LGI_ARRA	BR: Nonres	ALL	0.65	0.35
LGI_ARRA	Renewable Energy Market Development: Prj	RES	0.86	0.14
LGI_ARRA	Renewable Energy Market Development: Prj	COM	0.88	0.12
LGI_ARRA	Renewable Energy Market Development: Prj	IND	0.90	0.10
LGI_ARRA	Renewable Energy Market Development: Prj	INT_PB	0.87	0.13
LGI_ARRA	Renewable Energy Market Development: Prj	INT_PR	0.87	0.13
REMD_ARRA	Generalized workshops and demonstrations	ALL	0.65	0.35
REMD_ARRA	Renewable Energy Market Development: MFG	IND	0.90	0.10
REMD_ARRA	Renewable Energy Market Development: Prj	RES	0.86	0.14
REMD_ARRA	Renewable Energy Market Development: Prj	COM	0.88	0.12
REMD_ARRA	Renewable Energy Market Development: Prj	IND	0.90	0.10
REMD_ARRA	Renewable Energy Market Development: Prj	INT_PB	0.87	0.13
REMD_ARRA	Renewable Energy Market Development: Prj	INT_PR	0.87	0.13
REMD_ARRA	Target training / certification	All	0.65	0.35

- Participant costs (out-of-pocket costs for energy retrofit and upgrade projects) were the incremental project costs minus any rebate or other form of incentive. In most cases, these data were not available or were incomplete. To overcome this lack of cost data, the contractor team developed a model incremental-cost calculator to estimate the incremental project costs based on reported incentives, bill savings, and assumed payback periods for each Subcategory. These incremental equipment and labor costs along with the energy and bill savings datasets.

  The contractor team's approach to calculating incremental costs relied on the available data and assumptions on typical participant simple payback grounded in evaluation experience. Given an assumed typical payback period, the calculator solves for incremental costs using participant out-of-pocket expenses after rebates. Formally the equation is,

  Total Incremental Costs =

$$\sum_{i \to all\ program\ years} \left[\left(\left(\frac{SEP\ Attributable\ Incentives_i}{Total\ SEP\ Attributable\ Incentives} \right) \times \sum_{Payback\ period} Net\ Measure\ \$\ Savings\ (Bill\ Savings) \right) + SEP\ Attributable\ Incentives_i \right]$$

  i= specific program year

Table 31 shows the Subcategories included in our evaluation as well as the associated payback period we recommend using in the incremental cost calculator. Because payback periods can vary by type of renewable technology, the team plans used payback periods specific to the type of technology under review rather than one use assumption for all renewable projects. When information was available and documented for a specific PA, those data were incorporated into the incremental equipment and labor calculations.

Table 31: Payback period assumptions for incremental cost calculator

Subcategory/ Renewable Technology	Payback Period Assumption	Source
Policy and Market Studies; Legislative Support	Varies: Payback assumption made based on type of program	N/A
Building Retrofits: Nonresidential	4 years	A typical IRP filing assumes a customer payback of 2 years for retrofit projects. From our observation, the SEP PAs tend to face different barriers in the government sector, so we propose a longer payback period of 4 years. Sources for two-year payback periods include: HECO Payback Assumptions EPA consumer perspectives.pdf Deleware IRP Appendix Montana-Dakota IRP
Building Retrofits: Residential	4 years	
Technical Assistance to Building Owners	4 years	
Targeted Training and/or Certification (participants are traceable)	4 years	
Generalized Workshops and Demonstrations (Participants maybe traceable)	4 years	

Subcategory/ Renewable Technology	Payback Period Assumption	Source
Building Code Development and Support	User defined: These PAs will not use the incremental cost calculator but rely on secondary sources.	N/A
Alternative Fuels, Ride Share, and Traffic Optimization	User defined: These PAs will not use the incremental cost calculator but rely on secondary sources.	N/A
Renewable Energy Market Development: Projects- Residential Solar	11 years	Average of the following three sources: Output Performance and Payback Analysis of a Residential Photovoltaic System in Colorado Calculating Payback for a Solar Energy System Maine's Solar Industry: Technologies, workforce, market statistics, and Maine's position in the national solar industry
Renewable Energy Market Development: Projects – Nonresidential Solar	20 years	NREL FEMP Screening MAP: Took average across low and high payback states. We reduced their payback estimates by 30% assuming 30% incentive. Could do a state specific query if necessary.
Renewable Energy Market Development: Projects –Wind	14 years	NREL Wind Payback Calculator: NREL default was around 20 years. When assuming an incentive of about 30% we reduced payback to around 14 years.
Renewable Energy Market Development: Projects – Biomass (anaerobic digester – cattle waste)	5 years	Managing Manure with Biogas Recovery Systems. Improved Performance at Competitive Costs.
Renewable Energy Market Development: Projects – Residential Geothermal	Northeast: 6 Midwest: 7 South: 18 West: 14	Ground-Source Heat Pumps: Overview of Market Status, Barriers to Adoption, and Options for Overcoming Barriers: Gives different ranges by region and baseline fuel type. Used RECS fuel use by region to decide how to weight the ranges. Used mid-point of each range for successful R&D, which assumed 30% reduction in geothermal system cost – using as proxy for incentive.
Renewable Energy Market Development: Projects- Residential Solar Thermal	15 years	Average of the following three sources: Maine's Solar Industry: Technologies, workforce, market statistics, and Maine's position in the national solar industry

Subcategory/ Renewable Technology	Payback Period Assumption	Source
Renewable Energy Market Development: Projects – Nonresidential Solar Thermal (water heating)	12	Financial Analysis of Residential PV and Solar Water Heating Systems NREL FEMP Screening MAP: Took average across low and high payback states. We reduced their payback estimates by 30% assuming 30% incentive. Could do a state specific query if necessary.
Renewable Energy Market Development: Projects- Nonresidential Solar Thermal (air heating)	5	Solar Thermal Technology & Applications
Renewable Energy Market Development: Manufacturing	These PAs will assume the same payback periods as the Renewable Energy Market Development: Projects Nonresidential PAs.	N/A

H.4. REFERENCES

Helper, Susan, Timothy Krueger, Howard Wail, "Locating American Manufacturing: Trends in the Geography of Production," Brookings Institute, April 2012 http://www.brookings.edu/research/interactives/manufacturing-interactive

Regional Economic Models, Inc. REMI PI+ V1.6 model equations, 2014. http://www.remi.com/products/pi

U.S. Census Bureau, Manufactures: Manufactures—Establishments, Shipments, Employees, Payroll, series 12s1012, https://www.census.gov/compendia/statab/cats/manufactures/manufactures--establishments_shipments_employees_payroll.html

APPENDIX I. DETAILED CARBON IMPACT METHODOLOGY

I.1. INTRODUCTION

Annualized CO_2 reductions achieved as a result of SEP-funded efforts were calculated and reported for each year over the EUL of the measures evaluated. When the consumption of energy from fossil fuel resources is reduced from energy efficiency, the CO_2 emissions that would have resulted from burning those fuels are avoided. Likewise, when renewable energy is used as an alternative to fossil fuels, the CO_2 emissions associated with the replaced fuels are avoided. The use of biofuels for transportation also leads to reduced CO_2 emissions as the biofuels have lower carbon intensity than conventional transportation fuels. The evaluation team reviewed the use of biofuels for energy generation and incorporated additional CO_2 savings for instances where the biomass source represents a carbon sink before being harvested for use in energy generation.

Findings will be presented by BPAC and study period (PY 2008 and ARRA). Key avoided carbon emissions impact metrics are as follows:

- Avoided annual carbon emissions in million metric tons of carbon equivalent (MMTCE) (2009-2050)
- Total avoided carbon emissions in MMTCE by sector
- Total avoided carbon emissions in MMTCE by program mechanism
- Avoided annual social costs in U.S. dollars (2009-2050)
- Total avoided social costs of carbon emissions in U.S. dollars by sector
- Total avoided carbon emissions in U.S. dollars by program mechanism.

I.2. METHODS

I.2.1. Analysis approach

Carbon impacts were calculated by applying the appropriate emission rates to the verified SEP-attributable energy impacts from each BPAC. For renewable generation, the emission rates were applied to the energy displaced from renewable energy generated. State-level emission rates were applied to electricity savings and conventional electricity displacement from renewable sources since the mix of fuels used to generate electricity varies regionally. Because emission rates from fuels (e.g., natural gas, oil, and propane) do not vary much by region, only one emission rate was needed for each such fuel type. The appropriate emission rates were applied to the SEP-attributable energy savings from energy efficiency or energy displaced from renewable generation and aggregated to the BPAC level. A subset of programmatic activities, alternative transportation and some biomass-related PAs, had direct carbon impacts that did not correlate with energy savings or generation in the same way energy efficiency savings do. In these instances, the carbon savings were calculated separately using PA-specific data.

Emissions from energy efficiency, energy displaced from renewable generation, and direct carbon impacts were then aggregated to determine the total carbon impact for each BPAC. This process is shown in **Figure 37**.

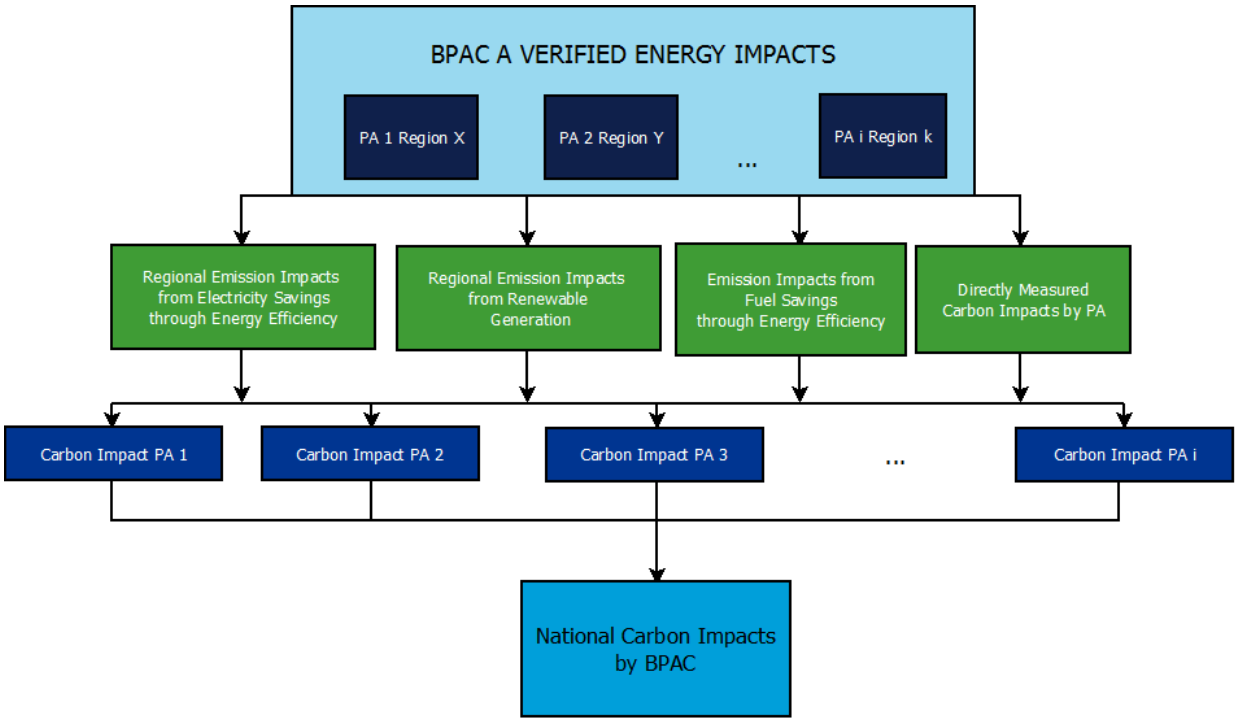

Figure 37: Analysis approach for national carbon impacts by BPAC

I.3. ASSUMPTIONS

I.3.1. Electricity impacts from energy efficiency

EPA recommends[49] that non-baseload emission rates be used to estimate emission savings resulting from energy efficiency and renewable energy programs. Non-baseload emission rates estimate the emissions from marginal generation units, which are those most likely to be displaced by electricity energy efficiency and/or renewable energy programs and projects. As such, the non-baseload emission rates used for this evaluation were derived from the EPA's 2009 Emissions & Generation Resource Integrated Database (eGRID) which provides non-baseload emission rates by state and emission type. The carbon dioxide equivalent emission rates used for this evaluation were calculated using the state-level carbon dioxide, methane, and nitrous oxide emission rates included in this database.

eGRID only reports emission rates for the 51 states; U.S. Territories are not included. Emission rates from the 51 states were not used as a proxy for the territories because the generation mix of the states was not

[49] E.H. Pechan & Associates, Inc., "The Emissions & Generation Resource Integrated Database for 2010 (eGRID2010) Technical Support Document," Prepared for the U.S. Environmental Protection Agency, Office of Atmospheric Programs, Clean Air Markets Division, Washington, D.C., December 2010.

comparable to the territories. Instead, the evaluation team used 2010 total facility emissions from EPA's Greenhouse Gas Reporting Program[50] and 2010 net electricity generation from EIA[51] to calculate an average lb/MWh. Given the data limitations, it was not possible to calculate non-baseload emission rates. Furthermore, these data were only available for Guam, Puerto Rico, and the Virgin Islands, so the calculated Guam emission rate was also used for The Mariana Islands and American Samoa based on their proximity to each other.

Electricity savings from energy efficiency and on-site generation only represents what is saved by the consumer. Those savings do not include line losses from transmission and distribution and therefore do not equal the total amount of energy displaced. The evaluation team adjusted these savings estimates to reflect the amount of energy saved at the generator by applying regional line loss factor[52] from eGRID year 2009 data to the state-level energy savings. We used the line loss factor from Hawaii for the territories. The line loss factors used for this evaluation are shown in **Table 32**.

Table 32: eGRID estimated grid gross loss factor

Region	Line Loss Factor (%)
Eastern	5.82
Western	8.21
ERCOT	7.99
Alaska	5.84
Hawaii/Territories	7.81
U.S.	6.50

I.3.2. Fuel impacts from energy efficiency

Emission rates from fuels (e.g., natural gas, oil, and propane) do not vary regionally like emission rates associated with electricity generation. As such, we used one national level emission rate for all fuels. Fuel emission rates were derived from the carbon dioxide, methane, and nitrous oxide emission rates included in EPA's Climate Leaders Greenhouse Gas Inventory Protocol.53 Line losses of 7.00% were added to the natural gas savings as well.[54]

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50 U.S. Environmental Protection Agency. GHG Reporting Program Data Sets, http://www.epa.gov/ghgreporting/ghgdata/reportingdatasets.html. May, 2014.

51 U.S. Energy Information Administration, International Energy Statistics, http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=2&pid=2&aid=12&cid=AQ,GQ,RQ,IQ,US,VQ,&syid=2010&eyid=2010&unit=BKWH. May, 2014.

52 A line loss factor is a multiplier that can be used to extrapolate energy saved at the generator level from energy saved at the consumer level.

53 U.S. Environmental Protection Agency, OAR, Climate Protection Partnerships Division. Climate Leaders Greenhouse Gas Inventory Protocol, http://www.epa.gov/climateleadership/documents/resources/stationarycombustionguidance.pdf, June, 2014.

54 U.S. Energy Information Administration, Annual Energy Review, August 19, 2010.

I.3.3. Impacts from renewable generation

The evaluation team determined what sort of conventional generation was displaced by all renewable energy generation evaluated so we could better determine what carbon impacts were associated with these programs. eGRID emission rates were applied to grid electricity displaced due to renewable generation, as recommended by EPA. The same process described above was used to create emission impacts from electricity displacement. Similarly, we used the fuel emission rates developed for energy efficiency savings when estimating the carbon impacts from renewable generation that displaced fuel use.

Typically, it is assumed that biomass generation is carbon neutral because the source would have emitted the same greenhouse gases through decay that were emitted when burned for generation purposes. As such, energy displacement due to biomass generation was evaluated in the same way as other renewable generation—emission factors were applied to the displaced energy. However, in some instances, the evaluation team felt that the biomass source was not carbon neutral and recorded the difference as a direct carbon impact. More information on these calculations is included in the next section.

I.3.4. Directly measured carbon impacts

The PY 2008 Loans, Grants, and Incentives BPAC contained a Subcategory of programs that were designed to promote and support alternative transportation fuels. In these programs, carbon impacts were achieved through fuel switching to a lower-carbon fuel. To address these impacts, the evaluation team used the GREET model[55] and PA-specific data to determine the amount of carbon saved from the use of alternative transportation fuels. A more detailed description on the use of this model is explained in Appendix H.

Since these savings are occurring in the transportation fleet of municipal or commercial facilities, we are presenting these impacts in the report as part of the transportation sector and not in the institutional or commercial sectors.

As mentioned above, the evaluation team considered whether there was an additional carbon impact where biomass generation was supported. In those cases where biofuels represented a carbon sink, the DOE National Energy Technology Laboratory Unit Process Library was used to calculate the direct carbon impact associated with the particular biomass source under review.[56]

[55] https://greet.es.anl.gov/

[56] http://www.netl.doe.gov/research/energy-analysis/life-cycle-analysis/unit-process-library

I.4. AVOIDED SOCIAL COSTS OF CARBON IMPACTS

I.4.1. Methods and assumptions for social cost of carbon impacts

This evaluation also considered the monetary impact associated with carbon emissions. The team monetized the carbon impacts associated with SEP-funded programs by using the social cost of carbon (SCC) from the following sources for the listed years:

- 2010-2050: Technical Support Document- Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis- Under Executive Order 12866.[57]
- 2008-2009: EERE Standard Impact Evaluation Method - Evaluating Realized Impacts of DOE/EERE R&D Programs.[58,59]

The social cost of carbon estimates provided in the above-named technical support document were developed by modelling the economic impacts associated with increases in temperature due to incremental carbon emissions. They are derived from three integrated assessment models: DICE,[60] PAGE,[61] and FUND.[62] While the methodology and calculations behind each model vary, the economic impacts are generally a function of climate processes, economic growth, and feedback between the climate and global economy. As shown in **Table 33**, the costs increase over time. This is due to the increased strain each marginal metric ton of carbon dioxide will have on the system; the three models assume that incremental emissions in later years cause more damage than previous emissions since they are being added to an already stressed system.

57 U.S. Interagency Working Group on Social Cost of Carbon, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, May 2013. http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf.

58 Ruegg, Rosalie et al. EERE Standard Impact Evaluation Method: Evaluating Realized Impacts of DOE/EERE R&D Programs, August 2014. http://www1.eere.energy.gov/analysis/pdfs/evaluating_realized_rd_mpacts_9-22-14.pdf

59 The technical support document only provides social cost of carbon values for 2010-2050. Historical SCC values were generated in the 2014 EERE Standard Impact Evaluation Method.

60 DICE: Duration, Integrity, Commitment and Effort, http://dice.bcg.com/

61 PAGE: http://www.jbs.cam.ac.uk/fileadmin/user_upload/research/workingpapers/wp1104.pdf

62 FUND: Climate Framework for Uncertainty, Negotiation, and Distribution. http://www.fund-model.org/

Table 33: Social cost of carbon (2009 $/MMTCO$_2$)[63, 64, 65]

Discount Rate	5%	3%	2.50%	3%
Year	Average	Average	Average	95th Percentile
2008	11	31	50	84
2009	11	32	51	87
2010	11	33	52	90
2015	12	38	58	109
2020	12	43	65	129
2025	14	48	70	144
2030	16	52	76	159
2035	19	57	81	176
2040	21	62	87	192
2045	24	66	92	206
2050	27	71	98	221

The evaluation team used the social cost of carbon estimates associated with the 2.5% discount rate because that is closest to the 2.7% 2009 real discount rate being used in the rest of the evaluation.

The annual monetary impacts of carbon emissions by BPAC were calculated after the annual energy impacts by BPAC were determined. The annual carbon impact by BPAC was multiplied by the social cost of carbon value for each year to create annual cost estimates.

I.5. REFERENCES

E.H. Pechan & Associates, Inc., "The Emissions & Generation Resource Integrated Database for 2010 (eGRID2010) Technical Support Document," Prepared for the U.S. Environmental Protection Agency, Office of Atmospheric Programs, Clean Air Markets Division, Washington, D.C., December 2010.

NETL. Unit Process Library. http://www.netl.doe.gov/research/energy-analysis/life-cycle-analysis/unit-process-library.

Ruegg, Rosalie et al. EERE Standard Impact Evaluation Method: Evaluating Realized Impacts of DOE/EERE R&D Programs, August 2014. http://www1.eere.energy.gov/analysis/pdfs/evaluating_realized_rd_mpacts_9-22-14.pdf

U.S. Environmental Protection Agency. GHG Reporting Program Data Sets. http://www.epa.gov/ghgreporting/ghgdata/reportingdatasets.html. May, 2014.

63 Dollars were converted to 2009 using the following Inflation Adjustment Formula: Current Year Price x (Base Year CPI ('09)/ Current Year CPI); where CPI is GDP Chain-type Price index as reported by EIA for 2011 and 2012.

64 The average options represent the average dollar economic impacts expected in each model. The 95th percentile option represents the SCC (with a 3% discount rate) from less likely, but more damaging economic impacts from increases in global temperature.

65 The discount rates used in this table are social discount rates. A higher discount rate implies consumers place a lower value on the future impacts of carbon.

U.S. Energy Information Administration, International Energy Statistics, http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=2&pid=2&aid=12&cid=AQ,GQ,RQ,IQ,US,VQ,&syid=2010&eyid=2010&unit=BKWH. May, 2014.

U.S. Environmental Protection Agency, OAR, Climate Protection Partnerships Division. Climate Leaders Greenhouse Gas Inventory Protocol, http://www.epa.gov/climateleadership/documents/resources/stationarycombustionguidance.pdf, June, 2014.

U.S. Energy Information Administration, Annual Energy Review, August 19, 2010.

U.S. Interagency Working Group on Social Cost of Carbon. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf, May 2013.

APPENDIX J. DETAILED BILL SAVINGS AND COST-EFFECTIVENESS METHODOLOGY

J.1. INTRODUCTION

This section describes the methods, metric inputs, assumptions and sources for customer bill savings estimation and cost-effectiveness analysis. Findings throughout this report are presented by BPAC and study period. Key indicators used in this report are as follows:

- Annual customer bill savings (2009-2050) and total customer bill savings by fuel and sector
- SEP Recovery Act Cost (RAC) Test
- Present value ratio comparing bill savings to program expenditures.

J.1.1. Customer bill savings estimation

Customer bill savings were estimated for energy savings and on-site generation by first estimating energy and generation impacts for each BPAC at the state level, and then applying appropriate retail energy rates. Retail rates for electricity, natural gas and other fuels are sourced from the EIA's State Energy Data System (SEDS).[66] These rates include fees, surcharges, and taxes collected by the utility even those taxes eventually remitted to a government authority.[67] All bill savings are expressed in constant 2009 dollars and are the same bill savings streams used in the labor and economic impacts analysis.

J.1.2. PY 2008 and ARRA-period performance metrics

Although the ARRA-period gave preference to activities that could be started and completed expeditiously, ARRA goals went beyond energy savings. ARRA sought to accelerate near-term deployment of energy efficiency and renewable technologies, meet U.S. energy security, economic vitality, and environmental quality objectives, and develop and adopt leading market transformation initiatives. Multiple metrics were developed to assess these activities:[68]

1. Jobs created
2. GHG emissions reduced (CO_2 equivalents)
3. Energy (kWh/therm/gallon/Btu/etc.) saved

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[66] U.S. Energy Information Administration's (EIA), http://www.eia.gov/state/seds/
Electricity Prices -
Natural Gas Prices - http://www.eia.gov/dnav/ng/ng_pri_sum_a_epg0_prs_dmcf_a.htm

[67] U.S. Energy Information Administration, State Energy Data 2012: Prices and expenditures. Section 3. Natural Gas, page 29. Section 6. Electricity, page 119. www.eia.gov/state/sep_prices/notes/pr_elec.pdf

[68] U.S. Department of Energy, Financial Assistance Funding Opportunity Announcement, State Energy Program Formula Grants, American Recovery and Reinvestment Act (ARRA), CFDA Number: 81.041, State Energy Program, March 12, 2009, p.24; http://www.energy.ca.gov/recovery/documents/SEP_Recovery_Act_Guidance_DE-FOA-00000521.pdf (accessed December 12, 2013).

4. Renewable energy installed capacity and generation
5. Energy cost savings
6. Funds leveraged.

Benchmark performance criteria were not established for PY 2008. For comparison purposes however, we apply the ARRA-period metrics to PY 2008 funding activity.

This section addresses only Metric 5, energy cost savings.[69] The first calculation discussed below is the SEP RAC test. The second is a ratio of the present value of savings over program funding (present value ratio or PVR). The flow chart in depicts how collected data flows into each metric.

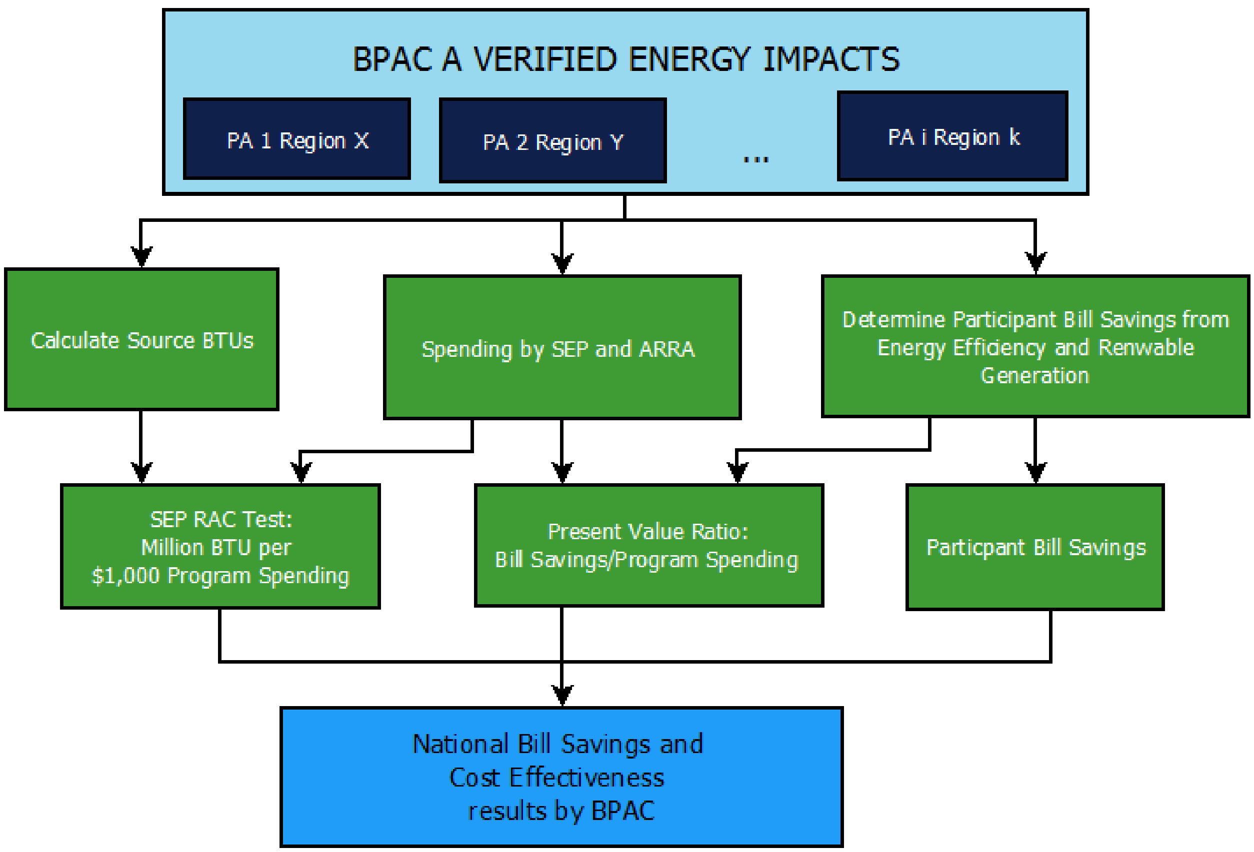

Figure 38: Flow from data to metrics

[69] Metrics 1 and 2 (jobs created and avoided carbon emissions) are addressed separately. Metric 6 is not addressed in this study.

J.1.2.1 State energy program Recovery Act Cost test

The SEP RAC test was created by DOE for states to use when designing and evaluating their program portfolios under ARRA.[70] According to DOE guidance, the ratio was to be applied during pre-implementation planning[71] and post-implementation evaluation at the portfolio, not program, level. This evaluation reports SEP RAC test results applied to studied BPACs for PY 2008 and ARRA-period.

The SEP-RAC test is expressed in average annual million Btu (MMBtu) of source energy saved or generated per $1,000 of program expenditures. To be considered cost-effective by DOE, portfolios (not individual programs) should achieve annual savings of at least 10 MMBtu per year, per $1,000 of SEP or Recovery Act expenditures. Funds leveraged from other programs such as utility or municipal programs are not included.

For this analysis, representative one-year Btu savings initially are calculated at the measure level, converted to source Btu by fuel type and then expanded to the PA level. These values are then expanded to regional BPAC levels, as opposed to the national level, so they can be multiplied by the regional energy rates to create bill savings.

The formula for the RAC is,

$$\text{RAC BPAC1} = \frac{MMBtu_a}{PgmExp}$$

Where,

MMBtua = Sum of BPAC annual source MMBtu savings

PgmExp = Administration + Grants + Rebates.

Loans are not included as a program expense since those dollars are returned to state energy office in the form of principal and interest loan repayments.

Similarly to the Energy Impacts, the SEP RAC test energy is calculated at the source level, which provides a consistent way to measure portfolio cost-effectiveness across regional fuel mixes. Site to source conversion values are presented in Section J.2. The EPA specifies a national average site-source conversion factor of 3.34 for electricity, meaning that delivery of 1.0 kWh of electricity to a site uses an average of 3.34 kWh of raw fuel.[72]

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70 "There are no other cost-effectiveness test requirements for SEP Recovery Act project portfolios. The cost-effectiveness test normally required within state regulatory environments that are focused on least cost net present value energy supplies do not apply to the SEP Recovery Act projects. DOE's objective is to achieve deep lasting savings that provide net energy efficiency, renewable energy, carbon reductions and job impacts well into the long-term future of the United States. State Energy Program Notice 1-001 and EECBG Program Notice 11-001, January 21, 2011. http://energy.gov/sites/prod/files/2014/01/f7/11_001_eecbg_sep_building_best_practice.pdf (accessed April 29, 2014).

71 U.S. Department of Energy, Financial Assistance Funding Opportunity Announcement, State Energy Program Formula Grants, American Recovery and Reinvestment Act (ARRA), CFDA Number: 81.041, State Energy Program, March 12, 2009, p.28; http://www.energy.ca.gov/recovery/documents/SEP_Recovery_Act_Guidance_DE-FOA-00000521.pdf (accessed December 12, 2013).

72 ENERGY STAR Performance Rating Methodology for Incorporating Source Energy Use, March 2011, http://www.energystar.gov/ia/business/evaluate_performance/site_source.pdf. (accessed October 1, 2014).

SEP RAC test results are presented from a building perspective, which evaluates cost effectiveness of energy savings and renewable energy generation, and from a system perspective, which evaluates cost effectiveness of energy savings and conventional energy displaced by renewable generation. The substantive distinction between the SEP RAC test from the building and system perspectives is the treatment of on-site renewable generation. From the building (consumer facility) perspective, on-site generation is considered supplemental electricity that does not incur transmission or production losses. From the system (electric grid) perspective, on-site generation replaces a need for conventional electricity generation such that the total displaced electricity is used in the RAC test numerator. In contrast, utility-scale renewable generation is always assumed to displace conventional electricity.

J.1.2.2 Present value ratio

The second approach creates a ratio that compares participant bill savings (benefits) to SEP program expenditures. A ratio greater than 1.0 means the present value of the bill savings for the life of the installed equipment is greater than total program spending. A ratio less than 1.0 means that program spending is greater than any energy bill savings resulting from SEP program activity.

The formula for this PVR is,

$$PVR = \frac{PV(B)}{PV(C)}$$

Where,

$$\mathrm{PV(B)} = \sum_{t=1}^{n} \frac{Part\_Bsvgs}{(1+d)^{t-1}}$$

Part_Bsvgs = the sum of participant annual energy saved or generated multiplied by state annual average retail rates by sector and fuel type, at the BPAC level

$$\mathrm{PV(C)} = \sum_{t=1}^{n} \frac{Pgm\_spend}{(1+d)^{t-1}}$$

Pgm_spend = the sum of program spending due to program activities at the BPAC level. Costs include expenditures for program administration, grants, incentives, and rebates.[73]

The PVR is reported under three discount rates to assess the sensitivity of the results. The primary discount rate used throughout the analysis is the average yield on the 30-year U.S. Treasury bond in 2009 (2.7%). Present value ratio also is calculated using discount rates of 0.7% and 4.7%.

[73] Excludes non-SEP funding (e.g. utility rebates that would have been issued independently of SEP).

J.2. KEY ASSUMPTIONS AND INPUTS

Many elements are used to perform the cost-benefit analysis described above. This section identifies these elements, their development, and proposed sources.

J.2.1. Energy savings to Btu

The SEP-RAC test requires that all site energy savings and generation be converted to Btu for comparison purposes. To do this, the following multipliers in **Table 34** are used.

Table 34: Site energy savings to source Btu conversion factors

Site Converted Savings	Site Btu Equivalent
Electricity (1 kWh)	3,412 Btu
Natural Gas (1 Therm)	100,000 Btu
Oil (1 Therm)	100,000 Btu
Propane (1 Therm = 1.1 gallons)	100,000 Btu
Kerosene (1 Therm)	100,000 Btu
Wood (MBTU)	100,000 Btu
Diesel (MBTU)	1,000 Btu
Ethanol (MBTU)	1,000 Btu
Gasoline (MBTU)	1,000 Btu
Other (MBTU)	1,000 Btu

Furthermore, Btu savings at the site level are to be converted to energy savings achieved at the power plant (source savings). Source savings also are expressed in Btu. Site Btu is converted to source Btu using the multipliers in **Table 35**.[74]

Table 35: Site to source Btw conversion factors

Fuel Type	Source-Site Ratio
Electricity (grid purchase)	3.34
Electricity (on-site solar or wind Installation)	1.00
Natural Gas	1.047
Fuel Oil (1,2,4,5,6, Diesel, Kerosene)	1.01
Propane & Liquid Propane	1.01
Ethanol	1.01
Gasoline	1.01
Wood/Coal/Coke/Other	1.00

J.2.2. Electricity and gas rates

Retail rates for electricity, natural gas and other fuels are sourced from the EIA's SEDS.[75] For the years 2008 through 2013, prices are derived from utility reports. For 2014-2040, retail rates are estimated using fixed

[74] ENERGY STAR Performance Rating Methodology for Incorporating Source Energy Use, March 2011, http://www.energystar.gov/ia/business/evaluate_performance/site_source.pdf. (accessed October 1, 2014).

growth rates. These are reported as average annual retail prices by state and sector in nominal dollars[76] (i.e., they have not been adjusted for inflation). For the analysis, all dollar values will be presented in terms of 2009 dollars.

J.2.3. Discount rate

The discount rate adjusts future dollar-value benefits and costs to a present day value. Applying a discount rate to future dollars is necessary to compare costs that occur in the first year with dollars in savings that accrue anywhere from 1 to 30 years into the future. For this analysis, a discount rate of 2.7 percent is applied. This rate is the "risk-free" real interest rate on the U.S. 30-year Treasury bond as of 2009.[77] To illustrate the potential effects of higher or lower interest rates, calculations are also performed with discount rates of 0.7% and 4.7%.

J.2.4. Inflation rate

The inflation rate is applied to nominal dollars in future periods to adjust for changes in purchasing power. The OMB circular cited in the discount rate section includes nominal and real interest rates. The difference between the nominal interest rate and the real interest rate often is used for the inflation rate. For 2009 only, the implied inflation rate is 1.8 percent (4.5% - 2.7% = 1.8%). Since the analysis results are reported in 2009 dollars this inflation rate is applied to 2008 dollars and as appropriate to future years to adjust costs and benefits before discounting.

J.3. REFERENCES

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[75] U.S. Energy Information Administration's (EIA), http://www.eia.gov/state/seds/
Electricity Prices - Natural Gas Prices - http://www.eia.gov/dnav/ng/ng_pri_sum_a_epg0_prs_dmcf_a.htm

[76] Retail energy prices are not adjusted for inflation by EIA. http://www.eia.gov/totalenergy/data/monthly/#prices

[77] Circular No. A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs", OMB Budget Assumption December 26, 2013 Budget Assumption http://www.whitehouse.gov/sites/default/files/omb/assets/a94/dischist-2014.pdf

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