CONSULTANT REPORT

EVALUATION OF THE CALIFORNIA ENERGY COMMISSION'S AMERICAN RECOVERY AND REINVESTMENT ACT PROGRAMS: COMBINED EVALUATION REPORT

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ABSTRACT

This report evaluates the California Energy Commission's portfolio of programs funded through the American Recovery and Reinvestment Act of 2009 (ARRA). Through these programs, the Energy Commission and subrecipients spent about $251 million statewide to implement a broad range of initiatives designed to improve existing building energy efficiency, reduce carbon emissions, support clean energy workforce education and training, increase clean energy manufacturing capacity, and create jobs. More than 14,000 homes and 7,700 nonresidential buildings had energy efficiency retrofits. In addition, more than 10,000 individuals participated in workforce education and training.

DNV KEMA Energy & Sustainability performed the evaluation from April 2010 through December 2013. The scope of the evaluation included measurement and verification activities, including 415 site visits and more than 450 participant telephone surveys, a macroeconomic assessment of the employment and economic impacts of the program, and an evaluation of program cost-effectiveness.

Overall, evaluation results indicate that energy savings exceeded 184 gigawatt hours and 3.8 million therms annually. Furthermore, 4.2 gigawatt hours in annual electricity generation has resulted from the implementation of renewable energy generation projects. Carbon emission reductions will total more than 1.15 million metric tons of carbon dioxide over the life of the generation and energy efficiency measures installed. During 2010 through 2012, the Energy Commission's direct ARRA program expenditures created more than 3,700 full-time and part-time jobs. The portfolio of programs meets the cost-effectiveness threshold established by the U.S. Department of Energy for ARRA programs.

In addition, the evaluations found very high levels of participant satisfaction – with the programs overall, with the program designs, and with interactions with Energy Commission staff. Areas of dissatisfaction centered on the difficulties some participants had complying with federal requirements, as well as various other administrative challenges. Evaluation recommendations center on continuing the programs, improving data management and verification, streamlining program administrative procedures and requirements, and continuing efforts to collaborate with a variety of partners.

Keywords: Energy Commission, evaluation, measurement, and verification; energy efficiency; ARRA; residential and nonresidential retrofits; workforce education and training; clean energy financing; cost-effectiveness; employment and economic development impacts

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EXECUTIVE SUMMARY

Objectives and Scope of This Report

This report presents the results of an evaluation of the California Energy Commission (Energy Commission) programs funded through the American Recovery and Reinvestment Act of 2009 (ARRA). In the wake of the worst recession since the Great Depression, President Obama and Congress enacted the ARRA economic stimulus program to preserve and create jobs and promote economic recovery; to assist those most affected by the recession; to provide investments needed to increase economic efficiency by spurring technological advances in science and health; to invest in transportation, environmental protection, and other infrastructure that will provide long-term economic benefits; and to stabilize state and local government budgets. United States Department of Energy (DOE) made State Energy Program (SEP) and Energy Efficiency and Conservation Block Grant (EECBG) ARRA funds available to the Energy Commission to administer a portfolio of programs.

The information in this report responds to DOE's request that when states evaluate ARRA programs, they focus on the following metrics: employment, energy savings, renewable energy capacity and generation, and carbon emission reductions. The Energy Commission contracted with DNV KEMA Energy & Sustainability to conduct an independent evaluation of the success of the Energy Commission's ARRA portfolio in achieving those objectives. In addition, the evaluation assessed free ridership and the level of participant satisfaction with the programs.

Overview

DOE established the following objectives for the ARRA SEP formula grants:

- Transform energy markets in partnership with states to accelerate near-term deployment of energy efficiency and renewable technologies.
- Promote an integrated portfolio of energy efficiency and renewable energy solutions to meet United States energy security, economic vitality, and environmental quality objectives.
- Strengthen core SEPs to develop and adopt leading market transformation initiatives.

The purpose of DOE's ARRA EECBG Program is to:

- Help eligible entities create and implement strategies to reduce fossil fuel emissions in a manner that is environmentally sustainable and, as much as possible, maximize benefits for local and regional communities.
- Reduce the total energy use of the eligible entities.
- Improve energy efficiency in the building sector, the transportation sector, and other appropriate sectors.

In response to this direction, the Energy Commission established an extensive portfolio of program initiatives to pursue the multiplicity of ARRA goals and objectives. The Energy Commission's ARRA portfolio represented a continuum of program initiatives ranging from immediate investment in known opportunities for upgrade of buildings, to investment in the development of market functions intended to transform the market and achieve California's energy efficiency and climate change goals. By design, ARRA programs conducted initiatives at particular points along this continuum. The Energy Commission's program portfolio as a whole achieved a balance of emphasis both on immediate upgrade projects and on sustained market transformation.

The portfolio consisted of seven main programs: six funded through SEP (one of which was also partially funded through the EECBG Program) and one funded entirely through the EECBG Program, as shown in Table 1. These programs included multiple subrecipients as implementers and different markets and program strategies, as shown in Table 2. This allowed the Energy Commission to pilot and field test several delivery approaches and multiple market segments simultaneously.

Table 1: Summary of Energy Commission ARRA Program Expenditures by DOE Funding Source

ARRA Program	DOE Funding Source		Total Energy Commission ARRA Program Expenditures
	SEP Formula Grants	EECBG Program	
California Comprehensive Residential Retrofit Program (CCRR)	$83,053,275	$14,820,727	$97,874,002
Clean Energy Business Financing Program (CEBFP)	$18,885,479		$18,885,479
Clean Energy Workforce Training Program (CEWTP)	$18,896,940		$18,896,940
Energy Conservation and Assistance Account (ECAA)-ARRA Loan Program	$19,551,511		$19,551,511
EECBG Small Cities and Counties Program		$32,471,587	$32,471,587
Energy Efficient State Property Revolving Loan Fund Program, Department of General Services (DGS Loan Fund Program)	$23,469,742		$23,469,742
Municipal and Commercial Building Targeted Measure Retrofit Program (MCR)	$29,976,830		$29,976,830
California Energy Commission (CEC) Support[1]	$7,301,202	$2,265,154	$9,566,356
All ARRA Programs	$201,134,979	$49,557,468	$250,692,447

Note: Total ARRA Program Expenditures includes Energy Commission labor expenses, as well as funding distributed to subrecipients.

[1] CEC Support includes expenditures for Evaluation, Measurement and Verification and other program support activities.

Source: DNV KEMA

Table 2: Summary of ARRA-Funded SEP and EECBG Programs

Program Name	Subprogram Name	Implementer Name	Energy Commission ARRA Program Expenditures by Funding Source	Program Accomplishments	Target Market
CCRR Program	Retrofit Bay Area	Association of Bay Area Governments (ABAG)	$10.8 million (SEP)	Retrofitted 919 single-family homes, and 30 multifamily properties (1,057 units); trained 780 contractors	Single-family homes in eight Bay Area counties
	Moderate Income Sustainable Technology Program	California Rural Home Mortgage Finance Authority Homebuyers Fund (CHF)	$26.8 million (SEP)	Retrofitted 564 single-family homes installed 121 photovoltaic systems; trained 100 contractors	Moderate-income families residing in rural communities throughout California
	Bay Area Affordable Multifamily Initiative	San Francisco Mayor's Office of Housing (SFMOH)	$0.7 million (SEP)	Retrofitted 6 multifamily properties (529 units)	Multifamily retrofits targeting affordable housing market in San Francisco Bay Area
	Sacramento Municipal Utility District (SMUD) Home Performance Program	(SMUD)	$18.0 million (SEP)	Retrofitted 836 single-family homes, 2,000 low-income homes, and 49 multifamily properties (2,513 units); trained 200 contractors	Single-family and multifamily home in SMUD service territory

Program Name	Subprogram Name	Implementer Name	Energy Commission ARRA Program Expenditures by Funding Source	Program Accomplishments	Target Market
	Energy Upgrade California™, including Sonoma County Energy Independence Program (SCEIP)	Local Government Commission[1] (LGC) and Sonoma County	$26.2 million (SEP)	Retrofitted 1,794 single-family homes, installed 239 photovoltaic systems, trained 96 contractors, conducted 334 workshops	Statewide program infrastructure developer and program implementer for single-family and multifamily. Marketing and outreach support to 30 California counties
	Fresno Regional Comprehensive Residential Retrofit Program	City of Fresno	$0.5 million (SEP) and $2.4 million (EECBG)	Performed 300 audits; retrofitted 22 single-family homes; trained 100 contractors	Single-family home retrofits in Fresno region
	Retrofit Los Angeles Program	County of Los Angeles	$8.9 million (EECBG)	Retrofitted 1,961 single-family homes and 9 multifamily properties (720 units); installed 3 photovoltaic systems; trained 240 contractors	Single-family and multifamily home retrofits in L.A. County
	Energy Upgrade California in San Diego Program	County of San Diego	$2.9 million (EECBG)	Retrofitted 19 single-family homes and 10 multifamily properties (884 units); installed 7 photovoltaic systems; trained 34 contractors	Single-family and multifamily home retrofits in San Diego County
CCRR Program (continued)	emPowerSBC, Alameda County Municipal Finance Program	County of Santa Barbara, County of Alameda	$0.6 million (EECBG)	Developed and implemented targeted marketing; installed 2 photovoltaic systems; trained contractors; developed Web-based tools and calculators	Single Family Homes in Santa Barbara or Alameda County

Program Name	Subprogram Name	Implementer Name	Energy Commission ARRA Program Expenditures by Funding Source	Program Accomplishments	Target Market
CEBFP		Energy Commission	$18.9 million (SEP)	Loans provided to four renewable-energy product manufacturers	Low-interest loans targeting clean energy manufacturing companies
CEWTP	Clean Energy and Green Building Pre-Apprenticeship and Retraining Program	Employment Development Department (EDD)	$15.9 million (SEP)	4,272 participants trained, 3,552 certifications obtained, and 1,889 jobs placed	Workforce education and training targeting new workforce entrants, unemployed, and underemployed
	Career Advancement Program	Employment Training Panel (ETP)	$3.0 million (SEP)	3,166 participants trained and retained in employment for required period (for example, 3 months)	Workforce education and training targeting incumbent workers or new hires
ECAA-ARRA Loan Program		California Energy Commission (Energy Commission)	$19.6 million (SEP)	Financed 33 loans covering a wide range of projects implemented at government buildings and facilities, including auditoriums, community centers, administration buildings, jails, police and fire stations, sports complexes, and maintenance yards	Local governments, special districts, and colleges
EECBG Small Cities and Counties Program		Energy Commission	$32.5 million (EECBG)	204 grants funding projects implemented at a range of local government facilities, including streetlighting, community centers, libraries, city halls, parking lots, and jails	Small cities and counties in urban and rural areas across the state, ranging from the city of Adelanto to the town of Yucca Valley

Program Name	Subprogram Name	Implementer Name	Energy Commission ARRA Program Expenditures by Funding Source	Program Accomplishments	Target Market
DGS Loan Fund Program		DGS	$23.5 million (SEP)	Funded 12 revolving loans supporting 64 projects implemented at state-owned and/or state-operated facilities, such as California Department of Corrections and Rehabilitation, Office of the Chief Information Officer, and, Department of Motor Vehicles	State-owned and/or state-operated buildings
MCR Program	EnergySmart Jobs (ESJ)	PECI	$18.2 million (SEP)	Completed 7,108 retrofits; trained 132 California Conservation Corps personnel and 160 contractors	Grocery stores, convenience stores, and restaurants
	Energy Technology Assistance Program (ETAP)	Energy Solutions	$6.7 million (SEP)	Completed more than 300 audits and feasibility studies at 99 organizations; 114 retrofit projects completed at 60 facilities; trained 40 electricians and 20 heating, ventilation, and air-conditioning (HVAC) contractors at 9 training events; conducted 6 technology seminars with 229 total participants attending; established positions for 4 interns	Local governments, universities, and nonprofit organizations
	Oakland Shines (OS)	QuEST	$5.1 million (SEP)	Conducted outreach to about 1,500 businesses and completed assessments at 612 facilities; 195 retrofit projects completed; established positions for 8 internships, drawing candidates from local community colleges	Businesses and college campuses in Oakland

[1] The Local Government Commission implemented marketing and outreach support to 30 California counties under the statewide umbrella program "Energy Upgrade California."

Source: DNV KEMA

Results from the evaluation indicate that:

- The Energy Commission distributed about $251 million in State SEP and EECBG funds to state and local governments, manufacturers, and energy service providers to implement a diverse program portfolio.
- Energy efficiency improvements occurred in more than 14,000 homes and about 7,700 nonresidential buildings throughout the state and resulted in more than 184 gigawatt hours and 3.8 million therms saved annually or 2,429 gigawatt hours (GWh) and 66 million therms over the life of the measures implemented.
- Furthermore, 4.2 gigawatt hours in annual electricity generation has resulted from the implementation of renewable energy generation projects.
- Carbon emission reductions total 1,146,638 metric tons of carbon dioxide (CO_2) over the life of the measures; the equivalent of removing more than 233,380 passenger vehicles from the road.
- More than 10,000 individuals – contractors, facility managers, local government representatives, students, and business managers– participated in workforce education and training activities throughout the state.
- More than 3,700 full-time and part-time jobs were generated from 2010 through 2012, as a result of direct program expenditures during the ARRA period. The combined stimulus of added household spending and gain in competitiveness by California businesses cumulatively creates nearly 17,000 full-time or part-time jobs from 2010 through 2026.
- Other economic activity attributable to the ARRA programs includes an increase in incremental personal income of $1.3 billion through additional wages and salaries, and a cumulative increase of $2 billion in gross state product over the 2010-2026 period. The added employment and economic activities from these program investments are forecast to increase state revenue from taxes and fees by about $243 million.
- Although market conditions will drive actual production, the Energy Commission supported development of clean energy manufacturing by increasing solar production capacity.
- The Energy Commission's ARRA portfolio meets the cost-effective threshold established by DOE. That is, when the programs and Energy Commission administration spending are combined, the portfolio achieved energy savings of at least 10 million British thermal units per $1,000 of program expenditures.
- Interviews and surveys with DGS Loan Fund Program, MCR, CEWTP, CEBFP, EECBG SCC, and ECAA-ARRA participants revealed very high levels of satisfaction – with the programs overall and with the program designs. EECBG and ECAA-ARRA program participants revealed very high levels of satisfaction with interactions with Energy Commission staff. For all programs, areas of dissatisfaction centered on the difficulties some participants had complying with federal requirements, as well as various other administrative challenges.

Evaluation Methods

DNV KEMA carried out the evaluation from April 2010 through December 2013. The scope of the evaluation included site-specific measurement and verification (M&V) activities, a macroeconomic assessment of the employment and economic development impacts of the program, and a comprehensive evaluation of program cost-effectiveness.

Most of the program evaluations involved discussions with Energy Commission program staff, including contract or agreement managers, engineers, and other technical support staff. In some cases, DNV KEMA also interviewed program implementation staff, including subrecipients and subcontractors. Evaluators completed detailed reviews of all available program documentation, such as proposals, contracts, implementation plans, progress reports, tracking databases, and final reports.

Site-specific M&V activities for nonresidential programs typically involved:

- Reviewing savings calculation spreadsheets, feasibility studies, tracking databases, and related information provided by manufacturers, contractors, and vendors.
- Developing site-specific M&V plans, including brief descriptions of the data requirements and analysis approaches for determining pre- and post-installation assumptions and conditions.
- Collecting data to catalog pre- and postretrofit operations and conditions, including equipment quantities, nameplate information, self-reported operational data, and spot measurements.
- For some sites, installing data loggers, collecting short-term (two weeks or, in some cases, longer) measurements, and conducting pre-retrofit monitoring to establish baseline conditions for HVAC measures.
- Participant surveys and in-depth interviews to gather data used to estimate net to gross ratios.

For residential programs, site-specific M&V began by reviewing project-specific model files and job reporting templates for pre-retrofit conditions, measures installed, and building characteristics. The evaluation team developed a general M&V plan, including brief descriptions of the data requirements and analysis approaches for model review, modification, and simulation runs, and then applied to all sampled sites. Once on-site, evaluators collected data to catalog pre- and postretrofit operations and conditions, including equipment nameplates, self-reported operational data, and building envelope characteristics. In addition, evaluators completed performance testing of home air leakage (infiltration), using blower door equipment, and performance testing of duct leakage and leakage to outside using Duct Blaster® equipment.

Evaluators completed telephone surveys with participants from most programs to assess program effectiveness and attribution, as well as participant satisfaction and suggestions for program improvement. Finally, for some programs, evaluators conducted additional in-depth interviews with various regional partners, manufacturers, contractors, and equipment vendors.

Table 3 summarizes the size of the various evaluation samples by program for M&V site visits, participant telephone surveys, and in-depth interviews with regional partners and market actors.

Table 3: Summary of Projects and Evaluation Sample Sizes by Program

Energy Commission ARRA Program	Number of Projects	Measurement and Verification Site Visits	Participant Telephone Surveys	In-Depth Interviews With Regional Partners and Market Actors
CEBFP	4 renewable-energy product manufacturers			12
CCRR	14,188 retrofit projects and solar photovoltaic system installations	200		
CEWTP	7,438 participants trained		306	21
DGS Loan Fund Program	12 revolving loans / 64 retrofit projects	18	16	
ECAA-ARRA	33 loans	17	17	
EECBG Small Cities & Counties[1]	204 grants	51	39	
MCR	7,417 retrofit projects	129	86	44
Total		415	464	77

[1] Residential programs funded through the EECBG Program were evaluated as part of the CCRR Program.
Source: DNV KEMA

The program evaluations produced estimates of annual and life-cycle project savings, and the program implementers provided project location information, full project costs, incentives and financing from ARRA and leveraged sources. These data, along with Energy Commission program administration expenditures, became the inputs used to develop cost-effectiveness estimates at the subrecipient, program, and portfolio levels. DNV KEMA determined cost-effectiveness using the guidance provided by DOE for ARRA programs, as well as three standardized California cost-effectiveness tests.

In addition to cost-effectiveness, DNV KEMA investigated potential employment and economic impacts resulting from the ARRA programs. The Energy Commission grouped counties in the state into one of seven regions. Evaluators used program expenditures along with participant project costs and bill savings as inputs for a general equilibrium economic model, called the Regional Economic Models, Inc., Policy Insights Plus (PI+) (REMI) model. This modeling

yielded incremental changes in employment created through direct program spending and indirectly through longer-term energy bill savings. In addition, this analysis quantified incremental changes in personal income, state revenue, and gross state product.

Detailed Evaluation Results by Program

The Energy Commission designed evaluations of the Energy Commission's ARRA Program to assess key outcomes, including:

- Net annual and net life-cycle energy savings and generation impacts.
- Annual and life-cycle avoided carbon emissions impacts.
- Cost-effectiveness.
- Employment and economic impacts.
- Workforce development accomplishments.

Table 4 summarizes these results for the Energy Commission's ARRA portfolio by DOE funding source. The following sections present program specific results.

Table 4: Summary of Evaluation Results by DOE Funding Source

Key Evaluation Results		DOE Funding Source		Total Energy Commission ARRA Portfolio
		SEP Formula Grants	EECBG Program	
Electricity Savings	Annual (MWh/year)	146,273	37,900	184,173
	Life-Cycle (MWh)	1,881,161	561,787	2,442,948
Natural Gas Savings	Annual (1,000 therms/year)	3,396	452	3,848
	Life-Cycle (1,000 therms)	58,231	8,322	66,553
Electricity Generation	Annual (MWh/year)	4,139	97	4,236
	Life-Cycle (MWh)	93,397	1,938	95,334
Carbon Emission Reductions	Annual (metric tons of CO_2/year)	64,834	14,842	79,676
	Life-Cycle (metric tons of CO_2)	920,722	231,689	1,152,411
Direct Employment Outcomes (2010-2012)	Full-Time and Part-Time Jobs	3,160	563	3,723
Direct, Indirect, and Induced Employment Outcomes (2010-2026)	Full-Time and Part-Time Jobs	14,857	2,089	16,946
Direct, Indirect, and Induced Economic Outcomes (2010-2026)	Personal Income (millions)	$1,096	$178	$1,274
	Gross State Product (millions)	$1,844	$200	$2,044
	State Revenue (millions)	$215	$28	$243
SEP Recovery Act Cost-Effectiveness Test (Annual MM BTU* / $1,000)		10.3	9.6	10.1

* MM BTU = Millions of British Thermal Units

Source: DNV KEMA

Annual and Life-Cycle Energy Savings and Generation Impacts

Based on the verified savings, the Energy Commission's ARRA portfolio wide net annual energy savings and generation impacts are shown in Table 5, and life-cycle impacts are shown in Table 6.

Table 5: Annual Energy Savings and Electricity Generation Impacts

Program	Ex Ante Annual Energy Impacts			Ex Post Annual Energy Impacts			Realization Rates		
	Electricity Savings (MWh/ year)	Natural Gas Savings (1,000 therm/ year)	Electricity Generation (MWh/ year)	Electricity Savings (MWh/ year)	Natural Gas Savings (1,000 therm/ year)	Electricity Generation (MWh/ year)	Electricity Savings	Natural Gas Savings	Electricity Generation
CCRR[1]	26,806	1,752	3,176	21,209	1,263	3,176	79%	72%	*Not evaluated*
DGS Loan Fund Program	31,115	1,193		29,713	1,427		95%	120%	
ECAA-ARRA	16,674	68	1,107	16,177	42	1,060	97%	62%	96%
EECBG Small Cities and Counties	34,337	240		32,893	172		96%	72%	
MCR	90,983	919		84,181	944		93%	103%	
Total	199,915	4,172	4,283	184,173	3,848	4,236	92%	92%	N/A

[1] Only a portion of the CCRR ex ante electricity and natural gas savings was included in the evaluation scope. The nonevaluated portion was assigned a realization rate of 100 percent. None of the electricity generation impacts were included in the evaluation scope.

N/A = not applicable

Source: DNV KEMA

Table 6: Life-Cycle Energy Savings and Electricity Generation Impacts

Program	Life-Cycle Energy Impacts		
	Electricity Savings (MWh)	Natural Gas Savings (1,000 therms)	Electricity Generation (MWh)
CCRR	424,181	25,257	63,519
DGS Loan Fund Program	429,574	22,944	
ECAA-ARRA	250,215	747	31,815
EECBG Small Cities and Counties	461,637	2,730	
MCR	877,341	14,875	
Total	2,442,948	66,553	95,334

Source: DNV KEMA

Annual and Life-Cycle Avoided Carbon Emissions Impacts

Energy Commission staff provided the CO_2 conversion factors. The following multipliers were used to estimate carbon emission reductions:

- Energy Efficiency (electric) – 690 pounds CO_2 per MWh
- Energy Efficiency (gas) – 11.69 pounds CO_2 per therm
- Renewable Generation (electric) – 830 pounds CO_2 per MWh

Applying these CO_2 conversion factors to the energy savings and generation impacts from the program-specific evaluations yields the annual and life-cycle carbon emission reductions shown in Table 7. Overall, Energy Commission programs achieved an estimated annual carbon emission reductions of 79,636 metric tons of CO_2 per year or 1.15 million metric tons over the life of the measures.

Table 7: Annual and Life-Cycle Carbon Emission Reductions

Program	Annual Carbon Emission Reductions (Metric Tons of CO_2 / year)*	Life-Cycle Carbon Emission Reductions (Metric Tons of CO_2)*
CCRR	14,530	290,599
DGS Loan Fund Program	16,864	256,113
ECAA-ARRA	5,725	93,271
EECBG Small Cities and Counties	11,206	158,963
MCR	31,351	353,465
Total	79,676	1,152,411

Source: DNV KEMA

Cost-Effectiveness Results

DOE specified a cost-effectiveness test requirement for evaluating SEP-funded program portfolios. The SEP Recovery Act Cost test is expressed in millions of British thermal units (MM BTU) of energy saved or generated annually per $1,000 of program expenditures. To be considered cost-effective, the overall portfolio (not individual programs) should achieve annual savings of at least 10 MM BTUs per $1,000 of SEP expenditures. States administering EECBG Program funds were to individually establish cost-effectiveness criteria. The Energy Commission expected that small cities and counties receiving EECBG Program funds would implement energy efficiency upgrade projects that met the same 10 MM BTUs per $1,000 criterion as in the SEP Recovery Act Cost test. However, DOE did not require that the EECBG Program as a whole, including administrative and program implementation costs, would meet this criterion.

As shown in Table 8, the full portfolio of ARRA-funded programs implemented by the Energy Commission achieved 10.1 MM BTU per $1,000 of program expenditures. These expenditures

include funds used by the Energy Commission for administrative purposes, including technical assistance; auditing; and evaluation, measurement, and verification. Expenditures do not include revolving loan funds that went to DGS, Los Angeles County, CHF, and LGC.

Table 8: Cost-Effectiveness Results by ARRA Funding Source

Funding Source	Total Program ARRA Expenditures	SEP Recovery Act Cost (SEP-RAC)
		Annual MM BTU/$1,000
ARRA Portfolio	$250,692,447	10.1
EECBG	$49,557,468	9.6
SEP	$201,134,979	10.3

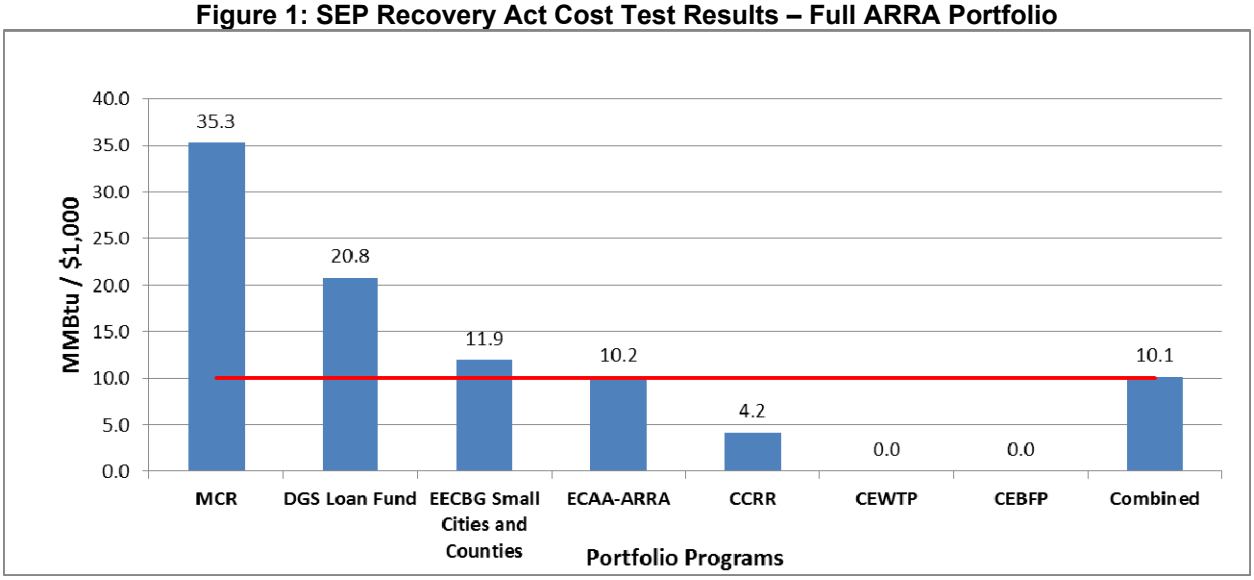
[1] Note that the SEP-RAC result for EECBG combines EECBG SCC programs that were above the SEP portfolio goal of 10.0 with EECBG funded portions of the CCRR program that were below the SEP portfolio goal, resulting in a score for EECBG as a whole at slightly below the SEP portfolio goal. EECBG programs were not required to meet the SEP-RAC test.

Source: DNV KEMA

The Energy Commission's program portfolio succeeded in meeting DOE's SEP Recovery Act Cost test threshold for the portfolio as a whole, vigorously pursuing market transformation initiatives that are designed to achieve long-term changes to the structure and function of the market and the behavior of market participants, and achieving high results on short-term cost-effectiveness tests for programs in the portfolio that primarily pursued immediate investments in known opportunities for upgrade of buildings.

Figure 1 shows the results of the SEP Recovery Act Cost test at the program and portfolio level. As shown, the Energy Commission's full portfolio of programs, which included a mix of programs focused on achieving near-term energy savings as well as programs focused on market transformation, including providing workforce development training and education, and long-term market behavior transformation, fell just above the 10.0 MM BTU threshold. Of the eight programs evaluated under this test, four (MCR, DGS, ECAA-ARRA and EECBG Small Cities and Counties) exceeded the DOE threshold. MCR achieved the highest result of all programs in the Energy Commission's portfolio, at 35.3 MM BTU per $1,000 of program expenditures, followed by DGS at 20.8 MM BTU per $1,000 of program expenditures.

Figure 1: SEP Recovery Act Cost Test Results – Full ARRA Portfolio



Note: The SEP Recovery Act Test results are not applicable for CEWTP and CEBFP, as these programs focused exclusively on training and market development instead of direct, short-term energy savings.
Source: DNV KEMA

The CCRR Program did not score as high on the SEP Recovery Act Cost test. This was expected given that the Energy Commission designed the program to achieve sustainable whole-house savings for residential customers and create a sustainable market for home energy assessments. The newly designed and implemented CCRR Program consisted mainly of pilot programs. Significant ARRA resources were spent on activities designed to increase building owner awareness and knowledge of whole-building energy efficiency and on-site renewable energy upgrades, and to increase contractors' and other professionals' technical expertise and business skills for delivering quality whole-building energy efficiency assessments and upgrades. This investment should lead to future opportunities and increased participation of residential customers, which tend to be hard to reach.

Employment and Economic Impacts

Overall, the ARRA funding provided through the State Energy Program and EECBG Program directly generated a combination of 3,723 full-time and part-time jobs from 2010 through 2012. Much of this direct employment, with a possible exception in the manufacturing sector, ended along with the ARRA funding. From 2010 through 2026, the spending from the programs created an estimated 16,946 direct, indirect, and induced jobs. Resulting from estimated lower energy bills, these jobs are a combination of extra spending by households, commercial businesses, and governmental entities, along with the increased market shares for participating commercial businesses.

Additional economic impacts include:

- Incremental personal income of $1.27 billion was created through additional wages and salaries over the 16-year period.

- The economic activity resulting from the program expenditures is expected to generate a cumulative value of $2.04 billion in gross state product over 16 years.
- Additional revenue of roughly $243 million is expected to flow to the state through taxes and fees over the same period. This incremental revenue is prior to subtracting any incremental expenses.

Program (ARRA) and base case (no-ARRA) results are summarized in Table 9. ARRA results represent incremental changes to the no-ARRA base case.

Table 9: Summary of Estimated Employment and Economic Outcomes (2010-2026)

	Direct Outcomes (2010-2012)	Direct, Indirect, and Induced Outcomes (2010-2026)			
	Employment[1]	Employment[1]	Personal Income	Gross State Product	State Revenue
Base Case	60 million	374 million	$35 trillion	$40 trillion	$4 trillion
Incremental Impact to Base Case from ARRA	3,723 full-time and part-time	16,946 full-time and part-time	$1.27 billion	$2.04 billion	$243 million

[1] The direct employment total during 2010-2012 is a subset of the direct, indirect, and induced employment total during 2010-2026. Employment is presented in job years (one job for one year). One job year can be due to either full time or part time employment.

Source: DNV KEMA and Economic Development Research Group (EDRG)

Region Contribution

In addition to reporting state-level effects, the analysis includes intrastate regional effects. For this analysis, the Energy Commission grouped the 58 counties in California into seven regions. Each region represents an economic unit in terms of job creation or trade flows. Table 10 lists these regions and their associated counties.

Table 10: Region Definitions

Region	Counties Included
Bay Area	Alameda, Contra Costa, Marin, Napa, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma
Greater Sacramento	El Dorado, Placer, Sacramento, Sutter, Yolo, Yuba
San Joaquin Valley	Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, Tulare
Los Angeles	Los Angeles, Orange, Ventura
Inland Empire	Riverside, San Bernardino
San Diego	Imperial, San Diego
Rest of State	Northern California (Del Norte, Humboldt, Lake, Lassen, Mendocino, Modoc, Nevada, Plumas, Sierra, Siskiyou, Trinity) Central Coast (Monterey, San Luis Obispo, Santa Barbara) Northern Sacramento Valley (Butte, Colusa, Glenn, Shasta, Tehama) Central Sierra (Alpine, Amador, Calaveras, Inyo, Mariposa, Mono, Tuolumne)

Source: DNV KEMA

Table 11 summarizes the estimated employment and economic outputs by region. As shown, direct employment impacts resulting from ARRA spending during the 2010-2012 period were highest in the Bay Area, followed by the San Joaquin Valley, Greater Sacramento, Los Angeles and "rest of state" regions.

Table 11: Summary of Estimated Employment and Economic Outcomes by Region (2010-2026)

Region	Direct Outcomes (2010-2012)	Direct, Indirect, and Induced Outcomes (2010-2026)			
	Employment	Employment	Personal Income (millions)	Gross State Product (millions)	State Revenue (millions)
Bay Area	1,317	8,460	$661	$1,310	$100
Greater Sacramento	510	1,816	$112	$151	$51
San Joaquin Valley	700	2,125	$136	$154	$23
Los Angeles	455	2,131	$151	$190	$35
Inland Empire	83	665	$46	$51	$8
San Diego	304	863	$52	$65	$7
Rest of State	354	886	$116	$123	$19
ARRA Portfolio	3,723	16,946	$1,274	$2,044	$ 243

Source: DNV KEMA and EDRG

Half of the estimated nearly 17,000 direct, indirect, and induced employment impacts expected through 2026 – resulting from estimated lower energy bills, extra spending by households and governmental entities, and increased market shares for participating California businesses – will be achieved in the Bay Area. Another 36 percent of these direct, indirect, and induced employment impacts are expected to be achieved in the San Joaquin Valley, Los Angeles, and Greater Sacramento regions (distributed somewhat equally among these three regions).

Economic impacts through 2026, such as incremental increased personal income, gross state product, and state revenue, are expected to be highest in the Bay Area. While much of the state's revenue is driven by income and sales taxes, a disproportionally larger percentage of the incremental gross increase in state revenue (21 percent) will be achieved in the Greater Sacramento region. This due to the mix of ARRA programs in the greater Sacramento region, as well as a characteristic of how the REMI model forecasts effects from spending occurring at government facilities.

Program Contribution

Estimated program contributions to job creation, personal income, gross state product, and state revenue are sorted by program spending and shown in **Error! Reference source not found.**. As shown, 74 percent of the Energy Commission's ARRA program spending was through four programs: CCRR, EECBG Small Cities and Counties, MCR, and DGS Loan Fund. These programs also contributed 68 percent of the direct employment impacts during 2010-2012.

Table 12: Summary of Estimated Employment and Economic Outcomes by Program (2010-2026)

Program	Direct Outcomes (2010-2012)	Direct, Indirect, and Induced Outcomes (2010-2026)			
	Employment	Employment	Personal Income (millions)	Gross State Product (millions)	State Revenue (millions)
California Comprehensive Residential Retrofit	1,281	486	$8	$2	$74
CEBFP[1]	358	7,159	$562	$1,209	$86
CEWTP	276	447	$29	$26	$3
Energy Conservation Assistance Act-ARRA	480	1,125	$67	$61	$5
EECBG Small Cities and Counties	357	1,988	$175	$197	$17
Energy Efficient State Property Revolving Loan (DGS Loan Fund Program)	230	1,875	$135	$159	$12
Municipal & Commercial Targeted Measure Retrofit	650	3,681	$283	$373	$46
CEC Support	91	185	$15	$17	0
Totals	3,723	16,946	$1,274	$2,044	$ 243

[1] ARRA program spending for the CCRR program has been updated since the initial employment and economic analysis was performed. Only direct employment from this program spending update is reflected in this report.
[1] CEC Support includes expenditures for Evaluation, Measurement and Verification and other program support activities.
Source: DNV KEMA and EDRG

CEBFP offered loans to manufacturing companies, located or planning to locate, in California. It accounts for 7 percent of total spending, but this analysis expects it to support the most significant statewide job creation over time. In the modeling framework, manufacturing drives the highest multipliers of spending, and this program finances the expansion of manufacturing operations for solar panels and other "green" products. This contribution to job creation assumes no closures of participating facilities or layoffs from 2013 and going forward. Other

1 This contribution to job creation assumes no closures of participating facilities or layoffs from 2013 and going forward.

programs creating jobs in the longer term are MCR, followed by EECBG Small Cities and Counties, and DGS.

Workforce Development

In addition to delivering cost-effective programs that generated energy savings, electricity generation, carbon emission, employment, and other economic impacts, the Energy Commission's portfolio of ARRA-funded programs also made substantial contributions to workforce development across the state. For example:

- MCR
  - PECI trained 132 California Conservation Corps personnel and 160 contractors from 83 California-based contracting firms, as part of the EnergySmart Jobs Program.
  - Energy Solutions trained 40 electricians and 20 HVAC contractors at nine training events and conducted six technology seminars with 229 total participants as part of Energy Technology Assistance Program.
- CCRR
  - Retrofit Bay Area Program trained 780 contractors
  - Moderate Income Sustainable Technology Program trained 100 contractors.
  - Sacramento Municipal Utility Home Performance Program trained 200 contractors.
  - Fresno Regional Comprehensive Residential Retrofit Program trained 100 contractors.
  - Retrofit Los Angeles Program trained 240 contractors.
  - Energy Upgrade in San Diego Program trained 34 contractors.
  - A total of 96 contractors were trained, and more than 500 attendees attended workshops conducted as part of the Local Government Commission's statewide marketing and outreach efforts.
- CEWTP
  - A total of 4,272 participants completed EDD training programs, and 3,166 participants completed ETP training programs.

All together, these activities resulted in more than 10,000 individuals – homeowners, tenants, students, contractors, business owners, facility managers, local government representatives, and so forth – participating in workforce education and training activities throughout the state.

Evaluation Recommendations

Overall, evaluation results indicate that the Energy Commission was well-prepared to use ARRA funding effectively for implementing energy efficiency programs. The trained staff,

existing procedures, and quality control processes provided a good foundation for the programs. The sample of program participants interviewed by evaluators were satisfied with their interactions with program administrators, and most would not have been able to move forward with projects without assistance from the ARRA programs.

- With respect to the DGS Loan Fund Program, ECAA-ARRA, and EECBG Small Cities and Counties Programs, the types of projects completed were appropriate for ARRA funding use – that is, most easily implementable, "shovel-ready" projects – such as efficient lighting and street lighting measures – that yielded excellent results and showed wise use of public funds.
- For the MCR Programs, the Energy Commission was highly successful in launching comprehensive and coordinated energy efficiency programs targeting emerging technologies in niche markets.
- The CCRR Program succeeded in launching pilot programs from which lessons learned can be carried forward as statewide efforts to improve energy efficiency in existing building stock continue to develop.
- CEWTP was also effective in implementing sector strategies and distributing resources to regional partnerships that could efficiently integrate clean energy workforce training within existing educational infrastructure.
- Finally, CEBFP also effectively leveraged existing market infrastructure to attract and fund clean energy manufacturing capacity within the state.

CHAPTER 1: California Comprehensive Residential Retrofit Program Evaluation Summary

Program Description

The California Energy Commission (Energy Commission) designed the California Comprehensive Residential Retrofit program (CCRR) to enable market transformation by piloting and establishing a platform for expanding whole-building energy upgrades in single-family and multifamily buildings in California. Program goals included spending the funds according to federal deadlines and requirements, creating jobs during the American Recovery and Reinvestment Act of 2009 (ARRA) period, developing new business practices and saving energy across California's existing residential building sector. The CCRR program worked in collaboration with regional and local governments, finance companies, the California Public Utilities Commission (CPUC), and utility companies to deliver comprehensive energy efficiency assessments and upgrades to existing single-family and multifamily homes under the statewide Energy Upgrade California™ brand.

The Energy Commission allocated about $98 million in ARRA funds to multiple subrecipients under this program. The following regional and local government administered programs were subrecipients that were allocated ARRA funding by the Energy Commission under the CCRR program, in collaboration with the Energy Upgrade California program.

The Retrofit Bay Area Program (primary administrator: Association of Bay Area Governments (ABAG), a regional joint powers authority) pursued market transformation and piloted delivery of whole-house energy assessments and upgrades to single-family homes in eight San Francisco Bay Area counties, offering regional and local incentives to homeowners, in conjunction with utility rebates. The program also piloted multifamily whole-building energy assessments and upgrades in San Francisco and Alameda County. The program recruited and supported building owners by educating them about the whole house approach, connecting them to participating contractors and other professionals, informing them about financing and other resources available in their county, and streamlining the program participation process. The program also promoted workforce development through technical and business skills training for participating contractors and Home Energy Rating System raters, and provided incentive scholarships to trainees.

The Affordable Multifamily Retrofit Initiative (primary administrator: San Francisco Mayor's Office of Housing) provided partial funding and risk mitigation for a revolving loan fund that provided capital for energy efficiency and water conservation improvements for multifamily, affordable housing projects in San Francisco, Oakland, and Berkeley. Collaboration with multiple programs that subsidize maintenance and upgrading of affordable housing led to development of jointly funded projects to meet multiple objectives and drive down the

participating building owners' cost share. The program pursued market transformation for these hard-to-reach buildings with outreach to candidate building owners in the region and workforce development to provide energy assessment protocols and training supported by participation scholarships. Projects were not completed in time for the site visits and, therefore, were not included in the scope of this evaluation.

The Moderate Income Sustainable Technology Program (primary administrator: CRHMFA [formerly California Rural Home Mortgage Finance Authority] Homebuyers Fund, a regional joint powers authority) delivered below-market interest rate revolving loan fund financing for deep whole-house energy efficiency measures. The program utilized 15-year loans with interest rates of 0 to 3 percent, and provided grants to single-family, moderate-income households to buy down the cost of whole-house upgrades, including on-site photovoltaic generation systems in some cases. This program was available in 31 counties throughout the state and required HERS ratings and documentation of upgrades for all loans. The energy efficiency upgrades completed through the program were included in the site visit evaluation.

The Home Performance Program (primary administrator: Sacramento Municipal Utility District) pursued market transformation and delivered whole-house/whole-building home performance upgrades to single-family and multifamily buildings in Sacramento County. The program provided rebates for contractor and Home Energy Rating System (HERS) rater performed energy assessments and for upgrades, in coordination with several county partners and Pacific Gas and Electric Company (PG&E). The program was open to all residential customers in the County, which included both low-income and higher-income owners. Low-income weatherization projects were not included in the site visit portion of this evaluation.

The Energy Upgrade California Program (primary administrator: the Local Government Commission (LGC), a statewide joint powers authority) administered statewide infrastructure support initiatives for the Energy Upgrade California collaboration, including development and implementation of the Web portal that provided homeowners with energy efficiency education; county-specific information and links to qualified, participating contractors and professionals that could provide energy assessments and upgrade services. The Program also conducted extensive, on-the-ground local outreach and education efforts in 30 counties statewide, and provided statewide marketing, education, and outreach materials and tools for all Energy Upgrade California partners to use. The program also conducted workforce development training for participating contractors and raters, and provided incentives for home energy ratings. The contract also included pilot programs for Property Assessed Clean Energy (PACE) financing for energy efficiency upgrades for single-family residential buildings in Sonoma County and commercial buildings in San Francisco City and County, City of Los Angeles, and Placer County. This program was not included in the site visit portion of the evaluation.

The Energy Independence Program (subprogram under the LGC contract, administrator: Sonoma County), under the Energy Upgrade California program, pursued market transformation and piloted delivery of PACE for permanently installed energy efficiency and water conservation measures in single-family homes. The Sonoma County Energy Independence Program (SCEIP) conducted marketing, provided education and outreach to

recruit and support homeowner participants, provided workforce development and support, offered an innovative "contractor float" revolving loan program that covered contractor carrying costs between the time that upgrade projects were completed and the closure of Property Assessed Clean Energy bond financing for the projects, and initiated a participating contractor tool lending library. The program also provided incentives for energy assessments. This subprogram was not included in the site visit portion of the evaluation.

The Energy Upgrade California in San Diego Program (primary administrator: County of San Diego) delivered single-family and piloted multifamily comprehensive residential whole-building upgrade programs for the San Diego region. In addition to energy assessments and upgrades, this program trained home performance contractors and HERS raters. The multifamily program co-developed and piloted energy assessment tools in a substantial number of multifamily buildings. Single-family whole-house energy efficiency projects (EEPs) were included in the site visit portion of the evaluation. Multifamily projects and photovoltaic system installations were not included. The Energy Commission allocated discretionary Energy Efficiency and Conservation Block Grant (EECBG) funding to support these program efforts in the region.

The Regional Comprehensive Residential Retrofit Program (primary administrator: City of Fresno) was delivered in four counties of the South San Joaquin Valley. The program provided no-cost energy assessments and HERS ratings as well as training and support to develop a contractor workforce for whole-house upgrades. The intent of the program was to increase homeowner awareness and knowledge regarding the opportunity for energy efficiency upgrades, recognizing that homeowners in the San Joaquin Valley region were among the hardest-hit by the recession and would more likely make incremental upgrades over time, some through do-it-yourself projects. Even though this program approach was not expected to achieve extensive whole-house upgrades, this program was included in the site visit portion of the evaluation. The Energy Commission allocated a portion of its discretionary EECBG funding in combination with State Energy Program (SEP) funds to support these program efforts.

The Retrofit Los Angeles Program (primary administrator: County of Los Angeles) was an extensive collaboration of initiatives that were jointly funded by discretionary EECBG funds from the Energy Commission, the United States Department of Energy (DOE) direct Better Buildings Program competitive grant, and the DOE large jurisdiction EECBG formula grant. The program pursued market transformation and pilot delivery of whole-building energy assessments and upgrade projects for single-family and multifamily buildings. The program recruited and supported building owner participants through marketing, education, and outreach, and supported workforce development through technical and business skills training for participating contractors. The program also pursued innovative financing options through loan loss reserve risk mitigation and interest rate buy downs. Single-family whole-house EEPs were included in the site visit portion of the evaluation. Multifamily projects and photovoltaic system installations were not included.

The Municipal Finance Program (primary administrators: the County of Santa Barbara and Alameda County) was awarded EECBG grant funding to develop residential PACE programs.

Before these programs were able to get started, the Federal Housing Finance Agency (FHFA) strongly discouraged federally funded lenders from cooperating with residential PACE programs. As a result, the Energy Commission allowed these administrators to revise their programs. The County of Santa Barbara withdrew their efforts to start a PACE program, using other ARRA funds they received directly from DOE to pursue instead a loan loss reserve risk enhancement to encourage the start-up of a low interest, unsecured loan program through local credit unions. The emPowerSBC program coordinated with Energy Upgrade California, providing homeowner outreach and information and participating contractor training. Alameda County chose to cancel their program, returning most of the initial funding.

The ABAG, SFMOH, California Rural Home Mortgage Finance Authority Homebuyers Fund (CHF), SMUD, Energy Upgrade California/ LGC, and SCEIP Programs were 100 percent funded through SEP. The Energy Upgrade California in San Diego Program, the Retrofit Los Angeles Program, and the Municipal Finance Program were 100 percent funded with EECBG discretionary funds. The Fresno Regional Comprehensive Residential Retrofit Program was largely funded with EECBG discretionary funds but also received funding from SEP.

Evaluation Results

Gross Energy Impacts

The primary goal of the evaluation was to assess the implementation effectiveness of the California Comprehensive Residential Retrofit subrecipient program and to verify the estimated energy savings of the programs. Overall, the programs successfully upgraded more than 8,100 single-family homes and more than 5,700 multifamily units, and installed more than 370 solar photovoltaic systems throughout California. These efforts delivered estimated annual energy savings of more than 21.2 gigawatt-hours and 1.3 million therms and produced more than 3.1 gigawatt-hours of annual electricity generation impacts. The results are shown in Table 13, Table 14 and Table 15.

Table 13: CCRR Evaluation Results – Estimated Annual Gross Program-Level Electricity Savings
(Whole-house Single-Family, Multifamily, Low Income, and Single Measure)

CCRR Subrecipient Program Group	Estimated Annual Gross Ex Ante Electricity Savings (kWh)	Estimated Annual Gross Ex Post Electric Savings[1] (kWh)
ABAG	2,053,273	1,768,817
CHF	2,417,072	1,356,461
Fresno	121,200	70,296
Los Angeles	6,005,091	4,342,655
San Diego	609,304	606,492
SFMOH	100,892	100,892
SMUD	11,796,173	10,637,284
Subtotal	*23,103,005*	*18,882,897*
Energy Upgrade California (LGC), SCEIP and Shared Projects	3,702,903	2,326,150
Total	26,805,908[2]	21,209,047[3]

[1] Overall, about 55 percent of the CCRR Program ex ante electricity savings were adjusted with ex post evaluation results. The remaining 45 percent of the CCRR Program ex ante electricity savings were essentially "passed through" with a 100 percent realization rate.

[2] Estimated annual gross ex ante electricity savings reflect the sum of Table 8 and Table 9 in the *Evaluation of the California Comprehensive Residential Retrofit Programs.*

[3] Estimated annual gross ex post electricity savings are consistent with the results reported in Table 1 in the *Evaluation of the California Comprehensive Residential Retrofit Programs.*

Source: DNV KEMA Energy & Sustainability (DNV KEMA)

Table 14: CCRR Evaluation Results – Estimated Annual Gross Program-Level Electricity Generation

(Whole-house Single-Family, Multifamily, Low Income, and Single Measure)

CCRR Subrecipient Program Group	Estimated Annual Gross Ex Ante Electric Generation (kWh)	Estimated Annual Gross Ex Post Electric Generation[1] (kWh)
ABAG	0	0
CHF	829,449	829,449
Fresno	0	0
Los Angeles	34,130	34,130
San Diego	49,201	49,201
SFMOH	0	0
SMUD	0	0
Subtotal	*912,780*	*912,780*
Energy Upgrade California (LGC), SCEIP and Shared Projects	2,249,631	2,249,631
Municipal Finance Program	13,574	13,574
Total	3,175,985	3,175,985

[1] None of the solar photovoltaic projects implemented with assistance provided by the CCRR Program were included in the evaluation scope. As a result, all of these projects were passed through with essentially a 100 percent realization rate.

Source: DNV KEMA

Table 15: CCRR Evaluation Results – Estimated Annual Gross Program-Level Natural Gas Savings
(Whole-house Single-Family, Multifamily, Low Income, and Single Measure)

CCRR Subrecipient Program Group	Estimated Annual Gross Ex Ante Natural Gas Savings (therms)	Estimated Annual Gross Ex Post Natural Gas Savings[1] (therms)
ABAG	454,649	300,023
CHF	126,649	73,406
Fresno	4,690	3,283
Los Angeles	282,541	240,382
San Diego	38,072	36,487
SFMOH	49,353	49,353
SMUD	406,898	301,487
Subtotal	*1,362,852*	*1,004,421*
Energy Upgrade California (LGC), SCEIP and Shared Projects	389,347	258,405
Total	1,752,199[2]	1,262,826[3]

[1] Overall, about 79 percent of the CCRR Program ex ante natural gas savings were adjusted with ex post evaluation results. The remaining 21 percent of the CCRR Program ex ante natural gas savings were essentially "passed through" with a 100 percent realization rate.
[2] Estimated annual gross ex ante natural gas savings reflect the sum of Table 8 and Table 9 in the *Evaluation of the California Comprehensive Residential Retrofit Programs.*
[3] Estimated annual gross ex post natural gas savings are consistent with the results reported in Table 1 in the *Evaluation of the California Comprehensive Residential Retrofit Programs.*
Source: DNV KEMA

As indicated in these tables, only a portion of CCRR Program impacts was included in the evaluation scope. Evaluators visited a sample of single-family homes across subrecipients. The programs or program elements not included in the site visit component of the evaluation included those that did not provide direct financial support for single-family energy efficiency upgrades but enabled the entire Energy Upgrade California collaboration through local and regional program development and delivery, contractor and rater training, energy assessment and rating incentives, and statewide education, outreach, and marketing. In addition, the site visit component of the evaluation did not include multifamily pilot programs that advanced energy efficiency upgrades and did not include solar photovoltaic system installations that were also advanced by the CCRR Program. The effects from programs or program elements not included in the site visit component of the evaluation were somewhat substantial and were essentially "passed through" with a 100 percent realization rate.

To verify the effects of the whole-house, single-family upgrade initiatives that were included in the scope of the ex post analysis, evaluators visited sites to confirm measure installations and building characteristics, and the results of these site visits informed the development of estimates of ex post energy savings. Finally, evaluators calibrated the preretrofit energy models to the actual historic electric and natural gas consumption of the sampled homes. Evaluators

used these data to determine the estimated savings of the programs. The differences between claimed and estimated savings are composed of these two adjustments:

1. **Verification Factor.** Both contractors and evaluators conducted on-site assessments that were input into energy models. The verification factor is the difference between contractor and evaluator models. The verification factor includes only differences the contractors could have controlled, such as data collection and data entry into the models. Since subrecipients' programs included contractor training and quality control (QC) procedures, this indicates the effectiveness of that training and QC.
2. **Billing Adjustment Factor.** Then for each subrecipient, evaluators compared evaluator-modeled energy consumption to weather-normalized billing data and developed billing adjustment factors. The contractors had very little ability to modify usage schedules or other inputs to perform a billing adjustment using the standard modeling software. Unlike the verification rate, the billing adjustment factor speaks primarily to the ability of the software tool, not the contractors.

Table 16 presents the verification factors and billing adjustment factor results for each subrecipient program. These results were applied only to the portion of whole-house, single-family upgrade initiatives that were included in the site visit component of the evaluation.

Table 16: CCRR Evaluation Results – Verification Factors and Billing Adjustment Factors

CCRR Subrecipient Program Group	Verification Rate	Billing Adjustment Factor – Electricity	Billing Adjustment Factor – Natural Gas
ABAG	98%	76%	58%
CHF	92%	61%	63%
Fresno	NA[1]	58%	70%
Los Angeles	90%	66%	93%
San Diego	85%	107%	50%
SMUD	86%	77%	69%
Subtotal	*90%*	*69%*	*72%*
Energy Upgrade California (LGC), SCEIP and Shared Projects	90%	69%	72%
Total	90%	69%	72%

[1] NA = not applicable. Site visits for the Regional Comprehensive Residential Retrofit (city of Fresno) were of homes that did energy assessments but not upgrades.

Source: DNV KEMA

Net Annual and Life-Cycle Energy Impacts

The evaluation scope did not include an estimation of a net-to-gross ratio; as such, the assumed value of 100 percent was applied to the gross energy savings and gross renewable generation impacts to yield both the annual and life-cycle net energy impacts, as shown in Table 17.

Table 17: CCRR Evaluation Results – Net Annual and Life-Cycle Program-Level Savings

	Net Ex Post Electricity Savings (MWh)	Net Ex Post Electricity Generation (MWh)	Net Ex Post Natural Gas Savings (1,000 therms)
Annual	21,209	3,176	1,263
Life-Cycle	424,181	63,519	25,257

Source: DNV KEMA

Carbon Emission Reductions

Evaluators estimated that more than 14,500 metric tons of carbon emissions were avoided annually as a result of this program under both baseline calculation methods. These results are shown in Table 18.

Table 18: CCRR Evaluation Results – Avoided Carbon Emissions

	Avoided Carbon Emissions (metric tons of CO_2)
Annual	14,530
Life-Cycle	290,599

Source: DNV KEMA

In addition to energy savings, the CCRR program's goals were to create a sustainable market for home energy assessments and piloting program components for deep energy efficiency savings through whole building retrofits. In each regional area subrecipients sought to increase building owner awareness and knowledge of whole-building energy efficiency and on-site renewable upgrades; increase contractors' and other professionals' technical knowledge, skills, and ability to deliver quality whole-building energy efficiency assessments and upgrades; and build from scratch both increased demand from willing building owners and increased supply of competent contractors and other professionals to meet that demand. The program supported the development of this nascent market through establishment of sustained local and regional government and utility collaboration, quality installations through effective quality control, and financing programs to help building owners meet the capital requirements for upgrades.

The program was successful in meeting the building owner information and workforce development goals, providing quality assurance, and establishing available financing mechanisms. The program trained more than 1,000 contractors and HERS raters. The programs also provided a Web portal to inform both homeowners and participating contractors, conducted targeted education and outreach, and provided contractor technical and business skills training.

Evaluation Recommendations

Evaluators made the following recommendations to improve the program going forward:

- **Target inefficient homes with greatest consumption** by using preproject historical energy usage and savings as the basis for determining rebate amounts and move toward an incentive per unit of energy saved like nonresidential custom programs.
- **Improve energy savings realization** by continuing to improve the accuracy of building simulation software estimated energy consumption and savings. Continue the efforts of the CPUC and Energy Commission to improve the consistency of building simulation savings estimates with program participant's energy usage by developing and implementing rules for limiting pre-project building characteristics assumptions consistent with national consensus Standards, and establishing a process to, on an ongoing basis, compare and adjust building simulations to match energy usage.
- **Provide improved contractor training**, including initial and residual training for using building simulation software, using pre-project building characteristics limitations, and focusing on matching of estimated energy consumption with home energy usage, on an ongoing basis.
- **Develop a comprehensive database for projects**, including:
    - Maintaining records on preproject conditions, limiting preproject conditions consistent with Building Performance Institute national standards, and allowing deviation only when building simulation energy consumption estimates are well-matched to energy usage or when verified by preproject QC.
    - Maintaining a record of all projects, including all funding sources and amounts or rebates and financing, and when energy upgrades are made in parallel to non-energy building improvements, a clearly separated estimate of the costs of the energy upgrades alone.
    - Storing all building simulation files and project data are stored in a format that is easily accessible for QC, evaluation and future program analysis.
    - Actively enabling of the sharing of data with all program administrators that have a stake in the delivery of the program and with the participating contractors and other market actors, recognizing the need for data security through effective access protections, and safe data transfer and data storage. IOUs must fully cooperate with this data sharing for the database to be successful.

CHAPTER 2:
Clean Energy Business Financing Program Evaluation Summary

The evaluation of Clean Energy Business Financing Program (CEBFP) examined the implementation and outcomes for this first-time loan program, which lasted from April 2010 through May 2012. The evaluation occurred between October 2011 and May 2012.

Program Description

CEBFP offered low-interest loans for clean energy manufacturing companies located, or planning to locate, in California. The Energy Commission used an interagency agreement with the California Business, Transportation, and Housing Agency to contract with regional financial development corporations for financial underwriting and loan servicing expertise. The initial pool of funds totaled nearly $29 million as of February 2011.

CEBFP was well-received in the market, and initially 44 companies with a broad base of technologies applied for funding. These technologies included solar, bio fuels, wind, fuel cells, batteries, and water efficiency. The Energy Commission awarded CEBFP loan funds to 10 solar companies and seven accepted the terms. Due to changing market conditions, the timing of funding distributions, and changing company strategies, the final awards went to four manufacturing firms and totaled $18.3 million (63 percent of the original pool).

Evaluation Results

All awardees reported that the loans were well-structured and had attractive terms relative to alternate financing options.

CEBFP already has begun to achieve its goals of supporting development of a clean energy manufacturing infrastructure in California and of a viable revolving loan fund. A total of $18.1 million of program funds were disbursed to borrowers through June 2012. Through the third quarter of 2013, the Energy Commission had received nearly $6.5 million in principal and interest repayments, including the early, full repayment of one of the loans. In general, applicants emphasized a void in the market for financing clean energy companies and appreciated the availability and terms of the program. They indicated that only the cap on the amount available to borrow limited their participation.

Interviewed firms reported that the program's funding directly influenced their decision to expand or locate operations in California. The production lines installed at the loan recipient firms were expected to produce an additional 155 megawatts (MWs) of electric generation capacity annually. This forecast assumed no facility closures due to market conditions or global competition. After the evaluation was complete however, two of the four manufacturing

facilities cited in the evaluation ceased California operations and employment. As a result, the on-going capacity forecast is 125 MWs.

Another part of this evaluation focused on the verification of equipment purchased and installed with the loan funds. The evaluation team visited all four manufacturing sites to view the equipment and learn how it supported production. Expanded production capacity was evident at all sites, and newly installed equipment was clearly marked. No photos were taken due to the proprietary nature of the production processes.

CEBFP is new to the Energy Commission's portfolio of programs, and the applicants did not have much experience with the detailed level of tracking or reporting required by federal government-funded loans. The federal requirements that caused the most confusion were the Davis Bacon Act prevailing wage tracking and reporting processes, which requires contractors to pay their labor no less than the prevailing wage, a mechanism that prevents contractors from bypassing local labor and using lower cost labor from other areas. The reporting difficulties stemmed from the need to separate labor costs from project costs; this was especially true when labor was specialized due to the equipment's specialized functionality. All four participating companies mentioned this as a difficulty but were pleased with the assistance the Energy Commission's staff provided in interpreting and complying with the requirements.

The fact that the CEBFP is new partially explains why the financial development corporations reported poor communication with program staff after the CEBFP was launched. For example, they reported experiencing procedural changes that were inconsistent with their understanding of the CEBFP.

Solar manufacturing remains a capital-intensive process. The dollar cap on individual loans of $5 million limited the amount of influence CEBFP could have on larger production decisions. Firms used the loans to expand production lines but not to the extent they could have. For example, one participating program firm also accepted a $100 million loan from the State of Mississippi and expanded its production capacity in that state by opening a 100 MW plant.

The CEBFP has been moderately successful to date, considering it is a start-up operation. Successes include:

- Strengthening the clean energy manufacturing economy in California.
- Creating and retaining clean energy manufacturing jobs.
- Increasing manufacturing capacity of renewable energy products.
- Deploying a revolving loan fund program for clean energy business development.

Recommendations

Consideration of these recommendations in the context of any program design changes will help to improve the CEBFP as it moves forward.

- **Either eliminate FDCs from the loan process or have them bear more risk/reward for outcomes**
    - The FDCs did not have a stake in who the Energy Commission loaned funds because FDCs do not fund the loans. There is an incentive for FDCs to be in program because it expands their client base and allows them to get more experience with emerging technology markets (in addition to a participation fee). Yet the FDCs lose nothing if loans become non-performing. If the FDCs had greater exposure to the outcomes, either the resulting portfolio or the mix of lenders may have been significantly different.
- **Continue to use the Energy Commission website as an advertising source for program.**
    - Companies continue to express strong interest in government sponsored loans. The companies we interviewed continuously scan for programs and are informed by existing funders. Creating a strong website portal for the revolving loan will contribute both to advertising the program as well as maintaining an updated source of information for the program's continuing status.
- **Get funding out the door faster.**
    - The CEBFP was able to disburse funds much faster than the DOE, but still lags behind other states in the time it takes to award and disburse funds. Streamlining the decision process for applications and underwriting will benefit the program by providing the underwriters with more defined decision criteria, and will help mitigate the amount of assumed risk inherent in the emerging technology industries that CEBFP targets. This recommendation is made with the understanding that all loan awards, loans, and modifications to loan terms have to be approved by the Energy Commission at a monthly business meeting and require a public notice process.
- **Work with underwriters/servicers prior to creating loan process deadlines to ensure better collaboration within the program.**
    - Include financing experts during the initial loan applicant screening process to address lack of Energy Commission underwriting knowledge. The FDCs interviewed expressed the opinion that more financial expertise at the beginning would have avoided decision delays later on.
- **Provide more funding or higher caps to address the high demand for these types of loans.**
    - Moving forward it is important to implement a strong structure for a revolving loan so that funding can be sustainable. While it would be great to continue to

finance these revolving loans at a federal level, creating a revolving loan with the funds allows states to independently continue to finance these programs when federal funds are no longer available.

- **Continue the CEBFP as a revolving loan pool.**
    - All four firms expect this to be a revolving loan fund. They treated their decision to participate as an investment decision. They expect the time and effort invested in learning about the process and the contracting requirements to be a competitive advantage in the next round of funding.

CHAPTER 3: Clean Energy Workforce Training Program Evaluation Summary

Program Description

This report evaluates the Clean Energy Workforce Training Program (CEWTP) administered by the Energy Commission and funded by ARRA. The Energy Commission designed CEWTP to leverage California's existing training framework, deliver industry-relevant training for displaced workers and new workforce entrants, and advance the structure to address anticipated demand for trained workers in the clean energy industry.

The primary objectives of the program were to close the talent gap for clean energy jobs by building capacity for clean energy training in the state; use sector strategies to create a well-planned workforce training effort through partnerships; establish standardized training leading to certifications in the clean energy sector; and create career pathways for the growing clean energy sector. Sector strategies leverage partnerships among employers, training providers, labor organizations, and other stakeholders to identify workforce needs within an industry sector in a geographic region and develop training plans relevant to those needs.

The Energy Commission entered into interagency agreements with the Employment Development Department (EDD) to administer funding to partnerships and with the Employment Training Panel (ETP) to administer funding to subcontractors to provide services for training. The Energy Commission distributed nearly $19 million of SEP ARRA funds to the program. Table 19 presents an overview of the various components included within CEWTP.

Evaluation Results

Overall, the results of this evaluation indicate that CEWTP more than adequately took into account the needs of the local labor markets. As shown in Table 20, roughly 4,200 individuals completed training activities funded through the EDD Pre-Apprenticeship and Retraining program elements, including more than 3,500 industry-recognized certifications obtained by training participants and nearly 1,900 placed in jobs upon completing the training activities. Almost 3,200 individuals completed training activities funded through the ETP's Career Advancement program element, and all of them completed the employment retention requirement.

Table 19: Summary of CEWTP Components

	EDD	ETP
CEC ARRA SEP Funds		
Program Implementation Expenditures	$15.37 million[1]	$2.58 million[2]
Administrative Costs	$0.5 million[1]	$0.42 million[2]
Total CEC ARRA SEP Expenditures	$15.87 million	$3.00 Million
Leveraged Workforce Investment Act Funds[3]	$9.7 million[1]	None
Total CEWTP Expenditures	$25.57 million	$3.00 million
Selection for Awards	Competitive and noncompetitive bid	Noncompetitive bid
Award Type	28 competitively-bid grant agreements, 4 noncompetitively bid grant agreements[4]	13 performance-based contracts
Target Awardees	Partnerships of community colleges and workforce investment boards	Employers, trade associations, unions, community colleges
Target Trainees	New workforce entrants or unemployed or underemployed	Incumbent workers and new hires

[1] From EDD's *Final Report for the California CEWTP*, April 13, 2012, available from *http://www.energy.ca.gov/ab758/documents/ARRA-Programs/final_reports/. CA_Clean_Energy_Wrkfc_Training_Program-Final_Report_2012-04-13.pdf* (Accessed 7/28/2013).

[2] From the *Final Report for the ETP*, May 11, 2012, available from *http://www.energy.ca.gov/ab758/ documents/ARRA-Programs/final_reports/Employment_Training_Panel-Final_Report_2012-05-11.pdf.* (Accessed 7/28/2013).

[3] Funds provided through the Recovery Act, Governor's Discretionary 15 Percent account, as stated in EDD's *California CEWTP Solicitation for Proposals*, available from *http://edd.ca.gov/Jobs_and_Training/pubs/wiasfp09-2.pdf*. (Accessed 7/28/2013).

[4] Four noncompetitively bid grant agreements were completed with on-the-job training subgrantees.

Source: DNV KEMA

Table 20: Summary of CETWP Accomplishments

	Number of CEWTP Implementers	Number of Trainees Enrolled	Number of Trainees Completing Training	Number of Certifications Attained	Number of Trainees Placed in Unsubsidized Jobs	Number of Trainees Placed in Training-Related Jobs[1]
EDD On-the-Job Training	4	78	62	N/A	N/A	N/A
EDD Pre-Apprenticeship	18	2,849	2,579	1,779	1,193	811
EDD Retraining	10	1,895	1,631	1,773	696	330
ETP Career Advancement[2]	13	4,422	3,166	N/A[3]	N/A	N/A
Total	45	9,244	7,438	3,552	1,889	1,141

1 Training-related jobs are reported as a subset of unsubsidized jobs.

2 All 3,166 of the ETP training participants were retained in employment for the required period (for example, three months).

3 While ETP preferred training that leads directly to a certificate of competency, ETP subcontractors did not have explicit goals pertaining to certifications and, consequently, were not required to track this information, however 40% of participants surveyed indicated that they obtained certificates.

Source: DNV KEMA

The following summarizes the key findings from the evaluation:

- **The use of sector strategies effectively engaged local clean energy workforce advisory groups and potential employers during the planning stages of the program to ensure that the training provided would meet the needs of the local labor market.** Sector strategies were essential to developing realistic, localized projections of clean energy labor requirements within a given industry and geographic region, as well as developing and implementing training activities relevant to those requirements.
- **The design and implementation of the CEWTP included efforts to target specific types of workers expected to require training on clean energy industry topics and skills.** In recognition of high rates of unemployment within the construction, mechanical, and electrical trades, training activities were designed to anticipate the need for training and retraining of these types of workers. Unemployed and underemployed workforce segments were specifically targeted, as were incumbent workers identified as requiring new or upgraded clean energy-related skills. CEWTP activities were also designed to target and to address the specific needs of underrepresented groups, such as females, younger workers, less educated workers, veterans, and the chronically unemployed. In this regard, the CEWTP activities were highly aligned with those of other ARRA-funded programs, such as the Municipal and Commercial Building Targeted Retrofit Program (MCR).

- **The CEWTP contributed toward building capacity within the clean energy industry workforce by incorporating relevant and appropriate training content.** That is, training curricula and activities were designed to address specific topics and end-use technologies, as well as other employment-related skills consistent with labor market needs. Training participants confirmed in telephone surveys that they received training on a wide range of topics and that these topics were directly related to their current job, providing further evidence of effective design and capacity building. Training activities were designed to address more general topics, including the basic skills needed to obtain and keep a job.
- **CEWTP activities were not only designed and implemented to meet industry and employer needs, they were also successful in furthering trainees on their career paths.** Training participant survey results confirmed that CEWTP training activities offered an entry point and/or supported growth along the participants' chosen career paths. Participants agreed that the training they received motivated them to continue to work in a field related to clean energy, that the training motivated them to consider additional training in clean energy, and that the training created more opportunities for career advancement. Participants also agreed that their careers had advanced or will advance because of the training, further suggesting the value they placed on their training experiences.
- **Participants reported high levels of satisfaction with the training.** Trainees confirmed that they received useful information and had effective instruction. Further, they valued the supportive services they received which helped reduce barriers to sustained participation.
- **CEWTP activities also provided standardized training that led to more than 3,500 industry-recognized certifications.** Obtaining certifications contributed to the sustained participation of trainees in the clean energy industry and aided training program recruitment, retention, and job placement. In addition, other ARRA-funded programs, such as the Comprehensive California Residential Retrofit Programs, required certifications that were valued in the market and supported through CEWTP initiatives. This alignment across and within programs helped ensure that the knowledge and skills acquired during training would be required in the clean energy workforce, and supportive of participants' desires to have recognized and viable career paths.
- **The CEWTP was also successful in meeting targets with respect to number of people trained and number of jobs placed or retained.** As part of the overarching goal to build capacity within the workforce in the state, the EDD subgrantees and the ETP subcontractors established specific goals in terms of the number of people they intended to train and how many would be placed in new jobs or retain existing jobs after having completed training activities. Overall, program documents indicate that more than 9,200 individuals enrolled in at least one of the CEWTP training activities, which was 116 percent of the enrollment goal. About 7,400 individuals completed at least one of the training activities in which they were enrolled, which was 101 percent of the goal. In terms of job placement and retention, about 1,900 participants in the EDD Pre-

Apprenticeship and Retraining program elements were placed in new jobs after having completed training, and nearly 3,200 participants in the ETP Career Advancement program element were retained in employment positions following training program participation.

- **Despite these accomplishments, the demand for workers during the 2009-2011 time frame was lower than expected for a number of reasons.** Respondents cited the economy as a prime reason for the lack of jobs, specifically the construction industry lagging due to the economic downturn. In mid-2011, California's overall unemployment rate was 12 percent statewide[2] in comparison to the national rate of 9 percent.[3] In addition, legislation and key programs – such as, PACE and Energy Upgrade California™– were cancelled, delayed in start-up, or did not reach the expected levels of penetration. As a result, businesses were reluctant to expand, and homeowners lacked confidence to invest in energy efficiency, leading to significantly fewer jobs than anticipated. Finally, uncertainty with regard to regulatory processes and confusion over utility rebate programs led to lower-than-expected installations of both utility-scale and customer-sited clean energy upgrade projects. These combined factors caused reductions in the demand for trained workers as compared to what was anticipated when the CEWTP was designed.
- **The CEWTP was found to be highly effective in terms of its recruitment and retention rates, adaptability, delivery approach, and instructor quality.** The high rates of trainee and employer retention achieved by the program were a result of effective marketing, recruiting, and screening, as well as important supportive services. The program was also effective in adapting and modifying the training and workforce goals as they were reassessed throughout the program period. Partnerships were particularly effective in facilitating an appropriate balance of private and public instruction and leveraging existing infrastructure, while simultaneously allowing for participation from new training partners and organizations. Finally, industry experience of instructors was universally regarded as a critical factor in program effectiveness.
- **Sustainability is often the most challenging goal for new and developing programs, even under the best labor market and economic conditions. The evaluation found evidence that the workforce development functions initiated through the CEWTP should continue beyond the ARRA funding period.** For example, the design of the CEWTP effectively leveraged existing resources and partnerships, and in some cases, led to the formation of new collaborative bonds between educational institutions, industry advisory councils, and local workforce agencies. The CEWTP strengthened these partnerships, which is a critical outcome that should lead to sustaining clean energy training into the future. Additional evidence of sustainability includes the development

2 United States Department of Labor, Bureau of Labor Statistics, *Local Area Unemployment Statistics*, available from http://data.bls.gov/timeseries/LASST06000003 (accessed 9/11/2013).

3 United States Department of Labor, Bureau of Labor Statistics, *Labor Force Statistics from the Current Population Survey*, available from http://data.bls.gov/timeseries/LNS14000000 (accessed 9/11/2013).

of training curricula that has now been incorporated within standard training programs in some areas, and the identification of funding sources to sustain clean energy training, such as fee-based models, nonprofit/charitable funding frameworks, public agencies, and educational institutions.

Evaluation Recommendations

Workforce education and training will continue to be a key element of California's Long Term Energy Efficiency Strategic Plan. Created in 2008, California's Long Term Energy Efficiency Strategic Plan identified workforce education and training as essential to the successful implementation of energy efficiency programs so that savings goals are achieved. In recognizing that many other entities in the state are involved in workforce education and training, the CPUC highlighted the need for a collaborative effort among state agencies, educational institutions, community-based and nonprofit organizations, private industry, and labor to create a comprehensive and coordinated statewide Workforce Education and Training Program for a new, energy-efficient economy. As such, the Energy Commission should continue to participate in statewide, collaborative efforts to support the development of a sustainable and high-quality clean energy training program, building on the successes and lessons learned from the CEWTP experience.

Policy and legislative support for the activities and programs that use these trained workers will also be required to sustain the success of ARRA-funded clean energy workforce education and training activities. Public resources should continue to be allocated in support of clean energy workforce education and training programs, and program implementers should be required to address the extent to which they address workforce education and training needs. Further, publicly funded energy efficiency programs should consider including industry and market recognized clean energy certifications and skill standards as part of their program requirements.

The following summarizes the key recommendations for future programs as determined through this evaluation:

- Future training programs should continue to use the sector strategy approach to ensure program design effectiveness, allocating funding as appropriate to ensure that support from community colleges, workforce investment boards, employers, trade associations, and unions can be made available.
- Future training programs should continue to be designed to address participants' desires to have a career in clean energy.
- In terms of training program format and content, various types of hands-on training should continue to be incorporated into future program designs, as well as maintaining an appropriate balance between theoretical knowledge and practical experience.
- Future training programs should continue to use workforce investment boards and other workforce partners to ensure effective leveraging of established employer networks and job search resources.

- Future programs should continue to seek ways to improve trainee and employer marketing and coordination strategies.
- To maintain trainee recruitment and retention rates, future programs should continue to screen for basic skills, aptitude, and experience.
- Future programs should continue to offer flexible schedules and financial and other supportive services.
- Future programs should continue to balance private and public sector options, provide sufficient time for upfront planning, and ensure instructor quality.
- Future programs should provide improved documentation to enhance evaluability, such as detailed information on the training activities and certifications, trainee characteristics, trainee contact information (or a means of obtaining it where privacy/confidentiality constraints exist), and employer documentation.

CHAPTER 4:
Energy Conservation and Assistance Account-ARRA Program Evaluation Summary

Program Description

The Energy Conservation and Assistance Account (ECAA)-ARRA Loan Program is a low-interest revolving loan program funded by DOE through ARRA. The Energy Commission based the program on the existing ECAA Loan Program, developed by the Energy Commission in 1979 but funded by a different source. The ECAA-ARRA Loan Program provided $19.6 million in low-interest loans for energy efficiency and renewable energy retrofits to cities, counties, special districts, public schools, and colleges.

Under the ECAA-ARRA Loan Program, the maximum loan amount was $3 million, and there was no minimum loan amount. The Energy Commission funded a broad range of measures under the ECAA-ARRA Loan Program including interior and exterior lighting and controls; heating, ventilation, and air-conditioning (HVAC) equipment replacement, retrofits, and controls; variable-frequency drives and efficient motors; retrofits for water and wastewater equipment; and on-site renewable energy generation. Most of the program's savings came from energy-efficient streetlight measures.

Between 2009 and 2011, the Energy Commission issued 33 program loans. Two of these loans funded solar photovoltaic energy generation projects, and the remaining 31 loans achieved energy savings by implementing energy efficiency measures. The Energy Commission awarded loans across the state, from Del Norte to San Diego Counties, in urban and rural areas. Typical facilities included libraries, offices, public safety buildings, colleges, and other local government buildings.

Evaluators determined that net annual energy savings were 16.2 GWh and about 42,000 therms; energy generation was estimated at 1.1 GWh per year.

Evaluation Results

DNV KEMA evaluated the effectiveness of the ECAA-ARRA Loan Program implementation and verified energy savings realized from loans approved in 2009 through 2011. Additional goals included estimating carbon emission reductions and program cost-effectiveness, assessing job creation, and informing the Energy Commission of any waste, fraud, or abuse of loan funds. Following development of an evaluation plan, the site visits and analysis were completed between May 2011 and August 2012.

Summary of Results

- **The program design concept was successful.** The Energy Commission effectively used ARRA funding to provide low-interest loans for energy efficiency and renewable energy projects in local jurisdictions, special districts, public schools, and colleges, which may not have had the resources to participate in this type of program before.
- **The Energy Commission was well-prepared to use ARRA funding effectively for this ongoing energy efficiency program.** The existing procedures, trained staff, and application review process all provided a good foundation for the loan program.
- **Local jurisdictions implemented many "shovel-ready" projects that yielded excellent results and showed wise use of public funds.** The types of projects completed were appropriate for ARRA funding. The bulk of the expected savings came from easily implementable lighting measures, an appropriate response for a stimulus program designed for quick results.
- **In particular, the dominance of highly efficient street lighting projects yielded excellent results.** Local jurisdictions implemented street lighting projects with relatively little effort. Furthermore, California's mild climate is appropriate for cost-effective, efficient light-emitting diode streetlights. This combination of factors allowed local jurisdictions with limited staff and resources to participate in the program.
- **Many jurisdictions also leveraged additional help and funding from other sources.** Many local governments were able to implement more, or larger, projects using a combination of its own capital funds, utility rebates, and/or EECBG Small Cities and Counties funding.
- **Solar energy generating projects were successful.** The two photovoltaic installation projects had good results in achieving expected electric generation.
- **Lessons learned can strengthen the future ECAA Program.** The development of a tracking system to compare planned and achieved energy savings allows an overview of what types of projects generate the best results.

In general, the evaluation results demonstrate that the Energy Commission was well-prepared to use ARRA funding effectively for this ongoing energy efficiency program.

The evaluators verified a sample of projects with the sample size designed to be large enough to produce reliable program-level estimates of energy savings and meet prescribed statistical precision levels. Since the evaluation's time frame overlapped with program implementation, not all projects could be part of the sample. The evaluators selected a sample that included all installed projects as of February 2012. A total of 17 sites representing a broad range of measures were included in the final sample.

Gross Energy Impacts

The evaluation results indicate that the program realized about 16 GWh in annual electricity savings from the implementation of energy efficiency measures, and about 1 GWh in annual

electricity generation from the implementation of solar photovoltaic measures. In addition, there were 10 ECAA-ARRA loan projects with expected reductions in natural gas or other fuels. Most of these projects were expected to save natural gas but, in a few cases, implemented measures reduced diesel or propane fuel. These were converted to therm equivalents, for a total energy savings of more than 42,000 therms per year. Annual gross energy impacts are shown below in Table 21, Table 22, and Table 23.

Table 21: ECAA-ARRA Evaluation Results – Gross Annual Program-Level Electricity Savings

Measure Group	Annual Gross Ex Ante Electric Savings (kWh)	Annual Gross Ex Post Electric Savings (kWh)
HVAC	1,240,644	1,308,235
Lighting	14,370,461	14,325,441
Other	1,062,854	575,568
Overall	16,673,959	16,209,244

Source: DNV KEMA

Table 22: ECAA-ARRA Evaluation Results – Gross Annual Program-Level Electricity Generation

Measure Group	Annual Gross Ex Ante Electric Generation (kWh)	Annual Gross Ex Post Electric Generation (kWh)
Solar Photovoltaic	1,107,450	1,062,616

Source: DNV KEMA

Table 23: ECAA-ARRA Evaluation Results – Gross Annual Program-Level Therm-Equivalent Savings

Measure Group	Annual Gross Ex Ante Natural Gas and Other Fuel Savings (therms)	Annual Gross Ex Post Natural Gas and Other Fuel Savings (therms)
HVAC	58,046	36,016
Other	9,609	6,376
Overall	67,655	42,392

Source: DNV KEMA

The evaluation results indicate that the program focused on highly effective projects to reduce energy consumption for local California jurisdictions. The emphasis on street lighting, interior lighting, and retrofitting aging HVAC infrastructure projects yielded significant savings. While HVAC projects had greater variability in savings achieved, the evaluation team verified that old or improperly operating equipment or controls had been replaced with more efficient operating equipment. Over the long term, this old equipment would have needed to be replaced and, in

some cases, had been operating inefficiently well past its expected useful life. The ECAA-ARRA Loan Program accelerated replacement of old, inefficient equipment and ensured that the replacement units were energy-efficient.

Evaluation findings indicate that the most common differences between ex ante and ex post estimates occurred in estimated operating conditions before the energy efficiency upgrades and observed site-specific operating conditions at the time of the evaluation. For example, evaluators may have observed operating hours or equipment control schedules that were different from the assumptions made when developing feasibility studies and ex ante estimates. In some cases, ex ante calculations encompassed high-level generalizations that were not consistent with site-specific conditions. In a few cases, the feasibility study provided to the evaluation team was not sufficiently detailed to determine the ex ante calculation, resulting in an inability to determine why estimates were different. The evaluation team also found several inconsistencies between the originally planned equipment and control installation scheme and what was actually installed and operational.

Net Annual and Life-Cycle Energy Impacts

Using participant responses, the evaluation team determined a net-to-gross ratio of 99.8 percent for the program. This ratio is applied to the gross energy savings and gross renewable generation impacts, shown in Table 21 through Table 23 above, to yield the net program impacts shown in Table 24. Net impacts are shown as both annual and life-cycle estimates.

Table 24: ECAA-ARRA Evaluation Results – Net Annual and Life-Cycle Program-Level Savings[1]

	Net Ex Post Electricity Savings (kWh)	Net Ex Post Electricity Generation (kWh)	Net Ex Post Natural Gas and Other Fuel Savings (therms)
Annual	16,176,825	1,060,491	42,307
Life-Cycle	250,215,264	31,814,723	746,914

1 These results were updated for the cost-effectiveness analysis to reflect the overlap between projects that received funding from both the ECAA-ARRA and EECBG Programs.

Source: DNV KEMA

Carbon Emission Reductions

Carbon emission reductions accrue when energy is saved or renewable energy is generated, thus avoiding or replacing fossil fuel generation. Evaluators estimated that more than 5,000 metric tons of carbon emissions were avoided annually because of this program. These results are shown in Table 25.

Table 25: ECAA-ARRA Evaluation Results – Avoided Carbon Emissions

	Avoided Carbon Emissions (metric tons of CO_2)
Annual	5,725
Life-Cycle	93,271

Source: DNV KEMA

Participant Satisfaction and Suggestions for Improvement

Interviews with loan participants revealed very high levels of satisfaction. Respondents were generally very happy with the program, the equipment installed, the loan structure, and the loan amounts. Many reported that the Energy Commission staff was extremely helpful. Suggestions for improvement of future programs included streamlining paperwork and application processes, as well as reducing the compliance requirements of the program (many of which were in effect due to ARRA funding).

Self-Reported Evidence of Job Creation

Although based on self-reported evidence, most loan recipients noted job retention and additional hiring occurred outside their operations, primarily through short-term contract hires and contractor jobs. Within their operations, they reported retaining no jobs or making additional hires. Temporary jobs types included solar installers, roofers, laborers, and electricians and, based on self-reported estimates, totaled 43 jobs across the 17 participants surveyed. Many participants indicated that they used contract hires during implementation of a project but were unaware if these turned into permanent positions.

Evaluation Recommendations

Overall, the results of the evaluation of the ECAA-ARRA Loan Program show that California should continue to fund the existing ECAA Program. This effective program should continue to expand and to reach out to local jurisdictions that have not participated in the past. The evaluation produced a set of recommendations for improving the program going forward:

- **Program implementation recommendations:**
    - Create a consistent set of requirements for feasibility studies and baseline definitions. The feasibility studies and supporting data should clearly identify critical assumptions made in developing the savings assumptions that they contain. Information like planned efficiency, operating hours, load factors, and controls should be described for both the baseline situation and the planned measure.
    - Build on the experience of the ARRA application process. Continue to provide assistance in completing the application as well as information about how to avoid problems that occurred in the past.

- Consider providing a flowchart to illustrate the different stages of the application process.
- Consider alternate approval methods instead of payback period, for example, life-cycle costs.

- **Program tracking and documentation:**
  - The database developed for the evaluation tracks measures planned, measures implemented, project costs, and expected energy savings. In the future, develop a database or build on the one developed for this evaluation that can be mined for information about costs, measures, and savings. This database will allow statistical and program analysis and serve as a basis for ongoing planning.
  - Develop overall tracking data for the program, compiling a database of the planned and implemented measures and expected savings. Tracking documentation procedures should also allow for changes in project scope to be reflected in the final tracking data.
  - Where cost-effectiveness and/or jobs analysis is a program goal, develop methods to obtain labor and equipment breakdowns, as well as planning or administrative costs. For example, invoices could be required to provide these data.
  - During the program design phase, consider what specific analytics should potentially be collected and design the tracking system to collect that information. For example, if the program wants to track lighting measures, data regarding the number of lights replaced should be collected rather than aggregated savings attributed to a lighting retrofit project.
- **Measure-specific recommendations:**
  - Require that new HVAC measures achieve above minimum efficiency levels, given that HVAC equipment may be left in place for many years.
  - Consider using deemed savings estimates for measures that are highly reliable, such as outdoor lighting, streetlights, and traffic lights.
  - For domestic hot water (DHW) measures, make sure that loads and operational conditions are well-defined and sufficiently documented to support the savings estimates.
  - Continue to include streetlight projects and computer power management measures that resulted in significant savings.
  - Prepare spreadsheet-based calculation tools to help local jurisdictions design lighting retrofits that meet Title 24 lighting power density requirements.
- **Evaluation recommendations:**
  - Evaluate the existing ECAA Program periodically to foster continual improvement.

- For evaluations of large HVAC projects, plan the evaluation to gather detailed site- specific data pre- and postinstallation.
- Plan the postinstallation evaluation such that most projects are completed and commissioned before beginning the field phase of the evaluation.

Finally, the existing ECAA Program provided an effective foundation for ensuring prudent use of ARRA funding. Lessons learned from the program implementation period can strengthen the existing ECAA Program.

CHAPTER 5: Energy Efficiency and Conservation Block Grant Small Cities and Counties Program Evaluation Summary

Program Description

The ARRA and the Energy Independence and Security Act of 2007 established the EECBG Program to provide formula-based grants for cost-effective EEPs. The U.S. DOE allocated $46 million to the Energy Commission for the EECBG Program. DOE required the Energy Commission to distribute at least 60 percent of these funds to small cities and counties throughout the state since small jurisdictions were ineligible for direct grants. The Energy Commission distributed a total of $31.9 million[4] in funding to small cities and counties; the remaining $14.7 million[5] went to the California Comprehensive Residential Retrofit (CCRR) Programs, which were evaluated separately.

The Energy Commission designed the EECBG Small Cities and Counties Program to use two approaches:

- **EEPs.** Cost-effective EEPs, for which energy savings and cost estimates were supported by a feasibility study. There were a total of 77 EEP agreements funded at $14.3 million.
- **Direct equipment purchase (DEP) projects.** For those jurisdictions without the resources or expertise to develop complex EEPs, the Energy Commission provided a list of preselected energy efficiency equipment that qualified for funding and did not need an associated feasibility study. One hundred and sixteen DEP projects were initially funded at $14.1 million. Eleven additional DEP projects were later funded at $3.5 million.

The EECBG Small Cities and Counties Program achieved savings primarily from lighting and HVAC measures. The program allowed a broader range of measures, providing some flexibility, but maintained focus on a limited number of easily implementable measures with known potential to achieve savings.

The Energy Commission implemented 204 program grants to small cities and counties, totaling $31.8 million, between 2009 and 2012. Annual energy savings were projected at about 34

4 Funding for the EECBG Small Cities and Counties Program totalled $32,471,587, which includes $590,360 in Energy Commission labor costs.

5 EECBG funding for the CCRR Programs totalled $14,820,727, which includes $99,524 in Energy Commission labor costs.

gigawatt-hours (GWh) and 240,000 therms. Local jurisdictions in both urban and rural areas across the state implemented projects, from Adelanto to Yucca Valley. Typical facilities included a range of local government buildings and facilities, including community centers, libraries, city halls, parking lots, and jails.

Evaluation Results

The Energy Commission retained DNV KEMA as evaluators to assess the effectiveness of the EECBG Small Cities and Counties Program implementation and verify the energy savings. Additional evaluation goals included attributing program influence, estimating carbon emission reductions and program cost-effectiveness, assessing job creation, and informing the Energy Commission of any waste, fraud, or abuse of grant funds. Following development of an evaluation plan, the evaluation site visits were completed between May 2011 and May 2013.

Summary of Results

- **The program design concept was successful.** In general, results from the evaluation demonstrate that the Energy Commission effectively used ARRA funding to initiate EEPs in smaller jurisdictions that may not have had the resources to participate in this type of program before. The program effectively targeted often-overlooked opportunities in small cities and counties for which small investments could result in significant savings. This was especially evident in jails and facilities with exceptionally out-of-date equipment. Program-funded projects resulted in better operations and long-term savings for the state.
- **Both EEP and DEP approaches proved to be successful.** Feasibility studies provided a good basis for EEP. In addition, measures that were known to be effective yielded good results for DEP projects, as expected.
- **Targeting "shovel-ready," "low-hanging fruit" was key to program success.** The evaluation team found that the types of projects completed were appropriate for ARRA funding. The program required projects to be easily implementable, "shovel-ready" projects that yielded cost-effective energy savings and showed wise use of public funds. Because so few small jurisdictions had previously implemented EEPs, there was a wealth of "low-hanging fruit" to be picked. Evaluators observed very old equipment replaced by the program with efficient units. These projects provided reliable savings with minimal effort and resources.
- **The program achieved significant savings, due in part to flexible program delivery.** The Energy Commission was able to get the program off the ground quickly, working closely with small jurisdictions through the evolution of their applications to find the most effective and efficient measures. The program achieved its goals of quick implementation, wide outreach, and significant savings.
- **Many jurisdictions also leveraged additional help and funding from other sources.** As a result, many local governments were able to implement more or larger projects using a

combination of its own capital funds, utility rebates, or low-interest loans provided through the ECAA-ARRA Program.

- **Technical support and assistance services were integral to the program.** The constant support of Energy Commission staff working closely with applicants was important to implement the program.
- **The Energy Commission was well-prepared to use ARRA funding effectively for this energy efficiency program.** The existing procedures, trained staff, and application review process all provided a good foundation for the grant program.
- **The program set a strong foundation for the future.** The program allowed small jurisdictions to enact EEPs. Participants reported instances of spillover in site visits and interviews; that is, many site contacts identified additional projects they were hoping to undertake. Others indicated that publicity from the projects caught the attention of their city councils, which opened the door for future projects.

Gross Energy Impacts

The evaluation team calculated ex post energy savings results relative to conditions found before the implementation of energy efficiency measures. Savings compared to this baseline reflect the savings expected on the utility bill due to the energy efficiency measure. Table 26 and Table 27 compare the expected savings estimates (ex ante) with the verified savings (ex post) from the evaluation. Expected savings estimates were derived from the project savings documentation, which was used as the basis for the grant. In the case of the DEP grants, preliminary expected savings were developed to be revised with more accurate evaluation results once the projects were finalized.

Table 26: EECBG Small Cities and Counties Program Evaluation Results − Gross Annual Program-Level Electricity Savings

Phase[1]	Project Type	Annual Ex Ante Electricity Savings (kWh)	Annual Ex Post Electricity Savings (kWh)
Phase I	DEP	13,073,230	13,114,415
	EEP	18,639,925	17,781,299
Phase II	DEP	2,624,009	2,668,877
Total	Total	34,337,164	33,564,591

[1] Phase I consisted of 193 grants funded at $28.4 million. Phase II funded 11 additional DEP projects at $3.5 million.
Source: DNV KEMA

Table 27: EECBG Small Cities and Counties Program Evaluation Results − Gross Annual Program-Level Natural Gas Savings

Phase[1]	Project Type	Annual Ex Ante Natural Gas Savings (therms)	Annual Ex Post Natural Gas Savings (therms)
Phase I	DEP	31,957	25,273
	EEP	208,082	150,197
Phase II	DEP	0	0
Total	Total	240,039	175,470

[1] Phase I consisted of 193 grants funded at $28.4 million. Phase II funded 11 additional DEP projects at $3.5 million.
Source: DNV KEMA

Overall, the 204 projects implemented through the EECBG Small Cities and Counties Program realized about 34 GWh relative to preexisting conditions. The program focused primarily on electric savings but also achieved annual natural gas savings of about 175,000 therms. The overall precision of these estimates, which indicates the reliability of the results, is 6 percent for electric savings at the 90 percent confidence interval. The therm savings estimates were less precise, at 32 percent at the 90 percent confidence interval.

Net Annual and Life-Cycle Energy Impacts

Using participant self-reported responses, the evaluation team determined a net-to-gross ratio of 98 percent for the program. This ratio is applied to the gross energy savings impacts shown in Table 26 and Table 27 to yield the net program impacts shown in Table 28. Net impacts are shown as both annual and life-cycle estimates.

Table 28: EECBG Small Cities and Counties Program Evaluation Results – Net Annual and Life-Cycle Program-Level Savings[1]

	Net-Adjusted Ex Post Electricity Savings (kWh)	Net-Adjusted Ex Post Natural Gas Savings (therms)
Annual	32,893,300	171,961
Life-Cycle	461,636,663	2,730,498

1 These results were updated for the cost-effectiveness analysis to reflect the overlap between projects that received funding from both the ECAA-ARRA and EECBG Programs.
Source: DNV KEMA

Carbon Emission Reductions

Carbon emission reductions accrue when energy is saved or renewable energy is generated, thus avoiding or replacing fossil fuel generation. Because the State of California encourages lower carbon emissions from the power generation sector, California must save more energy to achieve a similar level of carbon emission reductions compared to other states. Evaluators estimated that about 11,000 metric tons of carbon dioxide (CO_2) were avoided annually because

of this program. Over the equipment lifetime, more than 150,000 metric tons of carbon emissions are expected to be avoided. These results are shown in Table 29.

Table 29: EECBG Small Cities and Counties Evaluation Results – Avoided Carbon Emissions

	Avoided Carbon Emissions (metric tons of CO_2)
Annual	11,206
Life-Cycle	158,963

Source: DNV KEMA

Participant Satisfaction and Suggestions for Improvement

Participants revealed that they were generally very happy with the program. They found the Energy Commission's staff to be extremely helpful and believed that the program worked very well, citing the grant program as a positive experience that encouraged cities to enact more projects. They were also very satisfied with the installed equipment and the grant amount they received, although several respondents commented that the paperwork and application process was too bureaucratic and burdensome relative to the small size of the grants. Many participants indicated they had or planned to implement further energy efficiency measures outside the program.

Participants felt that funding received through the EECBG Small Cities and Counties Program was essential or instrumental in their decision to implement the projects. Two participants who reported that funding was helpful but their projects would have been implemented without the program were considered to be free riders. Almost half of respondents indicated that their projects received funding from sources other than the EECBG Small Cities and Counties Program, including other ARRA programs and utility funding. The most common reasons for implementing EEPs at their facilities included reducing energy costs and energy use, followed by replacing poorly performing or outdated equipment and getting funding from the program. Other reasons included reducing carbon emissions.

Self-Reported Job Creation

Evaluators asked participants to quantify job creation resulting from the grant program. Though not a rigorous or official job creation analysis, this offers some insight into the program's effects on local employment. Surveyed participants reported that the program created about 42 jobs, both permanent and temporary, primarily in the mechanical and electrical trades. Many reported that while the program provided work for contractors, they did not know whether this work led to jobs retained or added. Jobs for contractors or other outsiders were reported to be primarily temporary hires, in particular tradesmen such as plumbers and electricians. Permanent hires included layoffs avoided and staff retained. These positions were electricians, technicians, mechanics, and crane operators.

Evaluation Recommendations

Overall, results of the evaluation of the EECBG Small Cities and Counties Program show that California was well-prepared to use ARRA funding effectively for this energy efficiency program. The types of projects completed were appropriate for ARRA funding use. Many projects were easily implementable, "shovel-ready" projects that yielded excellent results and showed wise use of public funds. The evaluation produced a set of recommendations for improving similar programs, should a grant program be developed:

- **Program implementation recommendations:**
    - The use of marketing and outreach, including a workshop to introduce the program, was an effective approach to kick off the program and provides a good example for similar future programs. The Energy Commission team worked with small jurisdictions to provide marketing and outreach to smaller cities and counties, including using clinics to support development of the application.
    - Include technical support and assistance services, working closely with individual applicants. The constant support of Energy Commission staff was important to implement the program.
    - Continue to encourage leveraging other funding sources to provide unique opportunities to maximize funding. These may include incentives from both investor-owned and publicly owned utilities, as well as other Energy Commission funding, such as the Energy Conservation Assistance Account loans.
    - Develop standards for defining the baseline. For example, the Energy Commission could require photographs of the equipment and nameplates and a short statement about the equipment age and operation.
- **Project tracking and documentation:**
    - Continually improve the current approach of technical review and documentation of feasibility studies for EEPs, as this step is critical for effective project implementation.
    - For EEPs, create a consistent set of requirements for feasibility studies and measure justification. Require that the feasibility studies and supporting data provide a high level of transparency with a sufficiently detailed breakdown of how the savings estimates were generated.
    - For DEP projects, require documentation details of the final installation, such as the number and wattages of lights installed.
    - For accurate savings estimations, document preinstallation conditions. For example, preretrofit visits by staff would provide an opportunity to identify equipment age and operating conditions.
    - Where cost-effectiveness and/or jobs analysis is a program goal, develop methods to track labor and equipment costs separately, as well as planning or administrative costs.

- **Measure-specific recommendations:**
    - Continue the focus on lighting, as the low cost and simple installation make it ideal for small jurisdictions with limited experience with energy efficiency.
    - For all measures, require that improvements exceed minimum code requirements and are efficiency upgrades rather than normal replacements.
- **Overall recommendations for subsequent programs:**
    - Continue DEP and EEP approaches. Both approaches proved to be equally successful, yielding similarly high savings and realization rates.
    - Subsequent programs should continue encouraging facilities to replace aging energy equipment by using the savings to pay for new, highly efficient equipment.
    - Consider additional research on ways to reach small jurisdictions effectively and replace aging equipment. Examine the effectiveness of other funding opportunities, such as loans, workshops, and technical assistance.

CHAPTER 6: Energy Efficient State Property Revolving Loan Program

Program Description

California's Department of General Services (DGS) established the Energy Efficient State Property Revolving Loan Fund Program (DGS Loan Fund Program) to fund EEPs in state-owned and state-operated buildings. The initial pool of SEP ARRA funds allocated to DGS totaled $25 million. During the 2009 and 2010 fiscal years, DGS lent out these funds to fund projects. Loan payments are paid back into the program's loan fund and allocated to the next project in the queue. This process is intended to be self-sustaining, as long as loans are paid back and there are cost-effective energy efficiency measures to be installed at state-owned facilities. Since DGS identified many such opportunities, in September 2011 the California Legislature authorized the Energy Commission to transfer additional funds to allow for additional retrofit projects. The Energy Commission transferred about $2.7 million in 2012.

The DGS Loan Fund Program's four major elements consist of the small building element, the large building element, California Department of Corrections and Rehabilitation (CDCR) projects, and the Office of the Chief Information Officer (OCIO) project. The mix of projects implemented during 2009-2010 was extremely diverse, ranging from simple lighting retrofits at small buildings to complicated equipment upgrade and operation optimization projects at very large campuses.

As of August 2012, 64 projects had been implemented, and about $23 million in funds had been distributed. The first annual repayments, more than $3 million, were collected beginning in September 2012. This initial set of projects was expected to save more than 31 GWh and nearly 1.2 million therms per year in energy savings, with energy cost savings totaling about $4 million per year.

Evaluation Results

DNV KEMA evaluated the DGS Loan Fund Program implementation and verified energy savings realized from loans issued during 2009-2010. Additional evaluation goals included determining the proportion of energy savings that would have occurred without the DGS Loan Fund Program, estimating carbon emission reductions and program cost-effectiveness, assessing job creation and market transformation, and informing the Energy Commission of any waste, fraud, or abuse of loan funds. Following finalization of an evaluation plan in April 2011, the evaluation team visited sites from May 2011 through July 2012.

Summary of Results

- **The DGS Loan Fund Program design concept was successful.** In general, results from the evaluation demonstrate that California effectively used ARRA funding to initiate EEPs in state buildings that may not have otherwise had the resources to participate in this type of program. The program effectively targeted opportunities in California correctional facilities, office buildings, and operating facilities. Program-funded projects resulted in better operations and long-term savings for the state.
- **Leveraging existing studies and planned energy efficiency actions was key to the DGS Loan Fund Program success.** The evaluation team found that the types of projects completed were appropriate for ARRA funding. The program provided loans for needed projects that improved operating efficiency, often where existing contracts and feasibility studies could be leveraged. In particular, the funding of projects at CDCR facilities that had been developed but not funded provided reliable savings expeditiously.
- **Solving financial budgeting constraints allowed projects to move forward quickly.** The availability of loan funds that were outside the normal budgeting process allowed identified cost-effective, energy-efficient upgrade opportunities to be installed.
- **The DGS Loan Fund Program sets a strong foundation for the future.** The administrative framework of the program developed procedures and approaches for the ongoing effective use of the revolving loan funds. The availability of loan funds outside the normal budgeting process will continue to facilitate improvements in energy efficiency in state buildings for as long as loans are repaid into the fund. In fact, in February 2012, DGS received the first repayment of loans and has selected several new projects to implement.

Gross Energy Impacts

The evaluation results indicate that the program realized about 30 GWh and 1.4 million therms. The expected savings estimates (also called ex ante savings) are derived from the project savings used as the basis for the loan. Table 30 and Table 31 below compare the expected energy savings estimates (ex ante) with the verified savings (ex post) from the evaluation. The overall precision of these estimates, which indicates the reliability of the results, is 8 percent at the 90 percent confidence interval for electricity and 14 percent for natural gas.

Table 30: DGS Loan Fund Program Evaluation Results – Gross Annual Program-Level Electricity Savings

Loan Group	Annual Ex Ante Electricity Savings (kWh)	Annual Ex Post Electricity Savings (kWh)
Small Buildings	9,027,543	8,418,032
Large Buildings	6,788,621	5,591,422
CDCR	12,206,388	13,131,148
OCIO	3,092,234	2,572,269
Total	31,114,786	29,712,871

Source: DNV KEMA

Table 31: DGS Loan Fund Program Evaluation Results – Gross Annual Program-Level Natural Gas Savings

Loan Group	Annual Ex Ante Natural Gas Savings (therms)	Annual Ex Post Natural Gas Savings (therms)
Small Buildings	130,245	178,494
Large Buildings	60,893	37,929
CDCR	1,001,738	1,210,118
OCIO	0	0
Total	1,192,876	1,426,541

Source: DNV KEMA

Net Annual and Life-Cycle Energy Impacts

Using self-reported responses to a participant telephone survey, the evaluation team assessed the extent to which the gross energy savings could be attributed to the program. All 11 of the surveyed participants indicated that the projects would not have moved forward without the program. Most of these projects were previously identified by DGS and were determined to have cost-effective, energy-efficient retrofit opportunities. The results of the interviews indicate that without the financial support provided through the program, none of the projects would have been implemented during this same time frame, if at all. Therefore, the net energy savings attributable to DGS was determined to be equal to 100 percent of the gross energy savings.

Savings continue to accrue beyond the first year a facility implements an energy-efficient measure. As shown in Table 32, life-cycle savings for the measures implemented through DGS totaled more than 400 GWh and nearly 23 million therms. The projects implemented at CDCR facilities accounted for more than 95 percent of the life-cycle natural gas savings and more than 40 percent of the life-cycle electricity savings. These projects consisted primarily of HVAC retrofits in prisons and other correctional facilities.

Table 32: DGS Loan Fund Program Evaluation Results – Net Annual and Life-Cycle Program-Level Savings

	Net Ex Post Electricity Savings (kWh)	Net Ex Post Natural Gas (therms)
Annual	29,712,871	1,426,541
Life-Cycle	429,574,170	22,944,438

Source: DNV KEMA

Carbon Emission Reductions

Carbon emission reductions accrue when energy is saved or renewable energy replaces fossil generation. As shown in Table 33, evaluators estimate that nearly 17,000 metric tons of carbon emissions were avoided annually, and more than 250,000 metric tons avoided over the lifetime of the measures as a result of this program.

Table 33: DGS Loan Fund Program Evaluation Results – Avoided Carbon Emissions

	Avoided Carbon Emissions (metric tons of CO_2)
Annual	16,864
Life-Cycle	256,113

Source: DNV KEMA

Participant Satisfaction and Suggestions for Improvement

Interviews with participants revealed very high levels of satisfaction with the DGS Loan Fund Program, including the equipment installed and amount of the loans received. Participants were somewhat less satisfied with the loan structure and amortization schedule, and some reported dissatisfaction with the program compliance requirements, such as the Buy American Act and the Davis Bacon Act provisions.

Self-Reported Evidence of Job Creation

Although based on self-reported evidence, several participants reported that jobs were created in each of their facilities, with 31 jobs reported as added or retained. The participants were typically facilities managers or loan managers and did not necessarily have hiring or job creation authority. Many participants speculated that jobs might have been created and/or retained within the energy efficiency contracting industry, mostly engineers, but some at management level.

Evaluation Recommendations

The evaluation produced a set of recommendations for improving the program going forward:

- **Continue to identify, prioritize, and effectively target projects that will most cost-effectively contribute to meeting the state's energy and carbon emission reduction goals.**
    - DGS may want to identify and work with agencies and entities that need to reduce energy consumption further to meet government mandates requiring state agencies to reduce carbon emissions by 10 percent by 2015 and 15 percent by 2020.[6] By identifying where opportunities at state agencies exist, DGS can target them more effectively.
- **Improve the loan selection process.**
    - The federal timeline for spending ARRA funds reduced the opportunity to assess the loans and minimize risk. The ongoing program should incorporate a longer loan review stage to select projects that have reasonable certainty for achieving expected savings. DGS can adopt a more rigorous evaluation process of the project's feasibility to save energy before granting the loan.
    - DGS may want to compare the program approval process with other state or municipal revolving funds to seek the best practices for the loan approval process.
- **Consider researching and then implementing organizational "best practices" for meeting energy efficiency and building performance goals.**
    - Organizations have successfully implemented many activities to help reduce energy and meet building performance goals, ranging from the advanced (such as tracking energy consumption and mining energy management data to identify energy efficiency opportunities) to the simplistic (such as "treasure hunt" competitions among facility managers to identify opportunities).
    - Another energy efficiency building management best practice is to formally incorporate energy efficiency into long-term plant operations and capital planning.
    - Other organizations have found that building occupant and tenant education is key to realizing the full potential of energy efficiency measures. This practice is especially important when introducing new technologies, such as lighting and temperature controls.
    - In addition, creating a forum for agencies and facility managers to share energy efficiency success stories (and failures) within DGS should be considered. This forum will encourage innovative thinking and knowledge transfer.

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6 The Governor's Executive Order B-18-12 requires all state-owned buildings to reduce their grid-based energy purchases by 20 percent by 2018 and reduce carbon emissions by 20 percent by 2020.

- Revisit government procurement procedures to continually improve energy efficiency. This review will encourage agencies to keep energy innovation at the forefront.

- **Encourage project co-funding through other sources, such as utility programs and state budgets.**
  - Leveraging funding from utilities or internal state funding allows the completion of large, comprehensive projects. The funding through ARRA, combined with the CDCR partnership program with the utilities, resulted in significant savings.
  - Access to funding from other sources allows agencies to implement a greater range of measures, such as demand response and advanced building automation technologies that enable further savings, in addition to effectively designed EEPs that improve performance of state buildings.
- **Adopt more rigorous project savings analysis and documentation requirements.**
  - In general, the evaluators found less variation in realization rates from projects that were subject to more rigorous savings documentation early on, such as when developed by energy service companies (ESCOs) or in partnership with utilities. During on-site verification, the evaluation team sometimes saw substantial deviations between what was reported and what had been observed as implemented. For example, operational hours observed for installed equipment may have been significantly different from what was reported in ex ante estimates.
  - Preretrofit and baseline conditions should be carefully documented.
  - In addition, it is important to consistently maintain tracking data at the measure level as the program evolves. Data on scope of work changes for a project were not always available to the evaluation team, though status updates were useful. To ease future evaluation efforts, it would help to have a regularly maintained tracking database to keep abreast of project changes.
  - Provide protocols on how to calculate peak demand savings so that they are developed in a consistent format.
  - Require tracking of peak impacts.
- **Consider changes to program design.**
  - Develop an approach that focuses on small buildings across the state, allowing remote and rural locations to be addressed. Consider contracting terms that provide incentives for projects across the portfolio, regardless of contractor travel time.
  - Analyze buildings and develop targeted approaches for different building segments.
  - Provide technical resources, such as available staff and a toolkit for small buildings.

- Adapt loan payment due dates to allow projects to generate a year's worth of savings before payment is due.
- Consider including distributed generation projects that meet payback requirements.
- Consider including long-term monitoring for savings persistence for the projects with the most savings.

Finally, the DGS Loan Fund Program was designed to provide a continuous pool of funding for continuous energy efficiency upgrades to state buildings. According to the program loan administrator, the loans funded the largest number of EEPs since 2001. Before the loan fund under ARRA, many projects were identified, but the funding was not available to move forward. The ARRA funding allowed these projects to be completed. The program achieved its goal of delivering long-term, self-sustained energy efficiency in state facilities through this effective revolving loan program.

CHAPTER 7: Municipal and Commercial Building Targeted Measure Retrofit Program Evaluation Summary

Program Description

In response to the funding provided through ARRA, the Energy Commission designed and administered new SEP pilot programs, including the Municipal and Commercial Building Targeted Measure Retrofit (MCR) Program. This program was designed to install targeted, high-impact energy efficiency measures in nonresidential buildings across California. A primary goal of the programs was to move the markets for these technologies toward becoming self-sustaining. It built upon the Public Interest Energy Research (PIER) Technology Demonstration Program in which the successful deployment of several lighting and HVAC measures had saved at least half of the energy used by the technologies they replaced.

The MCR Program objectives were defined as follows:

- Achieve significant energy savings from targeted retrofit measures where opportunities exist in large numbers across the state's municipal and commercial building sectors.
- Capitalize on low-risk, high-return efficiency opportunities that are readily available throughout the state.
- Establish high-volume purchasing agreements with technology manufacturers to reduce equipment costs and minimize payback periods.
- Train entry-level workers and/or professional tradespeople to conduct on-site assessments and retrofit installations via partnerships with community colleges and other regional organizations.
- Develop public and private partnerships to deploy targeted measures quickly and effectively by leveraging other existing retrofit program funds, other related program-area funds, and/or revolving funds.

Through a competitive solicitation process, the Energy Commission awarded a total of $29.6 million to the three subrecipient programs described below.

1. **EnergySmart Jobs (ESJ)**, designed and implemented by PECI, delivered relatively new technologies to grocery stores, convenience stores, and restaurants. These technologies included light-emitting diode refrigerator case lighting, motion sensors, and multistaged refrigeration controls, along with off-the-shelf products such compact fluorescent lamps and beverage cooler controllers. The program trained (1) California Conservation Corps (CCC) members to conduct equipment surveys and deliver direct-install products and (2) contractor firms to install program products requiring greater sophistication. To

catalyze and transform the markets for the newer technologies promoted by the program, PECI pursued strategies that included pricing reductions, product research and development, market penetration assessment, and energy efficiency education for grocery/convenience store and restaurant owners.

2. **Energy Technology Assistance Program (ETAP)**, designed and implemented by Energy Solutions, targeted city, county, university, and nonprofit buildings. The program delivered bilevel luminaires with occupancy sensors at and around garages and parking lots, wireless controls for constant volume HVAC systems, and wireless lighting controls. Energy Solutions developed information sheets and case studies to educate the targeted markets about the program's advanced technologies. In addition, the program provided workforce development training for electricians, building ventilation installers, interns, and building staff members such as facility managers.
3. **Oakland Shines (OS),** designed and implemented by QuEST, targeted commercial building owners, their tenants, and college campuses within Oakland. The program delivered bilevel luminaires with occupancy sensors at garages and parking lots, light-emitting diode refrigerator case lighting and occupancy sensors at grocery/convenience stores, wireless controls for constant volume HVAC systems, and custom lighting projects. The OS Program developed a strong marketing campaign in Oakland that included door-to-door visits and signs at bus stops and Bay Area Rapid Transit stations. Workforce development efforts included training contractors about the program's advanced wireless technologies and an intern program for students looking to develop a career in energy efficiency or other "green" fields.

Evaluation Results

The evaluation team determined that the MCR Program installed energy efficiency measures at 7,417 project sites and achieved significant energy savings across California's municipal and commercial building sectors. Using the results of on-site visits, engineering analyses, and participant surveys from a sample of the project sites within each subrecipient program, the evaluation team determined the annual and life-cycle energy impacts for electricity, demand, and natural gas as well as the avoided carbon emissions.

Gross Energy Impacts

The evaluation results indicate that, overall, the MCR Program realized about 85.8 GWh in annual electricity savings, about 8.6 MW in demand reductions[7] and about 950,000 therms in annual natural gas savings. These results are shown in Table 34, Table 35, and Table 36.

7 For this analysis, demand savings were defined as hourly electricity usage reductions; these differ from peak demand saving as defined by the CPUC.

Table 34: MCR Evaluation Results – Gross Annual Program-Level Electricity Savings

MCR Subrecipient Program	Annual Gross Ex Ante Electric Savings (GWh)	Annual Gross Ex Post Electric Savings (GWh)
ESJ	63.6	58.9
ETAP	23.0	23.1
OS	4.3	3.8
Total	90.9	85.8

Source: DNV KEMA

Table 35: MCR Evaluation Results – Gross Annual Program-Level Demand Reductions

MCR Subrecipient Program	Annual Gross Ex Ante Demand Reductions[1] (MW)	Annual Gross Ex Post Demand Reductions[1] (MW)
ESJ	6.9	6.3
ETAP	1.3	1.3
OS	0.7	1.0
Total	8.9	8.6

[1] Demand savings are defined as hourly electricity usage reductions; these differ from peak demand saving as defined by the CPUC.

Source: DNV KEMA

Table 36: MCR Evaluation Results – Gross Annual Program-Level Natural Gas Savings

MCR Subrecipient Program	Annual Gross Ex Ante Natural Gas Savings (therms)	Annual Gross Ex Post Natural Gas Savings (therms)
ESJ	(94,923)	(56,771)
ETAP	948,018	990,827
OS	65,418	14,033
Total	918,513	948,089

Source: DNV KEMA

Net Annual and Life-Cycle Energy Impacts

Using participant responses, the evaluation team determined net-to-gross ratios for each of the MCR subrecipient programs as follows:

- ESJ – 97.8 percent
- ETAP – 99.5 percent
- OS – 94.0 percent

These ratios were applied to the gross energy impacts presented above to yield the net program impacts shown in Table 37. Net impacts are shown as both annual and life-cycle estimates.

Table 37: MCR Evaluation Results – Net Annual and Life-Cycle Program-Level Savings

	Net Ex Post Electricity Savings (GWh)	Net Ex Post Electricity Demand Reductions[1] (MW-years)	Net Ex Post Natural Gas Savings (therms)
Annual	84	8.4	943,645
Life-Cycle	877	76.7	14,874,614

[1] Demand savings are defined as hourly electricity usage reductions; these differ from peak demand saving as defined by the CPUC.

Source: DNV KEMA

Carbon Emission Reductions

Evaluators estimated that more than 31,000 metric tons of carbon emissions were avoided annually because of this program, as shown in Table 38.

Table 38: MCR Evaluation Results – Avoided Carbon Emissions

	Avoided Annual Carbon Emissions (metric tons of CO_2)
Annual	31,351
Life-Cycle	353,466

Source: DNV KEMA

While each subrecipient program targeted different markets and segments, each approached their respective markets in similar ways. The programs collaborated with established entities to gain market acceptance, offered technologies typically not promoted in investor-owned and municipal utility programs, and trained surveyors, installers, and building owners to install and maintain these technologies properly and effectively. A more detailed discussion of each program follows.

ESJ Evaluation Results Summary

The ESJ Program, implemented by PECI, proved enormously successful at delivering energy efficiency measures to grocery/convenience stores and restaurants across California. ESJ installed energy efficiency measures at 7,108 stores and restaurants, realizing 58.9 GWh of annual electricity savings and 6.3 MW of demand savings. Since PECI accounted for the interactive effects of installing more efficient lighting equipment in conditioned spaces − typically causing heating loads to increase − the program yielded negative annual natural gas savings of -56,771 therms.

ESJ was well-received by the target market and resulted in a much higher-than-anticipated uptake of the contractor-installed technologies early in the program. Due to this early success, the implementer and the Energy Commission decided to scale back the targeted 25,000 in-store surveys; as of the program's conclusion, 6,025 surveys were completed. Furthermore, all rebate funds had been committed nearly nine months prior to the program's conclusion. However, the accelerated uptake left some of the partner contractors and manufacturers with less-than-favorable perceptions of the program as the product demand did not persist after rebate funds were exhausted.

Workforce development was an integral goal of the ESJ Program. When PECI chose the technologies to offer, it not only considered demonstrated energy savings potential, but also considered the necessary training to conduct on-site surveys and install the simpler energy efficiency measures. PECI trained 132 CCC members to perform these duties. These were multiday training sessions held around the state to teach about energy efficiency technologies, best practices, and benefits, and to develop the necessary skills to perform the on-site surveys.

More than one-third of the program-trained surveyors were selected to participate in the advanced surveyor training that was developed in partnership with product manufacturers, and to learn how to identify opportunities for and install the more complex, contractor-installed technologies offered by the program. To ensure effective installations of these technologies, only contractors with prior experience with the more complex technologies were selected to perform the retrofits.

The program met its workforce development goals by establishing 118 full-time- equivalent positions during the program. While participating contractors hired some surveyors, there is no evidence that the majority of the jobs created during the program will be sustained beyond the end of the program. However, some contractors indicated that they may have hired some of the program-trained surveyors if they been more aware of them.

ESJ had three major market transformation goals:

- Product pricing reductions through higher volume production triggered by the increased project demand generated by the program.
- Penetration of the historically difficult-to-reach grocery and convenience store markets.
- Significant increase in the knowledge regarding the benefits of energy efficiency among grocery/convenience store owners, surveyors, and contractors.

The program met these goals with varying success:

- The price of the program products proved more difficult to influence than desired given the relatively brief duration of the program. However, a few contractors reported that they experienced a growing number of inquiries from nonparticipants regarding the program technologies. These inquiries have led them to expect slow but gradual market growth.

- Reaching the grocery and convenience store markets was far more successful than planned and yielded a dramatically higher percentage of stores that went on to implement the contractor-installed measures than anticipated. In particular, the program successfully reached small grocery and convenience stores that conventional rebate programs have struggled to reach.
- The market uptake of the program's relatively new energy-efficient technologies grew dramatically through the program. Participant understanding regarding the benefits of program participation and energy efficiency grew, but maintenance practices proved harder to influence.

Telephone surveys of ESJ participants revealed the following:

- Most participants reported a high degree of satisfaction with many program delivery facets, including surveyor services, contractor installations, rebate application processes, and reporting requirements.
- Most participants surveyed achieved both energy savings and operating cost reductions consistent with their expectations. They were also satisfied with the energy efficiency information and technical assistance provided to them by the program.
- Most participants indicated that they would be very likely to participate in a similar incentive program (74 percent). However, without the same incentives, only 7 percent indicated the same likelihood, and 63 percent of participants surveyed indicated that they would still require financial assistance to proceed with similar projects in the future.
- Very few participants were free riders (2 percent, weighted by savings)—hence, the net savings attributable to the program are 98 percent of gross savings.

ETAP Evaluation Results Summary

ETAP, implemented by Energy Solutions, was very successful at delivering energy efficiency measures to municipal and higher education facilities in California. The program installed energy efficiency measures at 114 project sites and realized 23.1 GWh of annual electricity savings, 1.3 MW of demand savings, and 990,827 therms of natural gas savings.

In addition to saving energy, ETAP provided technical assistance and financial incentives to accelerate the uptake of three advanced energy efficiency technologies in the local government market and create a sustainable market. Furthermore, the program increased contractor and facility manager knowledge of new energy efficiency technologies through outreach that included showcasing completed retrofits. The program set out to increase the number of trained workers knowledgeable about the program technologies through its workforce development activities. The program successfully trained 40 electricians, 20 HVAC installers, and 4 interns. The program conducted six seminars as planned but nearly quadrupled its attendance target of 10 per seminar for a total of 229 attendees.

Market actor interviews revealed that contractor and facility manager knowledge of, and interest in, the program's energy efficiency technologies improved through the program's outreach and educational activities. Contractors also promoted the technologies outside the program as a way for customers to save money by realizing both smaller energy bills and decreased maintenance costs. The program successfully overcame barriers to adoption of the technologies by demonstrating to facility managers that the retrofits and technologies were affordable and would generate energy bill savings. Training participants agreed that the program improved their awareness of the broad array of energy-efficient technologies available and increased their knowledge of the features, benefits, and maintenance requirements of the technologies. They reported plans to disseminate this knowledge throughout the relevant groups within their organizations. Through telephone surveys of program participants, evaluators learned that:

- The vast majority reported a high degree of satisfaction with many facets of program delivery, including presentation of energy efficiency information, technical assistance, contractor installations, rebate application processes, and reporting requirements.
- Most participants surveyed achieved both the energy savings and cost reductions that they had expected. Slightly more than half reported that their participation also affected the way they maintained or used equipment, suggesting that some behavioral effects may persist.
- Most participants (81 percent) are very likely to participate in a similar program if that program offers comparable financial incentives. Without similar financial incentives, only 11 percent would be very likely to participate again.
- Very few participants were free riders (1 percent, weighted by savings) – hence, the net savings attributable to the program are 99 percent of gross savings.

Oakland Shines Program Evaluation Results Summary

The OS Program, implemented by QuEST, was very successful at delivering energy efficiency measures to commercial and municipal buildings in Oakland. Each Oakland business located on the ground level was contacted at least twice to inform owners of the program and, when permitted, conduct a survey. With the help of interpreters, the OS Program experienced the greatest level of participation in a very difficult-to-reach neighborhood: Oakland's Chinatown.

At the beginning of the program, the need for efficient office and classroom lighting in the downtown corridor was thought to have been greater than was actually found during the surveys. However, the need for efficient lighting in the refrigeration cases in stores and restaurants was greater than anticipated, particularly in Oakland neighborhoods outside the downtown corridor. These findings led to a shift to promote the LED luminaires more heavily to all Oakland businesses. Since LED luminaires are a very cost-effective measure, the Energy Commission increased OS Program funding by $250,000 to support this shift and meet the needs of more Oakland's businesses.

At the program's conclusion, 227 instances of energy efficiency measure installations at 195 project sites realized 3.8 GWh of annual electricity savings, 1.0 MW of demand savings, and 14,033 therms of annual natural gas savings.

In addition to energy savings, the OS Program's goals included:

- Reduction of energy costs to businesses operating in Oakland through the installation of targeted energy-efficient technologies.
- Workforce development through program-specific training.
- Creation of jobs through collaboration with city government and investor-owned utilities to generate more contracts for energy efficiency contractors and consultants.

The OS Program achieved the above goals to varying degrees as described below:

- Since the retrofits offered through the OS Program yielded 44 GWh of net electricity savings over the life of the equipment, the energy cost savings to Oakland businesses were substantial. Most participants reported achieving both energy savings and cost reductions comparable to their expectations.
- The training element of the program successfully delivered technical training sessions through partnerships and internships. Contractors and facility managers reported their knowledge of the benefits of energy-efficient equipment improved as a direct result of the program.
- Job creation, however, was not as successful. The program generated new retrofit projects, but there is no evidence to show that new jobs resulted at participating facilities or contractors.

Through telephone surveys of OS program participants, evaluators learned:

- Overall, program participants expressed a high degree of satisfaction with many of the program's facets, including audit services, installations, and the application process.
- While participants did report an increased knowledge of energy-efficient equipment, more than two-thirds reported no expectation that this new knowledge would affect their equipment maintenance practices.
- Likely due in part to their positive experience with the program, the majority of participants expressed a high likelihood of implementing additional projects when a rebate became available (82 percent). However, this percentage dropped dramatically if no incentives were available (19 percent).
- More than half of the surveyed participants indicated they would consider installing other energy efficiency measures without incentives in the next two years.
- Few participants were free riders (6 percent, weighted by savings)—hence, the net savings attributable to the program are 94 percent of gross savings.

Evaluation Recommendations

The ESJ Program used a very effective design to achieve a large energy impact at a relatively low cost. Hence, the evaluation team prepared a relatively short list of recommendations for future programs similar to ESJ:

- Provide timely communication of changes to program strategy so partner contractors and manufacturers can shift their expectations and make purchasing and hiring decisions to match program needs.
- Only 7 percent of program participants surveyed indicated that they would participate in a similar program without financial incentives. However, when comparable financial incentives are included, the participation proportion increased to 75 percent. The implication is that rebates will continue to be essential to reach this market.

The ETAP evaluation concluded that a dramatic decrease in participation would likely result if financial incentives were no longer offered. This difference is very likely due to external factors affecting the market targeted by the program: municipal customers operate under severe budget constraints. Even though the program made significant strides to overcome information barriers, the activities promoted under the program will not become significant without incentives until facility managers have larger capital budgets. Recommendations to improve the program going forward include:

- Understand and budget for the time necessary to develop partnerships with associations, organizations, and vendors that will help accelerate program uptake.
- Design marketing tactics specific to the targeted markets. For example, produce educational materials and training specifically geared for staff in municipal and higher educational markets.
- Provide technical assistance to state-funded entities that includes education on technology applications and benefits, along with interactive guidance regarding participation requirements, applications, and reporting forms.
- To help sustain the rate of uptake generated through the program, continue to offer financial support to overcome first-cost barriers associated with the advanced technologies promoted by the program.

Recommendations to improve the OS Program going forward include:

- Consider training contractors on general business practices and customer service in addition to energy-efficient technologies.
- Continue to build relationships with community groups and regional agencies to foster trust and increase awareness of energy efficiency technologies. Avoid emphasizing

electronic social media at the expense of approaches such as door-to-door marketing and community events that generate direct contact between implementers and customers.

- Develop a more rigorous tracking database at the beginning of the program by requiring a unique record for each measure type installed at given site.
- Establish a clear and consistent method for determining the demand savings. The methods used for claimed demand savings varied and led to evaluation challenges.

CHAPTER 8:
Other Evaluation Results

In this chapter, the evaluation team presents other results from the evaluation, including impact evaluation results using alternative definitions of baseline, and results from additional cost-effectiveness tests.

Alternative Baseline Analysis

The evaluation team calculated ex post energy savings results relative to two baselines:

- Baseline 1 corresponds to the existing conditions found before implementing the energy efficiency measures and considers the operating efficiency of the equipment, along with the control strategies found at that time. This baseline is relevant when considering payback periods.
- Baseline 2 corresponds to the expected replacement conditions (for example, standard practice, or code minimum). The annual savings are estimated comparing the installed measure to expected replacement. This baseline represents the savings from improvements in efficiency due to the measure, compared to currently available options.

Baseline 1 assumes that conditions found before implementation of energy efficiency measures would persist indefinitely without the program. Savings compared to Baseline 1 reflect the savings expected on the utility bill due to the energy efficiency measure. As such, this approach results in an estimate of energy savings to which participants can relate and use as a point of comparison to past utility bills.[8] Savings compared to Baseline 1 were reported in the preceding chapters of this report.

Baseline 2 assumes that, if the preexisting equipment has exceeded its remaining useful life (RUL), it would have been replaced with more efficient equipment without the program, based on codes or standard practice. Savings compared to Baseline 2 show the value of selecting energy-efficient equipment that exceeds standard practice or minimum code requirements. Estimating the impacts using Baseline 2 is useful from a policy perspective since it avoids the chance of double-counting potential savings from the ARRA-funded programs and savings from codes and standards programs. In addition, this conservative estimate is useful as an input to forecasts for electricity and natural gas demand, where double-counting of impacts could lead to supply interruptions or overbuilding of facilities.

8 State and Local Energy Efficiency Action Network. 2012. *Energy Efficiency Program Impact Evaluation Guide*. Prepared by Steven R. Schiller, Schiller Consulting, Inc., www.seeaction.energy.gov.

In addition, evaluators developed life-cycle savings estimates for each baseline. Life-cycle savings are sum of the annual savings expected to accrue for each year of the life of the measure.

- The evaluation team calculated life-cycle savings for Baseline 1 by using the same annual savings for every year of measure life. The evaluation team assumes that the preexisting equipment would have operated for the full effective useful life (EUL) of the new equipment regardless if the existing equipment was at the end of its useful life. Life-cycle savings for Baseline 1 were reported in the preceding chapters of this report.
- Baseline 2 uses the preexisting equipment as the baseline of the measure only until the end of the RUL of the existing equipment. After that, an expected replacement baseline (such as standard practice or code minimum) is used until the EUL is reached. Resource planners use this baseline as a conservative assumption so that efficiencies that would be gained over time are not double-counted.

For measures where the existing equipment was still within the EUL, Baseline 2 was applied at the end of the EUL of the equipment to calculate the life-cycle savings. For example, if a chiller with an EUL of 20 years was replaced after only 15 years of service, the life-cycle savings calculations used the existing equipment (Baseline 1 annual savings) as a baseline for the first 5 years and an "expected" replacement (Baseline 2 annual savings) for the remaining 15 years. However, there were many sites where the equipment replaced was beyond the EUL. If this equipment was still operational, it was given an RUL of one year. This means the first year of the life-cycle savings would use the existing equipment as the baseline (Baseline 1 annual savings), and the rest of the years would use the "expected" replacement annual savings (Baseline 2 annual savings). If there was no preexisting equipment (as in the case of many controls measures), the RUL was effectively zero. In this case, there is no difference between Baseline 1 and 2.

For many measures, the two baselines are the same. Add-on measures, such as occupancy sensors to reduce lighting energy and retrocommissioning measures to improve controls and operation, do not change the efficiency of the underlying equipment; there are no differences between the baselines. For lighting retrofits that do not trigger Title 24 lighting power-density requirements, both baselines are the same. Where there were differences, Baseline 2 savings were typically lower than Baseline 1 savings. This was especially true for HVAC measures, given that old HVAC equipment operates much less efficiently than standard, code-compliant equipment.

There was one large project (ECAA-ARRA) where an efficient HVAC system was installed, replacing a system that could not meet the facility needs. The new system improved performance but used considerably more energy. Compared to current conditions (Baseline 1), the new system showed more fuel consumption, but compared to a comparable, properly sized, standard efficiency system (Baseline 2), the realization rate was more aligned with expectations. In this case, the savings are greater for Baseline 2. This case illustrates the usefulness of having

both baselines for comparison. The value of this project is more apparent when comparing the new efficient system to a minimally compliant system than it is in comparing it to the old, poorly functioning system.

Table 39 presents Baseline 1 and Baseline 2 evaluation results for the six programs where it was relevant (DGS, ECAA-ARRA, EECBG Small Cities and Counties, and the three MCR Programs). As shown, for these six programs combined, the overall percentage difference between Baseline 1 and Baseline 2 was 7 percent for electricity savings and 15 percent for natural gas savings.

Table 39: Comparison of Baseline 1 and Baseline 2 Evaluation Results

Program Name	Annual Ex Post Electricity Savings (GWh)			Annual Ex Post Natural Gas Savings (therms)		
	Baseline 1	Baseline 2	Percent Difference	Baseline 1	Baseline 2	Percent Difference
DGS Loan Fund Program	29.7	29.6	0%	1,426,541	1,061,804	26%
ECAA-ARRA	16.2	15.5	4%	42,392	63,532	-50%
EECBG Small Cities and Counties	33.6	32.2	4%	175,470	127,822	27%
MCR – ESJ	58.9	49.7	16%	-56,771	-56,771	0%
MCR – ETAP	23.1	23.1	0%	990,827	990,827	0%
MCR – OS	3.8	3.5	8%	14,033	14,033	0%
Total	165.3	153.6	7%	2,592,492	2,201,247	15%

Source: DNV KEMA

Cost-Effectiveness

Background

A key component of the evaluation process for programs using public funds is to compare programs' benefits and costs. Showing the relationship between the value of a program's benefits and the costs incurred to achieve those benefits provides decision makers with information to judge whether programs should be retained and/or improved. The ARRA programs were designed to provide a wide range of benefits, including jobs and economic recovery, energy bill savings, environmental benefits, and many non-energy benefits to building owners and operators, as well as supply system cost and reliability benefits. From strictly an energy system resource perspective, the costs to achieve the energy savings can be compared to supply-side options and provide feedback on whether the program in its existing form pays for itself.

The foremost objectives of ARRA were to create jobs and encourage economic recovery during the ARRA program period, and to encourage market transformation and promote national, state, and local energy goals and programs. DOE directed that the SEP Recovery Act Cost test (SEP-RAC) be used for planning purposes and measuring the cost-effectiveness of SEP-funded program portfolios. (The SEP-RAC test is not intended to be applied to individual programs.)[9] DOE guidance stated, "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 did not want these tests focused on least-cost energy supplies to get in the way of accomplishing the short-term jobs and long-term program development goals of ARRA.

DOE guidance for EECBG stated, "…each entity is required to use the funds in a cost-effective manner that is of maximum benefit to the population of that entity and in a manner that will yield continuous benefits over time in terms of energy and emission reductions."[10] States and local governments administering EECBG funds were on their own to establish cost-effectiveness criteria. The Energy Commission expected that small cities and counties receiving EECBG funds from the Energy Commission would meet the SEP-RAC test for their facilities upgrade projects. There was no expectation that the EECBG program as a whole, including administrative and program implementation costs, would meet the SEP-RAC test.

In addition to the SEP-RAC test, the Energy Commission asked DNV KEMA to assess the ARRA programs' cost-effectiveness using other optional tests for information purposes only. The other tests related to least-cost resource comparison − the Total Resource Cost Test (TRC), the Program Administrator Cost Test (PAC), and the Participant Cost Test (PC) − are defined in California's Standard Practice for Cost-Benefit Analysis of Conservation and Load Management Programs Manual (SPM). The SPM tests were performed because they are the main tests that the CPUC uses when evaluating California's energy efficiency programs.

Each cost-effectiveness test differs in terms of (1) perspectives, (2) the applicability to different program types, (3) which cost and benefit elements are included in the calculation, (4) the methods by which the cost and benefit elements are computed, and (5) the uses of the results. Each test provides different information about the effects of the ARRA programs from different vantage points in the energy system. On its own, each test provides a single stakeholder perspective. Looking at the cost-effectiveness tests together helps characterize the attributes of a program to provide decision makers with information regarding whether programs in their current form are effective overall or too costly, whether some costs or incentives are too high or

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9 State Energy Program Notice 1-001 and EECBG Program Notice 11-001, January 21, 2011. http://www1.eere.energy.gov/wip/pdfs/11_001_eecbg_sep_building_best_practice.pdf.

10 U.S. DOE, Financial Assistance Funding Opportunity EECBG − Formula Grants, ARRA, CFDA Number: 81.041, State Energy Program, March 26, 2009, p.25; http://www.energy.ca.gov/recovery/guidelines/DE-FOA-00000131.doc (accessed December 12, 2013).

too low, and what adjustments could be made to improve the distribution of costs and benefits among stakeholders.

As shown in Table 40, the Energy Commission's portfolio of ARRA programs was successful overall and achieved the goal of a SEP-RAC test result of greater than 10. More details about the other cost-effectiveness tests follow.

Table 40: Cost-Effectiveness Results by Program

Program	SEP-RAC Test	Other Cost Effectiveness Tests					
		TRC Test		PAC Test		PC Test	
		Levelized Costs					
	MM BTU (annual)/ $1000	$/kWh	$/therm	$/kWh	$/therm	NPV Benefits with Incentives	Discounted Payback (years)
CCRR	4.2	$0.42	$5.00	$0.14	$2.49	($11,620,717)	23.2
DGS Loan Fund Program	20.8	$0.06	$0.62	$0.01	$0.06	$40,810,181	4.9
ECAA	10.2	$0.16	$1.75	$0.02	$0.26	$14,829,068	8.7
EECBG SCC	11.9	$0.12	$1.35	$0.10	$1.11	$62,077,602	0.0
MCR	35.3	$0.07	$0.53	$0.04	$0.21	$92,089,971	1.5
Portfolio	10.1	$0.15	$2.32	$0.07	$1.17	$198,186,105	6.1

Source: DNV KEMA

Total Resource Cost Test

The TRC test measures the net costs of a program as a resource option. The TRC helps to answer whether an energy efficiency program is cost effective compared to alternative sources of electricity generation. Project costs and program operator expenditures are included, but incentives and loans are considered transfer payments[11] and are not included in this test. The TRC test is usually calculated on a life-cycle basis, considering savings and costs that accrue over the lifetime of installed energy efficiency equipment or systems. This is a commonly applied cost-effectiveness test. The CPUC's reliance on the TRC test as the primary indicator of energy efficiency program cost-effectiveness is consistent with its view that ratepayer-funded energy efficiency should focus on portfolios of programs that serve as resource alternatives to supply-side options. The TRC test assesses the full costs (or total resource cost) from both the program administrator and program participant perspective, divided by the lifetime energy savings achieved. Incentives do not influence this test since they are considered a transfer payment. For this analysis, results of the TRC test are expressed as levelized cost of energy or

11 In economics, a *transfer payment* is a redistribution of income that is made without any exchange of goods or services.

constant dollars per energy unit saved (for example, $/kWh) over the useful life of the resource. By levelized (or average) costs, cost of energy is typically used to compare the average costs over time of demand side and supply side resources. However, it is not the only aspect of programs to evaluate. It does not capture the non-energy benefits (such as increased comfort, convenience, or property values) and externalities (such as environmental benefits) of programs. It also does not consider whether a program is cost-effective from the perspective of the program administrator.

Table 40 shows the results from the TRC test. As shown, the Energy Commission portfolio of programs achieved an overall levelized cost for electric measures of $0.15 per kWh and a levelized cost for gas measures of $2.32 per therm. The DGS and MCR programs were the most cost-effective program on the electric side with levelized costs of $0.06 and $0.07 per kWh saved, respectively. The EECBG Small Cities and Counties Program was the next most cost-effective program with a levelized cost of $0.12 per kilowatt hour (kWh) saved. Gas TRC results varied from $0.62 and $0.53 per therm for DGS and MCR, respectively, and $1.35 and $1.75 per therm for the EECBG Small Cities and Counties Program and ECAA-ARRA, respectively. The CCRR Program achieved TRC levelized cost results of $0.42 per kWh and $5.00 per therm.

Program Administrator Cost Test

The PAC test assesses cost-effectiveness from the perspective of the program administrator and considers only program costs. For this analysis the results of the PAC test are expressed as levelized cost of energy or constant dollars per energy unit saved (for example, $/kWh) over the useful life of the resource. By levelizing (or averaging) costs, program administrators can compare inclusion of alternative measures and incentive levels to achieve energy savings and can compare energy efficiency programs to the cost of building or purchasing supply side resources.

Overall, as shown in Table 40, the ARRA portfolio of programs achieved an electric levelized cost of $0.07 per kWh and $1.17 per therm. Due to its relatively low administrative costs, the DGS Loan Fund Program was the most cost-effective program from the PAC test perspective, with levelized costs of less than $0.01 per kWh and $0.06 per therm. ECAA-ARRA was similarly cost-effective from the program administrator perspective.

Participant Cost Test

The PC test assesses cost-effectiveness from the perspective of the customer (program participant) installing the measure and takes only participant costs and benefits into account. Participant project costs net of any incentives (both ARRA and leveraged) and finance costs and/or benefits are measured against the present value of participant benefits (for example, annual bill savings accrued over the effective useful life of the EEP). The results of the PC test are expressed as net present value (NPV) of benefits. When NPV is positive, benefits over time exceed the investment cost to achieve those benefits. The higher the NPV, the more incentive customers have to participate in programs. However, providing high incentives will reduce the PAC test results, so the PC and the PAC combined provide useful information in designing appropriate customer incentive levels.

As shown in Table 40, the MCR Program was the most cost-effective from the perspective of program participants, yielding more than $92 million in NPV benefits (including incentives) over the life of the efficiency measures. The grants distributed through the EECBG Small Cities and Counties Program achieved NPV participant benefits of about $62 million. Overall, the Energy Commission's portfolio of programs yielded NPV participant benefits of nearly $200 million and achieved a discounted payback of just over six years.

Sensitivity analyses were performed to assess how different rate forecasts might affect the PC test results. The PC test was run under three rate scenarios to reflect high, medium, and low electricity rate forecast scenarios. The "middle rate" scenario is what was presented above in Table 40. Under the other two scenarios, electric benefits increase by about 10 percent (high) or decrease by about 13 percent (low).[12] The NPV results under each scenario are shown in Table 41.

Table 41: NPV of Benefits Results – Retail Rate Forecast Scenarios

Program	NPV Benefits With Incentives (2012 Dollars)		
	Low Rate	Middle Rate	High Rate
CCRR	$(17,819,147)	$(11,620,717)	$(3,753,981)
DGS Loan Fund Program	$36,358,341	$40,810,181	$45,639,234
ECAA-ARRA	$13,298,356	$14,829,068	$17,490,346
EECBG Small Cities and Counties	$59,327,221	$62,077,602	$66,269,200
MCR	$87,659,154	$92,089,971	$98,730,559
Portfolio	$178,823,924	$198,186,105	$224,375,358

Source: DNV KEMA

Cost-Effectiveness Results by Program

As discussed below, the cost-effectiveness results by program are mixed.

- **DGS.** From the TRC perspective, the DGS Loan Fund Program was the most cost-effective program on the electric side, with levelized costs of $0.06 per kWh saved. The PAC test results are noteworthy, indicating very low program administration costs.
- **ECAA-ARRA.** The ECAA-ARRA Program was designed to encourage installations of comprehensive packages of efficiency measures in public facilities. Projects are required to meet the program's simple payback threshold of 13 years set by statute. Typical

12 Rates depend on assumptions of future natural gas, coal, and carbon prices. They also depend on the future quantities of energy efficiency, renewable generation, and combined heat and power. The high, middle, and low rates are reasonable scenarios provided as a sensitivity analysis.. Cost-effective energy efficiency provides more benefits as rates increase.

projects combined measures with long paybacks, such as HVAC and solar photovoltaic systems, with more cost-effective measures, such as lighting. Overall, the program more than met the payback requirement with a PC test result of 8.7. The TRC test results show that the program does reasonably well as a resource program. Similar to DGS, the very low PAC test result indicates that the program is cost-effective from the program administrator perspective.

- **MCR.** MCR performed very well under all tests, indicating the program is attractive as a resource program and had low program administration costs, and that participants who installed energy efficiency measures will quickly recoup project costs through energy bill savings. The MCR Program also succeeded at its market transformation efforts to advance several emerging technologies toward increased commercialization.
- **CCRR.** The CCRR Program was primarily designed as a market transformation program to pilot and establish a baseline platform for expanded whole-building upgrades in single- and multifamily buildings. It was funded using both SEP and EECBG funds. Given that, 1) market transformation efforts front load program costs and 2) piloting of consumer awareness and infrastructure development program components results in gradual increasing of program participation, cost-effectiveness criteria that were originally designed for procuring resources in a mature market were expected to be a challenge. The programs rolled out during the recession when the housing market was trying to stabilize and without the support of PACE financing, as was originally expected, creating even greater challenges. The valued non-energy benefits of the upgrades were not included in the analysis. Another concern was that the analysis did not use time-sensitive avoided costs or tiered rates and used a period of analysis that was shorter than the useful lives of the installed measures. The least-cost energy resource tests also used average rates, underestimating the cost-effectiveness and leaving out the non-energy benefits that drove participation.
- **EECBG Small Cities and Counties.** The EECBG Small Cities and Counties Program targeted hard-to-reach small cities and counties. It performed adequately as a resource program. When the PAC test results are compared to some of the other programs, the higher results are an indication of the level of effort that it took to administer and implement the program. Energy Commission staff spent significant time working one on one with the small cities and counties to help make their projects successful. The payback of zero reflects the assumption that 100 percent of the project costs were covered by the combination of ARRA and leveraged funds. This level of subsidization was necessary to motivate the budget-constrained small cities and counties to implement EEPs.
- **CEWTP and CEBFP.** These programs were entirely designed to achieve market transformation through workforce development (CEWTP) and manufacturing capacity investment (CEBF) without direct energy savings, so evaluators did not apply program-level tests.

Recommendations

The following is a summary of the recommendations from the cost-effectiveness evaluation:

- Given that California is trying to foster the use of energy efficiency as a preferred resource, programs that perform well on the TRC, PAC, and PC tests should be encouraged and continued.
- Programs that seek incorporation into the CPUC portfolio will be subject to pressure for good results using similar resource tests. Since the ARRA programs served as pilots for programs that continue to be implemented with CPUC oversight, evaluation of the ARRA programs using the resource tests may signal the need for improvement to meet CPUC expectations.
- The various cost-effectiveness tests used in this evaluation – that is, the SEP-RAC, TRC, PAC, and PC tests – have clear disadvantages that make them flawed metrics to assess programs designed to develop, demonstrate, or commercialize promising emerging energy efficiency technologies or structurally change the marketplace. When evaluating future program designs and effects, program implementers and administrators will need to develop and consider additional factors and performance metrics. Program performance metrics need to be objective, quantitative indicators of the progress of a program toward the short- and long-term market transformation goals and objectives of the state.

CHAPTER 9: Evaluation Methods

This chapter presents a consolidated summary of the evaluation methods carried out for each of the SEP- and the EECBG-funded programs. The first section describes the evaluation approach followed for the DGS, ECAA-ARRA, and EECBG Small Cities and Counties Programs combined, as the methods used were very similar. Following sections describe evaluation methods for the MCR Programs, CCRR Programs, CEWTP, and CEBFP.

DGS, ECAA-ARRA, and EECBG Small Cities and Counties Program Evaluation Approach

The evaluation of the DGS, ECAA-ARRA, and EECBG Small Cities and Counties Programs sought to assess the effectiveness of program implementation and verify the energy savings realized from the loans and grants distributed during the ARRA period.

Across all three programs, the evaluation relied on a number of data sources, including:

- Interviews and ongoing discussions with the Energy Commission staff involved in contract management, as well as Energy Commission engineers and other staff who provided technical support. For the DGS Loan Fund program, evaluators also interviewed the program administrator. These initial interviews covered topics related to developing an understanding of the programs' overall goals and design and identifying elements of uncertainty and risk associated with program delivery and execution. Ongoing discussions touched on how well the programs were organized and managed, as well as kept track of any changes in project-specific scope and implementation.
- Program-specific documents, including program plans and progress reports, as well as a range of project-specific documents and summary data (such as feasibility studies, preliminary savings estimates, and so forth). The evaluation team developed Microsoft® Excel databases to store project-specific details for each of the three programs. The team periodically reviewed and updated these databases based on DGS, ECAA-ARRA, and EECBG project documentation throughout the evaluation period.
- Site visits to support the estimation of program savings. For DGS, 18 site visits were conducted, 17 site visits were conducted for ECAA-ARRA, and 51 site visits were conducted for EECBG. Site-specific engineering analyses and measurement and verification (M&V) activities were completed for the sampled projects, and the results were extrapolated to the full population of projects implemented through each of the programs.
- In-depth interviews completed by telephone with decision makers at sampled sites. For DGS, 11 interviews representing 16 sampled sites were conducted. For ECAA-ARRA, 17

interviews representing all 17 sampled sites were completed, and for EECBG, 30 interviews were completed with representatives from 39 sampled sites. The primary purpose of the interviews was to gather information about net-to-gross ratios, program effectiveness, and attribution.

Data Collection Methods

Data collection for all three programs fell into roughly five steps: data requests and review, site scheduling, site planning, site-specific M&V activities, and in-depth interviews with participants.

- **Data requests and review.** The evaluation team requested from DGS and site contacts relevant information for calculating energy savings, including detailed measure descriptions, savings calculation spreadsheets and related documentation, feasibility studies, and contractor, vendor, and equipment manufacturer information. This information was then reviewed to begin planning for the site-specific M&V data collection and analysis.
- **Site scheduling.** For each sampled project, an evaluation engineer contacted the site to initiate site planning, confirm project details, and schedule the site visit.
- **Site planning.** Following data review and assessment, the evaluation engineers developed customized data collection and analysis plans, including brief descriptions of the data requirements and analysis approaches that would be used to determine both the pre- and postinstallation assumptions and conditions.
- **Site-specific M&V.** The evaluation team collected data to catalog pre- and postretrofit operations and conditions, including equipment nameplates, feasibility study reviews, self-reported operational data, and spot measurements. At many sites, the evaluation team installed data loggers and collected long-term measurements over a two-week or more period.
- **In-depth interviews with participants.** Evaluators developed for participants an in-depth interview guide, which was designed to address research questions ranging from program attribution to participant satisfaction.

Site-Specific Analyses to Determine Energy Savings

Calculating energy savings depends on the estimated base-case energy use of a given end use before a retrofit and the estimated energy use after the retrofit. The base-case conditions were established for the preretrofit conditions as follows:

- Preretrofit data were collected to establish the control scheme, operating conditions, equipment load, and equipment efficiency. In the absence of metered data, information from the feasibility study, site contact, as-built drawings, and research and engineering judgment were used to establish the base-case parameters.
- Postretrofit data were similarly collected, and base-case parameters were established.

Both pre- and postretrofit data were normalized to the same operating conditions to establish savings estimates that could be directly compared.

For each site within the sample, evaluators determined the efficiency of a measure and EUL and RUL of the preretrofit equipment. The evaluation team calculated life-cycle savings of the energy efficiency measures. Each measure was assigned an EUL, and the savings for each year of the EUL were summed over the measure life to determine the life-cycle savings. As discussed in Chapter 8, evaluated energy savings were calculated relative to two established baselines, and life-cycle savings were developed for each baseline. Life-cycle savings are sum of the annual savings expected to accrue for each year of the life of the measure.

MCR Evaluation Approach

The MCR Program evaluations were designed to provide estimates of savings of electricity, demand, natural gas, and avoided carbon emissions, as well as assessments of market transformation efforts and recommendations for future program design and implementation. These evaluation goals were met by gathering information using a variety of methods, as summarized in Table 42.

Table 42: Steps Taken to Achieve MCR Evaluation Goals

Evaluation Tasks for Each MCR Subrecipient Program	MCR Subrecipient Program Evaluation Goals		
	Estimate Energy Savings & Carbon Emission Reductions	Assess Market Transformation & Jobs Created	Provide Recommendations for Future Programs
Reviews of Implementers' Publications & Tracking Data	▲	▲	▲
Sample Designs	▲	▲	
On-Site Visits & Engineering Analyses	▲		▲
Statistical Analyses to Determine Overall Energy Savings	▲		
In-Depth Interviews of Implementers & Market Actors		▲	▲
Telephone Surveys of Participants	▲	▲	▲

Source: DNV KEMA

Similar to reported above for DGS, ECAA-ARRA, and EECBG Small Cities and Counties, impact evaluation activities for the three MCR Programs fell into five steps: data requests and review, site scheduling, site planning, site-specific M&V activities, and site-level report and calculation preparation.

- **Data requests and review:** The evaluation team requested project site contacts and relevant information for calculating energy savings, including detailed measure descriptions, savings calculation spreadsheets and related documentation, feasibility studies, and contractor, vendor, and equipment manufacturer information. The evaluation team reviewed this information to begin planning for the site-specific M&V data collection and analysis activities.
- **Sample design.** Using information provided by the implementers, evaluators stratified the population of MCR Program participants by total annual electricity energy savings estimated per site. Samples were selected to represent the range of measures installed in each program. For ESJ, 75 site visits were completed, 27 site visits were completed for ETAP, and 27 site visits were completed for OS.
- **Site scheduling:** For each sampled project site, a scheduler contacted the site to initiate the site planning process, to confirm project details, and to schedule the site visit.
- **Site planning:** Following data review and assessment, the evaluation engineers developed data collection and analysis plans, including brief descriptions of the data requirements and analysis approaches to be used to determine both the preretrofit and postretrofit assumptions and conditions.
- **Site-specific M&V:** The evaluation team collected data to catalog preretrofit and postretrofit operations and conditions, including equipment nameplates, feasibility study reviews, postretrofit monitoring, and self-reported operational data.
- **Site-specific report:** The evaluation team prepared a report and accompanying spreadsheet documenting the findings and savings resulting from each visit to project sites in the sample during the M&V effort.

In addition, telephone surveys with participants in each of the MCR Programs were conducted to address factors influencing the decision to participate in the programs, participant satisfaction, and spillover and behavioral changes attributable to the program. A total of 43 telephone surveys were completed for ESJ, 27 surveys were completed for ETAP, and 16 surveys were completed for OS.

In addition, in-depth interviews were completed with a range of market actors involved in program marketing and delivery. Evaluators used results from these interviews to draw conclusions about the program's effectiveness at achieving short- and intermediate-term market transformation goals and overcoming barriers to adoption. Sample sizes for each of the MCR Programs are summarized below:

- **ESJ:** Three lighting manufacturers, eight contractors (representing a cross-section of high-volume, mid-volume, and low-volume contractors), and nine CCC surveyors.
- **ETAP:** Seven HVAC and lighting vendors and six community partners engaged in marketing, technical assistance, and workforce development.
- **OS:** 10 program partner managers (including utility, government, and community partners), and one program contractor.

CCRR Evaluation Approach

The overall goal of this evaluation was to assess the effectiveness of the CCRR subrecipient program implementation and verify the energy savings realized from program-specific activities. To determine the subrecipient program savings, evaluators conducted site visits to confirm measure installations and building characteristics and to inform estimates of ex post energy savings. In the gross savings analysis, preretrofit energy models were billing-adjusted to the actual electric and natural gas consumption of the sampled homes to determine the actual savings of the programs.

Data Collection Method

Essentially, data collection fell into four steps: data requests and review, site scheduling, site-specific M&V activities, and in-depth interviews with participants.

- **Data requests and review:** The evaluators developed a sample of program participants who received CCRR Program incentives for retrofits or audits and constructed a data set of all sampled participants' electric and natural gas usage histories from one to three years prior to the retrofit, to time of evaluation. Once the billing data set was assembled, it was examined for consistency. Anomalies were removed, including incongruous bill information, homeowner turnover, insufficient billing information (for example, fewer than three months of summer and winter data for a particular period), and lack of preinstallation data.
- **Sample design:** The sample was designed to be proportional to the number of retrofits completed for each CCRR subrecipient program. Table 43 shows the sample sizes for each subrecipient program during two rounds of data collection. Round 1 was completed in February 2012, and Round 2 was completed in November 2012. The evaluation sampled only ABAG, SMUD, and CHF in Round 1.
- **Site scheduling:** For each sampled project, a telephone recruiter contacted the participant to initiate site planning, to confirm project details, and to schedule the site visit.

- **Site-specific M&V:** On-site data collection teams assessed building characteristics and performed testing, including blower door measurements of home air leakage, duct blaster measurements of duct leakage, and measurements of window properties. The tested characteristics were compared with the contractor-reported measurements, and the results were input into savings estimate software.
- **On-site discussions with participants:** Evaluators met with the homeowner or the occupant who was most knowledgeable about the work to clarify uncertainties or discrepancies about the installed measures and conditions of the home before the retrofit.

Table 43: Planned Sample Sizes by CCRR Subrecipient Program

Program	Subrecipient Program	First Round Sample	Second Round Sample
EECBG	Energy Upgrade California in San Diego	-	20
	Fresno Regional Comprehensive Residential Retrofit	-	30
	Retrofit LA	-	30
SEP	Retrofit Bay Area	35	10
	Moderate Income Sustainable Technology Program	35	0
	SMUD Home Performance	30	10
Totals		100	100

Source: DNV KEMA

All on-site visits were conducted after measure installations were completed. For some sites, only a rating or assessment was conducted by a contractor, and, therefore, no measures were installed. For sites with measures installed, evaluators could not observe preretrofit conditions for building elements that changed, such as amount of infiltration or insulation levels. No adjustments were made to preretrofit building elements where measures were installed.

Site-Specific Analyses to Determine Energy Savings

The evaluation of the CCRR Programs produced energy savings estimates based on billing-adjusted simulation modeling. The building simulations were performed by modifying existing EnergyPro models that represented each sampled home. Each model was compared to weather-normalized, monthly billing data prior to retrofit.

In the gross savings analysis, preretrofit energy models were billing-adjusted to the actual electric and natural gas consumption of the sampled homes to determine the actual savings of

the programs. The estimated differences in savings between contractor and evaluator were divided into two factors.

1. The on-site assessments were input into energy models, and the differences between contractor and evaluator models were reported as the verification rate. The programs included contractor training, and the verification rate includes only differences the contractors could have controlled, such as data collection and data entry into the models.
2. The modeled energy consumption was compared to weather-normalized billing data to develop billing adjustment factors at the subrecipient–program level. The contractors had very little ability to modify usage schedules or other inputs to perform a billing adjustment using the standard modeling software. Unlike the verification rate, this difference speaks primarily to the ability of the tool, not the contractors.

Evaluators calculated gross energy savings for the sampled sites using the adjusted energy model results and billing adjustment factor adjustment, and then these savings estimates were extrapolated to represent the total energy savings resulting from each CCRR subrecipient program. No energy savings were calculated for audit-only sites, as there were no ex ante savings estimates.

CEWTP Evaluation Approach

The evaluation approach for CEWTP incorporated several methods, including reviewing information reported by the Energy Commission and the program administrators; completing in-depth interviews with subgrantees, subcontractors, and employers; and conducting telephone surveys with training program participants.

- **Program Documentation Review:** Evaluators reviewed program documents, including contractual documents, interagency agreements, proposals, award summaries, agreements with subgrantees and subcontractors, monthly and annual reports, extracts from program tracking databases, and final invoice documentation. These documents provided high-level information related to program objectives and descriptions of the program elements, as well as detailed data on program goals accomplishments, including numbers of enrollees, training completions, certifications, job placements, and demographic characteristics of the target trainee populations. In addition, many of the documents provided by the subgrantees and subcontractors contained insights and rich discussion pertaining to design and implementation challenges. Evaluators used the content in these documents and the databases to characterize the training activities, to assess the accomplishments of the program as compared to the initial goals, and to inform assessment of the alignment with labor market needs.
- **In-Depth Interviews:** Evaluators used primary data collected through in-depth interviews with key program participants, including program administrators,

subgrantees, subcontractors, monitoring staff (regional analysts and regional advisors), and employers who have hired a CEWTP trainee. Table 44 summarizes the number of interviews completed for each category of respondent, and the following summarizes some of the key issues discussed:

- **Program Administrators:** Evaluators interviewed program administrators from EDD and ETP in November 2010, while developing the evaluation research plan. The interviews covered program design, allocation of funding to recipients, and specific details about how each administrator established program implementation metrics and then monitored program activities. In addition, evaluators contacted the program administrators throughout the evaluation to request additional information.

Table 44: Summary of CEWTP In-Depth Interviews Completed

Program Elements	Respondent Type	Completed
EDD Pre-Apprenticeship and Retraining	Program Administrator	1
	Regional Advisor	6
	Subgrantee	10
	Employer	5
	Total	*22*
ETP Career Advancement	Program Administrator	1
	Regional Analyst	3
	Subcontractor	6
	Total	*10*

Source: DNV KEMA

- **Interviews with Monitoring Staff:** These interviews gathered information on overall program design and administration, including curriculum development, alignment of the training programs with the needs of local labor markets, and aspects of the program that have been effective and what challenges subrecipients have faced.
- **Interviews with Subgrantees and Subcontractors:** These interviews discussed collaborative efforts in training program design, alignment with local workforce needs, and steps taken to project employment opportunities and conduct employer outreach and job placement. Interviews also gathered information on training characteristics, such as certifications, hands-on training, and basic/ancillary skills. Subgrantees and subcontractors were also encouraged to describe the challenges of program administration and to assess the sustainability of local clean energy training programs in the future. Evaluators

selected a sample of EDD subgrantees and ETP subcontractors to be interviewed, with a goal of representing a variety of implementers, including community colleges, workforce agencies, and trade associations.

  - **Interviews with Employers:** Employers provided insightful observations and evaluations of employees hired from the CEWTP training program. Another goal of the interviews was to determine what skills employers looked for in a potential employee, and whether these skills had been demonstrated in their experiences with employees hired from CEWTP. The interview also asked employers to comment on the value of various elements of training, such as certifications, hands-on training, and basic/ancillary skills, and to assess the effects of training in terms of increased wages and career potential. Evaluators sampled five employers from a sample of representative industries: construction, energy auditing, green technologies, utility-scale solar, and weatherization.

- **Telephone Surveys With Training Participants:** The evaluation also collected primary data through surveys with a sample of CEWTP training participants. The goal of these surveys was to elicit perceptions and experiences with the program, ranging from overall satisfaction levels to relevance of training to current or potential employment opportunities. A total of 306 surveys were completed: 128 from the EDD Pre-Apprenticeship program element, 73 from the EDD Retraining program element, and 105 from the ETP Career Advancement program element.

CEBFP Evaluation Approach

To assess CEBFP, evaluators interviewed three sets of market actors. These actors included financial development corporations, state energy officers from outside California, and manufacturers that received funds from the program.

Evaluators did not design this to be a quantitative study. To understand how the CEBFP funds were disbursed and if funds were used as intended by recipients, the evaluation team interviewed all program participants. For the loan awardees, these interviews were conducted at the manufacturing facility where the equipment was located. The results of the interviews are consolidated and presented as common themes that emerged.

To assess outcomes, findings from the manufacturer interviews were compared to their eligibility applications. Although these are not hard thresholds by which to evaluate the program, they do provide benchmarks to compare what the program expected to achieve and what has been achieved to date.

Employment and Economic Effects Evaluation Approach

To assess the economic and employment effects of the Energy Commission's ARRA programs on California's economy, evaluators used a dynamic, input-output model called the Regional

Economic Models, Inc., Policy Insights Plus (PI+)[13] model. This tool is a computable general equilibrium [14] annual forecasting system that uses industry and labor market interactions and inputs specified by the user to make an alternative forecast to the baseline (status quo) market. The Energy Commission requested results for seven regions within the state. The model was customized to reflect the economic conditions for these regions. Industry types were classified at the two-digit level of the North American Industry Classification System (NAICS). The model generates a default baseline level of economic activity based on regional interactions. Changes in the model output from the baseline represent the effect caused by a "proposed action," which, in this analysis, is the introduction of the additional ARRA spending. When model inputs are changed (for example, a change to participant estimated energy bill savings), the model recalculates economic flows and presents results in terms of change from the baseline.

To estimate job impacts along with other macroeconomic changes from ARRA spending, evaluators assembled information from the program impact evaluations, the cost-effectiveness analyses, and other relevant sources. For most of the programs in the Energy Commission's portfolio, tracking data included project costs and incentives, including ARRA funds and leveraged funds. Detail-level data were not available for some programs. In most cases where these data were not available, the evaluation team developed estimates. Energy savings data were developed by the evaluation team as documented in the evaluation reports for each program.

Key input data included 1) expenditures of ARRA stimulus funds for program operations and support services; 2) household, business, and institutional energy bill savings; 3) household and business spending; and 4) equipment economic linkages. Equipment economic linkages are associated with purchases from a wholesale distributor located within each of the seven regions defined in the model and installed within the same region and economic linkages associated with equipment manufactured in the region or in the state. Data were classified by the geographic region where expenditures occurred and by the type of activity (for example, energy audits/assessments, and energy efficiency upgrades or on-site renewable electricity generation). The labor costs were further broken down into industry type at the two-digit level of NAICS. NAICS codes were assigned based on the predominate end use for the project. For example, for solar photovoltaic system installation projects, NAICS Code 23 applied.

Evaluators incorporated the ARRA programs' regional-level direct effects into the Regional Economic Model (REMI) model to generate estimates of economic changes. These are short-term and long-term job creation, the annual and cumulative outcomes for income, gross state revenue, and gross state product. Results are presented at the state, regional, and program level and are expressed as an incremental change from a base case where no stimulus spending occurs. Impacts are specified for households and 23 industry sectors. When model inputs are changed (for example, a change to participant estimated energy bill savings), the model recalculates economic flows and presents results in terms of change from the baseline.

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13 Amherst, Massachusetts. www.remi.com.

14 http://en.wikipedia.org/wiki/Computable_general_equilibrium.

Cost-Effectiveness Evaluation Approach

To assess the cost-effectiveness of the Energy Commission's ARRA programs, DNV KEMA gathered data on electricity and natural gas savings, measure life, program expenditures, project costs, and leveraged funds. The source of these data was from the impact evaluation reports, program implementers, and the Energy Commission.

For the SEP-RAC test, evaluators converted the savings to millions of British thermal units (MM BTU) of energy saved or generated using the following conversion factors:

- 1 kWh of site savings = 3,412 site BTUs
- 1 therm of site savings = 100,000 site BTUs

To convert site BTU savings to source BTU savings, ENERGY STAR® conversion factors were used:

- 1 BTU of electric site savings = 3.34 source BTUs
- 1 BTU of gas site savings = 1.047 source BTUs

For the California specific tests, the Energy Commission used a levelized cost of energy savings, which represents the level of payment needed each year to recover the total investment and the interest payments over the life of the measure. This way of presenting cost-effectiveness does not embed the avoided fuel, generation, transmission, or distribution costs of providing the energy that would be needed in the absence of the programs into the cost-effectiveness formula. Evaluators used a real discount rate of 2.83, a 2.47 inflation factor, and retail electric and gas rates from the *California Energy Demand 2012 -2022 Staff Revised Forecast*- Mid-Demand Case. DNV KEMA estimated retail rates beyond 2022 by using the 10-year average growth rate embedded in the energy demand forecast. Where programs funded both electric and natural gas measures, and only project costs were known, the costs were allocated to the energy type using source BTU as the weighting factor. The data were entered into a cost-effectiveness spreadsheet tool developed specifically for the Energy Commission. *California Standard Practice Manual* and DOE formulas were used to calculate TRC, PAC, PC, and RAC. Levelized costs express energy saved in terms of expenditures to achieve that savings. These are expressed in terms of dollars per kWh or therm. As a result, estimates of environmental and non-energy benefits were not included in these cost-effectiveness calculations.

CHAPTER 10: Glossary

ABAG	Association of Bay Area Governments
ARRA	American Recovery and Reinvestment Act of 2009
Btu	British thermal unit
CCC	California Conservation Corps
CCRR	California Comprehensive Residential Retrofit Program
CDCR	California Department of Corrections and Rehabilitation
CEBFP	Clean Energy Business Financing Program
CEWTP	Clean Energy Workforce Training Program
CHF	California Rural Home Mortgage Finance Authority Homebuyers Fund (CRHMFA)
CO_2	carbon dioxide
CPUC	California Public Utilities Commission
CRHMFA	formerly known as California Rural Home Mortgage Finance Authority
DEP	direct equipment purchase
DGS	Department of General Services
DHW	domestic hot water
DOE	United States Department of Energy
DNV KEMA	DNV KEMA Energy & Sustainability
ECAA	Energy Conservation and Assistance Account
EDD	Employment Development Department
EDRG	Economic Development Research Group
EECBG	Energy Efficiency and Conservation Block Grant
EEP	energy efficiency project
Energy Commission	California Energy Commission
EnergyPro	EnergyPro 5 Software, Residential Performance Module
EnergyPro Model	A model produced using EnergyPro 5 Software, Residential Performance Module
ESCO	energy service company
ESJ	EnergySmart Jobs
ETAP	Energy Technology Assistance Program

ETP	Employment Training Panel
EUL	effective useful life
ex ante	energy savings estimates for energy efficiency measures developed by the program implementers
ex post	energy savings estimates for an energy efficiency measure developed by the evaluation team
GWh	gigawatt-hour
HERS	Home Energy Rating System
HVAC	heating, ventilation, and air-conditioning
Joint powers authority	An entity permitted under California law, whereby two or more public authorities can operate collectively.
kBtu	Thousand British thermal units
kW	kilowatt
kWh	kilowatt-hour
LGC	Local Government Commission
M&V	measurement and verification
MCR	Municipal and Commercial Building Targeted Measure Retrofit Program
MM BTU	millions of British thermal units
MW	megawatt
MWh	megawatt-hour
N/A	not applicable
NAICS	North American Industry Classification System
OCIO	Office of the Chief Information Officer
OS	Oakland Shines
PAC	Program Administrator Cost Test
PACE	Property Assessed Clean Energy Financing
PC	Participant Cost Test
PG&E	Pacific Gas and Electric Company
PIER	Public Interest Energy Research
QC	quality control
RAC	Recovery Act Cost
REMI	Regional Economic Model
RUL	remaining useful life
SCEIP	Sonoma County Energy Independence Program

SEP	State Energy Program
SEP-RAC	State Energy Program Recovery Act Cost
SFMOH	San Francisco Mayor's Office of Housing
SMUD	Sacramento Municipal Utility District
therm	A unit of heat equivalent to 100,000 British thermal units
TRC	Total Resource Cost Test