California Workforce Education and Training Needs Assessment

For Energy Efficiency, Distributed Generation, and Demand Response

DONALD VIAL CENTER ON EMPLOYMENT IN THE GREEN ECONOMY
Institute for Research on Labor and Employment
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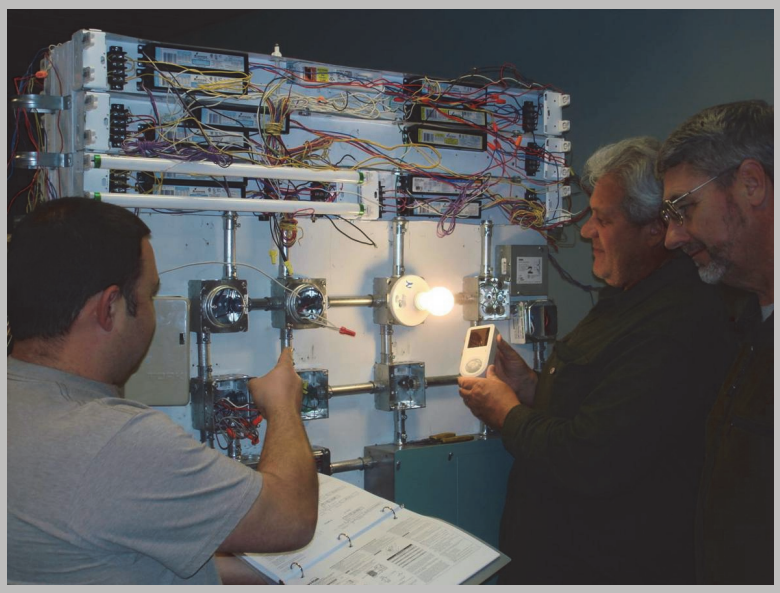

My Fellow Californians,

Over three years ago, the California Public Utilities Commission recognized that California's ambitious energy efficiency and greenhouse reduction goals required long term strategic planning. In September 2008, the Commission approved the California Long-Term Energy Efficiency Strategic Plan (Plan) in September 2008 providing a roadmap, through the year 2020 and beyond, for a dramatic scaling-up of statewide energy efficiency efforts designed to meet California's clean energy challenges and goals. The objective of the Plan is to push forward sustained market transformation, thus moving California toward long-term, deep energy savings.

The Plan targets, chapter-by-chapter, four market sectors and seven cross cutting sectors. While the industry and cross cutting sectors are the bones of the Plan, four specific programmatic goals—the big bold energy efficiency strategies—may be considered its heart. In the development of the Plan, we recognized that California would not be able to meet these ambitious goals without adequate numbers of trained personnel working the various fields of energy efficiency. Thus we directed the utilities to include a workforce education and training component as one of the cross cutting sectors in the Plan.

With the input of the utilities and other relevant stakeholders at the Plan workshops, the Commission adopted a vision for workforce education and training:

By 2020, California's workforce is trained and fully engaged to provide the human capital necessary to achieve California's economic energy efficiency and demand site management potential.

The Plan lays out two goals to achieve this vision. First, establish energy efficiency education and training at all levels of California's educational systems. Second, ensure that minority, low income and disadvantaged communities fully participate in training and education programs at all levels of the energy efficiency and demand side management industries.

While the Plan provides several strategies to meet each of the goals, it recognized that in the immediate future, the state must initiate a needs assessment: an in-depth formal statewide training and education resource inventory of current efforts and an assessment of the training and education resources necessary for successful delivery of the long range goals set forth in the Plan. Thus over the past year, the Donald Vial Center has been conducting interviews and collecting and analyzing data on California workforce resources and issues in the energy efficiency sector. The information and recommendations provided within this report summarize the information collected and present an independent analysis of these issues.

This report is a key step in the implementation of the Workforce Education and Training Chapter of the Plan. It gives us a strong idea of where we are and recommendations on how we can ensure that we have a properly trained workforce to enable us to meet California's clean energy goals, particularly with regard to energy efficiency.

Sincerely,

Dian M. Grueneich
Former Commissioner
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ACRONYM GLOSSARY

ACRONYM	DEFINITION
ABET	Accreditation Board for Engineering and Technology
ACCA	Air Conditioning Contractors of America
AEE	Association of Energy Engineers
AFL-CIO	American Federation of Labor-Congress of Industrial Organizations
AgTAC	Agricultural Technology Application Center
AIA	American Institute of Architects
AMI	Advanced Metering Infrastructure
ANSI	American National Standards Institute
ARE	Architect Registration Examination
ARRA	American Recovery and Reinvestment Act
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
AVI	Advanced Vocational Institute
BBEES	Big Bold Energy Efficiency Strategies
BEAP	Building Energy Assessment Professional
BEMP	Building Energy Modeling Professional
BII	Building Industries Institute
BOC	Building Operator Certification
BPI	Building Performance Institute
BTP	Building Technologies Program
CA HERCC	California Home Energy Retrofit Coordinating Committee
CAC	California Apprenticeship Council
CAD	Computer-Aided Design/Drafting
CALBO	California Building Officials
CALCTP	California Advanced Lighting Controls Training Program
CARB	California Air Resources Board
CAROP	California Association of Regional Occupational Centers and Programs
CBC	Community Business College
CBCP	Certified Building Commissioning Professional
CBO	Community-Based Organization
CBPCA	California Building Performance Contractors Association
CCA	California College of the Arts
CCSE	California Center for Sustainable Energy
CEA	Certified Energy Auditor
CEC	California Energy Commission
CEM	Certified Energy Manager
CEWD	Center for Energy Workforce Development
CEWTP	Clean Energy Workforce Training Partnership
CFL	Compact Fluorescent Lamp

ACRONYM	DEFINITION
CHEERS	California Home Energy Efficiency Rating Services
CIDP	Comprehensive Intern Development Program
CLTC	California Lighting Technology Center
CMAA	Construction Management Association of America
COE	California Community Colleges Centers of Excellence
CPA	California Partnership Academy
CPMP	Commissioning Process Management Professional
CPUC	California Public Utilities Commission
CREECN	California Regional Environmental Education Community Network
CSD	California Department of Community Services and Development
CSDP	Certified Sustainable Development Professional
CSE	California Supplemental Examination
CSI	California Solar Initiative
CSLB	Contractors' State Licensing Board
CSU	California State University
CTAC	Customer Technology Application Center
CTE	Career Technical Education
DAS	California Division of Apprenticeship Standards
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
DSM	Demand-Side Management
E-DRAM	Environmental Dynamic Revenue Analysis Model
EDD	California Employment Development Department
EE	Energy Efficiency
EECBGP	Energy Efficiency and Conservation Block Grant Program
EEI	Education and the Environment Initiative
EERE	Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy
EFM	Employ Florida Marketplace
EIS	Employment Information Systems
EIT	Engineer in Training
EOPS	Extended Opportunity Programs and Services
EPA	Environmental Protection Agency
ERC	Energy Resource Center
ERP	Emerging Renewables Program
ESCO	Energy Service Company
ETA	Employment and Training Administration
ETC	Energy Training Center
ETP	Employment Training Panel
FE	Fundamentals in Engineering
FEMP	Federal Energy Management Programs

ACRONYM	DEFINITION
FEWC	Florida Energy Workforce Consortium
FSTC	Food Service Technology Center
GBCI	Green Building Certification Institute
GBE	Green Building Engineer
GCI	Green Career Institute
GCJC	Green Collar Jobs Council
GED	General Educational Development
GIS	Geographic Information Systems
HERS	Home Energy Rating System
HHS	U.S. Department of Health and Human Services
HPBDP	High Performance Building Design Professional
HVAC(R)	Heating, Ventilation, and Air Conditioning (and Refrigeration)
IAC	Industrial Assessment Center
IBEW	International Brotherhood of Electrical Workers
IDP	Intern Development Program
IDSM	Integrated Demand-Side Management
IHACI	Institute of Heating and Air Conditioning Industries, Inc.
IOU	Investor-Owned Utility
ITP	Industrial Technologies Program
JAC, JATC	Joint Apprenticeship Committee, Joint Apprenticeship Training Committee
KEEP	K-12 Energy Education Program
LADWP	Los Angeles Department of Water and Power
LATTC	Los Angeles Trade–Technical College
LEA	Local Educational Agency
LED	Light-Emitting Diode
LEED	Leadership in Energy and Environmental Design
LEED AP-BDC	LEED Accredited Professional–Building Design and Construction
LIEE	Low Income Energy Efficiency
LIHEAP	Low Income Home Energy Assistance Program
LIOB	Low Income Oversight Board
LiUNA	Laborers' International Union of North America
LMCC	Labor Management Cooperation Committee
MAAC	Metropolitan Area Advisory Committee
MASH	Multifamily Affordable Solar Housing
MEP	Maximizing Engineering Potential
MITC	Minimum Industry Training Criteria
MNREM	Minnesota's Renewable Energy Marketplace
NABCEP	North American Board of Certified Energy Practitioners
NAHB	National Association of Home Builders
NAICS	North American Industry Classification System

ACRONYM	DEFINITION
NARI	National Association of the Remodeling Industry
NATE	North American Technician Excellence
NCEES	National Council of Examiners for Engineering and Surveying
NCQLP	National Council on Qualifications for the Lighting Professions
NECA	National Electrical Contractors Association
NEEC	Northwest Energy Efficiency Council
NEED	National Energy Education Development Project
NYSERDA	New York State Energy Research and Development Authority
OA	Office of Apprenticeship, U.S. Department of Labor
OJT	On-the-Job Training
OPMP	Operations & Performance Management Professional
PACE	Property Assessed Clean Energy
PAHRA	Partnership for Air-Conditioning, Heating, Refrigeration Accreditation
PE	Professional Engineer
PEC	Pacific Energy Center
PG&E	Pacific Gas and Electric
PIER	Public Interest Energy Research
PIP	Program Implementation Plan
PLA	Project Labor Agreement
PSA	Project Stabilization Agreement
QI/QM	Quality Installation and Quality Maintenance
REDI	Regional Equitable Development Initiative
RESNET	Residential Energy Services Network
RFP	Request for Proposals
RHA	Richard Heath and Associates, Inc.
ROP, ROCP	Regional Occupational Program, Regional Occupational Centers and Programs
RSES	Refrigeration Services Engineering Society
RSI	Related Supplemental Instruction
SCE	Southern California Edison
SCG	Southern California Gas
SDG&E	San Diego Gas and Electric
SDSU	San Diego State University
SDUSD	San Diego Unified School District
SEER	Seasonal Energy Efficiency Rating
SEP	State Energy Program
SFSU	San Francisco State University
SGIP	Self-Generation Incentive Program
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SMUD	Sacramento Municipal Utility District
SMWIA	Sheet Metal Workers' International Association

ACRONYM	DEFINITION
SOC	Standard Occupational Code
SWH	Solar Water Heating
TABB	Testing, Adjusting and Balancing Bureau
TANF	Temporary Assistance for Needy Families
TSLA	Train to Sustain Los Angeles
TWI	Training Within Industry
UA	United Association of Plumbers, Pipefitters and Sprinkler Fitters
UAC	Unilateral Apprenticeship Committee
UC Berkeley	University of California–Berkeley
UC Davis	University of California–Davis
UCLA	University of California–Los Angeles
USC	University of Southern California
USGBC	United Stated Green Building Council
VIP	Veterans in Piping
WAP	Weatherization Assistance Program
WASC	Western Association of Schools and Colleges
WE&T	Workforce Education and Training
WHPA	Western HVAC Performance Alliance
WIA	Workforce Investment Act
WIB	Workforce Investment Board
WIP	Weatherization and Intergovernmental Programs

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PART ONE:

POLICY IMPACT ON JOBS AND ECONOMIC DEVELOPMENT

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CHAPTER ONE:

1. INTRODUCTION TO THE WORKFORCE EDUCATION & TRAINING NEEDS ASSESSMENT

This report presents the results of the California Workforce Education and Training Needs Assessment for Energy Efficiency, Demand Response, and Distributed Generation (WE&T Needs Assessment). This project was carried out under joint management by the California Public Utilities Commission (CPUC) and the investor-owned utilities (IOUs) of California with Southern California Edison (SCE) serving as the lead utility for the IOUs.[1] The project was funded by the ratepayers of California under the auspices of the CPUC.

Consistent with the direction of the CPUC, this is a third party report and does not necessarily represent the viewpoints of the CPUC or the four IOUs, though CPUC and utility staff reviewed it for factual accuracy. The WE&T Needs Assessment was conducted throughout calendar year 2010.

1.1 WHY A WORKFORCE EDUCATION AND TRAINING NEEDS ASSESSMENT FOR CALIFORNIA?

The WE&T Needs Assessment is one of the products resulting from the California Long Term Energy Efficiency Strategic Plan (EE Strategic Plan or Plan), which the CPUC adopted in September of 2008.[2] Developed using an intensive stakeholder process in 2007 and 2008, the Plan provides a road map for a dramatic scaling up of statewide energy efficiency efforts designed to meet California's clean energy goals. The objective of the Plan is to compel sustained market transformation, thus moving California towards long-term deep energy savings. The Plan delineates a set of strategies for residential, commercial, industrial, and agricultural sectors. In addition, the Plan is a central element in the implementation of California's Global Warming Solutions Act of 2006 (AB 32) and is also a main component of the implementation of California's Comprehensive Energy Efficiency Program for Existing Residential and Non-residential Buildings law, passed in 2010 (AB 758).

Workforce Education and Training (WE&T) was one of the key issues identified in the EE Strategic Plan. The WE&T section of the Plan begins with a vision statement followed by detailed goals, strategies and implementation plans. The vision statement states:

> *"By 2020, California's workforce is trained and fully engaged to provide the human capital necessary to achieve California's economic energy efficiency and demand-side management potential."* [3]

[1] The four major IOUs serving California's electric and natural gas customers are: Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), San Diego Gas and Electric Company (SDG&E) and Southern California Gas Company (SoCalGas).

[2] California Public Utilities Commission (CPUC) (2008). D.08-09-040. *Decision Adopting the California Long Term Energy Efficiency Strategic Plan.* The CPUC both adopted the plan and "… required that adopted strategies be incorporated in energy efficiency program planning and implementation starting in 2009."

[3] California Public Utilities Commission (2008). California Long Term Energy Efficiency Strategic Plan: Achieving Maximum Energy Savings in California for 2009 and Beyond. p. 74. Retrieved from: http://www.cpuc.ca.gov/NR/rdonlyres/D4321448-208C-48F9-9F62-1BBB14A8D717/0/EEStrategicPlan.pdf.

The Plan calls for the establishment of "…energy efficiency education and training at all levels of California's educational system," and for ensuring that "…minority, low income and disadvantaged communities fully participate in training and education programs at all levels of the DSM [demand-side management] and energy efficiency industry." Both of these goals emphasize the potential for energy efficiency investments to create careers for Californians of all background, not just for the college educated or for those with ready access to a college education. The Plan also recognizes that an extensive collaborative effort among state agencies, educational institutions, community-based and non-profit organizations, private industry and labor is required for an effective and comprehensive WE&T program for a new energy efficient economy.

Following adoption of the Plan in September 2008, a process of refining the needs assessment took place, which included gathering stakeholder input, drafting a Request for Proposals (RFP) based on that input, and selecting a third-party group to conduct the study. This process was completed by December 2009 and resulted in the research presented in this WE&T Needs Assessment report.[4]

The CPUC's direction for the WE&T Needs Assessment initially focused on achieving California's energy efficiency goals and the need to have a "trained and fully engaged" workforce to do so. However, the CPUC also recognized the importance of workforce outcomes through its explicit consideration of disadvantaged workers and its emphasis on collaborating with state training agencies, educational institutions, community-based and non-profit organizations, and industry and labor organizations, whose priority is to improve job opportunities and outcomes rather than energy efficiency outcomes. To support the development of collaborative arrangements and to address equity concerns, the WE&T Needs Assessment thus addresses two distinct goals—worker outcomes and energy efficiency outcomes.

It is also important to draw attention to the fact that the WE&T Needs Assessment is meant to identify all workforce strategies that could help achieve the state's clean energy and workforce goals, and does not limit the review of possible strategies to expanding or changing training and education programs. As we will see, training and education is often a necessary, but not sufficient, strategy to solve the various workforce issues that might impede desired energy outcomes or improve job opportunities for Californians.

1.2 SCOPE

The WE&T Needs Assessment focuses on the customer side of the energy market, meaning strategies that reduce the need for power from the electrical grid or gas distribution networks. This limited slice of the clean energy economy encompasses energy efficiency, distributed generation, and demand response. Energy efficiency reduces the amount of energy required for specific services, while demand response is aimed at reducing peak demand.[5] For this study, distributed generation is limited to customer-owned generation that relies on solar and other renewable fuel sources and is less than 20 MW in size.[6] In the rest of this document we use the terms "energy efficiency" or "energy efficiency related" as a shorthand for these demand-side management strategies, including distributed generation and demand response.

[4] During this process and in the initial months of the project, the goals and scope of the project were delineated to include a more comprehensive understanding of California's workforce infrastructure, a module on employment information systems to support the development of the WE&T web program, and a number of specific efforts designed to disseminate the preliminary findings of the study.

[5] Demand response generally involves reductions in load during on-peak periods and the possible shifting of this load to off-peak periods; these shifts are in response to direct load control programs as well as significant variations in customer energy prices. Energy storage and smart meters are part of demand response.

[6] The various types of distributed generation facilities are addressed by the CPUC in D.09-08-026. *Decision Adopting Cost-Benefit Methodology for Distributed Generation.* Distribution generation facilities that rely on natural gas or fuel oil (e.g., combined heat and power facilities) were excluded from the scope at the direction of the CPUC and IOUs.

This scope uses categories that are meaningful to the CPUC and the utilities and is not a definition of specific economic sectors per se. In fact, energy efficiency, and some demand response activities, mostly entail changes in processes—changes in the way we do things—rather than specific products or services, i.e., changes in what we produce. Some types of firms specialize in energy efficiency services, like home performance contractors and energy service companies (ESCOs). In other cases, however, energy efficiency activities are carried out (and can be incentivized) during new construction, remodeling or other activities whose primary goal is not energy savings. This is less the case with distributed generation, which consists mostly of solar, but also encompasses wind or fuel cells on customer sites. Solar and wind energy distributed generation can be more directly defined as a specific clean energy sector, but even here, many solar installations are installed by general or electrical contractors rather than by solar-specific contractors.

The definition described above has some grey areas, and the study team followed CPUC direction regarding what to include or exclude. For example, in the demand response area, smart meters were included but smart grid work was not. Transportation related activities, such as the construction of electric vehicle plug-in stations were also excluded. See Chapter 3 for a detailed list of the policies under consideration.

The WE&T Needs Assessment defines the scope of its economic sectors as all those that are impacted by policies and programs aimed at reducing energy use as defined above. Once we identify the industries impacted, these form the core of our analysis of job impacts and workforce education and training issues. As we will see, the largest industry segments that are affected are the construction industry and the professional services industries linked to construction—such as engineering and architecture. The only part of the utility workforce that is under study are employees directly involved in the energy efficiency program areas and these form a very small proportion of the overall workforce.

The WE&T Needs Assessment is statewide and includes the study of all policies and programs within the scope just described, not only those under the jurisdiction of the CPUC or implemented by the investor-owned utilities (IOUs). In addition, the recommendations for workforce strategies are not limited to those that can be carried out by the CPUC or the utilities, but rather are aimed at all those with the capacity to effectuate the needed changes. The EE Strategic Plan specifically called for collaborative solutions to workforce issues among state agencies, including the CPUC, the education and training agencies, and others.

1.3 RESEARCH APPROACH AND CONCEPTUAL FRAMEWORK

In order to address the two broad goals of the WE&T Needs Assessment, our research design encompasses investigation into both the demand and supply sides of the labor markets affected by energy efficiency and related policies. In order to develop the information base needed to analyze workforce strategies, the first area of research focuses on the impact of federal and state energy efficiency policies on job growth and job transformation. The second area of research is a comprehensive assessment of the many pieces of California's workforce development system and its collective capacity to prepare, place, or retrain workers in the jobs that are created or transformed by the energy efficiency policies and programs under the scope of this study. The study relies on a mix of quantitative and qualitative methodologies, which are explained in each chapter.

1.3.1 JOB IMPACTS OF ENERGY EFFICIENCY POLICIES

The first research goal requires an analysis of the specific job impacts of the policies and programs designed to support energy efficiency and demand-side management. This includes an identification of all the policies and

programs that impact energy efficiency, distributed generation and demand response and their impact on the number of jobs that will be created or transformed, the industries and occupations affected, the businesses carrying out these activities (including both the specialized energy efficiency firms and other firms carrying out this work), the skill sets for new jobs, skill changes for transformed jobs, the wages and other job characteristics, and the demographics of the workers in these sectors (including the numbers of dislocated and unemployed workers).

This also includes an understanding of the market environment in which these policies operate and the overall forces shaping the workforce and workplace in California. Thus, in addition to the quantitative analysis just described, our approach includes a qualitative analysis of the impact of market dynamics and policy interventions on the labor market and, in turn, an analysis of how this labor market impacts both energy savings outcomes and workforce outcomes.

This qualitative analysis is a critical part of our research because the overall labor market in California is beset by two critical problems—very high unemployment rates and very high wage inequality. While the high unemployment rate is a cyclical problem and is expected to eventually abate, the growing wage inequality and increasing percentage of low wage jobs is a structural problem with deep implications for this needs assessment. As we will see, the prevalence and dynamics of low-wage labor markets in California results in poor outcomes for workers in many jobs requiring less than a four-year college degree, which directly impacts the workforce goals under study here. Low wage labor markets also affect product and service quality by impacting businesses' capacity to attract, retain, and fully engage qualified workers. Training must be viewed within this complex labor market, which can potentially undermine the value of training investments. Given the complexities of how training works in the labor market, the study tries to identify all strategies for addressing the workforce goals, including, but not limited to, expanding or changing our current portfolio of workforce education and training programs.

1.3.2 WORKFORCE DEVELOPMENT INFRASTRUCTURE

The research on California's workforce development infrastructure comprises an assessment of California's education and job training programs at all educational and career levels that are relevant to the energy efficiency and related sectors. It includes both an inventory of education and job training programs in key occupations related to energy efficiency and a random sample survey of programs in the inventory, looking at the following institutions:

- → Four-year universities
- → Community colleges
- → Certified apprenticeship programs
- → Private industry training programs
- → Community-based organization training programs
- → Regional Occupational Centers and Programs
- → Utility training programs

It also includes an analysis of K-12 programs in the energy efficiency sectors and an analysis of employment information systems (online job matching systems). The emphasis of the analysis is on the key roles that each institution plays and how they fit together, including an assessment of the various planning arenas and mechanisms in the state to link economic development and workforce development and coordinate workforce development efforts.

To address strategies supporting the full participation of minority, low-income and disadvantaged communities, the Needs Assessment includes a separate chapter focused on identifying best practices for workforce education and

training programs and other interventions and policies. Again, the researchers do not assume that training and education is the only avenue that is needed to improve opportunities for disadvantaged workers, but also look at policies and programs that intervene in the demand side of the labor market to affect the kind of jobs created and who is hired. Although initially asked to focus on overcoming barriers to entry into training programs, the research team found that a more important consideration is overcoming barriers to placement in good jobs—not just in training programs—that may or may not lead to good jobs. Consideration of the issues facing disadvantaged workers is integrated throughout the report, as well as separately addressed in this chapter.

As with any research project, choices are made in terms of the levels of analysis and the resources expended on each piece of the puzzle. This is the most in-depth study of workforce issues in energy efficiency sectors in California to date, encompassing both the restructuring of jobs and the relevant workforce development infrastructure. Our emphasis is on providing as complete an overall picture as possible in order to surface all the issues that affect a project's energy savings and workforce goals. However, it is impossible to be completely comprehensive and we focus our efforts particularly on an analysis of middle skills construction jobs. The reasons for this emphasis are that our projections show that most of the jobs needing energy efficiency training are middle skills construction jobs, and that middle skill jobs are in the segment of the labor market plagued by low wages, poor links between training programs and jobs, and other labor market challenges. Finally, recent studies have focused on the energy efficiency professional workforce and there is a paucity of prior research on the construction trades workforce.[7]

As is apparent in the approach just described, the research team puts front and center the analysis of both the demand and supply sides of the labor market, and embeds issues of education and training within the larger labor market issues that impact both energy savings and workforce outcomes. Training investments operate within a complex labor market affected by the factors that determine what kinds of jobs are created (labor demand) and those that determine the availability and preparation of workers (labor supply).

1.4 PAVING THE HIGH ROAD AND CLOSING OFF THE LOW ROAD

The dual goals of saving energy and improving job opportunities and outcomes for low-income and disadvantaged Californians suggest that the WE&T Needs Assessment focus explicitly on strategies that can maximize the complementarities of these two goals, as well as identify the trade-offs between them where they exist. The conceptual framework for connecting these goals is based on the business and economic literature known as high road economic development. This approach focuses directly on the relationship between quality work and quality jobs. High road development consists of business competitive strategies built on quality and innovation, on jobs that pay well, use training to increase skills, and provide wage ladders to encourage learning and tenure within the same employer or industry.[8] In contrast, low road development consists of business strategies based on cutting

[7] Goldman, C., J. Peters, N. Albers, E. Stuart, M. Fuller (2010, March). Energy Efficiency Services Sector: Workforce Education and Training Needs. Lawrence Berkeley National Laboratories; Research Into Action, Inc.; Goldman, C., M. Fuller, E. Stuart, J. Peters, M. McRae, N. Albers, S. Lutzenhiser, M. Spahic (2010, Sept.). Energy Efficiency Services Sector: Workforce Size and Expectations for Growth. Lawrence Berkeley National Laboratories; Research Into Action, Inc.

[8] According to the business and economic development literature, a high road economic development strategy is one in which businesses compete by investing in a committed workforce that is both highly skilled and rewarded for those skills. JRank.org's online Encyclopedia of Business Management states, "The 'high road' to competitiveness is based on the cultivation of employee commitment and an exchange of high wages for high productivity." For a more thorough discussion see: Parker, E. & J. Rogers (2001). Building the High Road in Metro Areas: Sectoral Training and Employment Projects. *Rekindling the Movement: Labor's Quest for Relevance in the 21st Century*, eds. L. Turner, H. Katz and R. Hurd. Ithaca: ILR Press.; Bernhardt, Annette, Laura Dresser and Joel Rogers (2004). Taking the High Road in Milwaukee: The Wisconsin Regional Training Partnership. In *Partnering for Change: Unions and Community Groups Build Coalitions for Economic Justice*, ed. D. Reynolds. Armonk, NY: ME Sharpe.; Schweke, B. (2006). *A Progressive Economic Development Agenda for Shared Prosperity: Taking the High Road and Closing the Low*. Washington DC: Corporation for Enterprise Development.

costs, which leads to jobs that do not pay as well, do not use training, do not have career ladders and result in high turnover.

Increasingly, the U.S. economy, and particularly the California economy, are characterized by low road development, and there is no reason to expect that the sectors under study here will be different. Green jobs are likely to resemble other private sector jobs in California i.e., there will be some good professional jobs and many low-wage jobs, but not enough of the middle-wage jobs that are required for economic growth built on shared prosperity. Low-wage jobs are almost always jobs in which little investment in skill development occurs, which in turn affects the quality of the products and services produced. Thus, the dominance of low road firms in an energy efficiency industry often undermines both clean energy and workforce goals. To the extent that achieving our energy goals requires consistent work quality and a highly skilled workforce, policies that close off the low road and pave the high road may be necessary.

The high road conceptual framework allows us to address the two goals of the WE&T Needs Assessment in a comprehensive way and to study training and education within this larger context. Effective investments in training are necessary, but will not build the high road unless they are accompanied by labor demand policies to support work quality and job quality.

1.5 WHAT THE STUDY DOES NOT DO

This study is not able to assess the specific skills required to meet the work quality standards for all jobs impacted by energy efficiency policies and programs. It is also not an evaluation of the effectiveness of training programs in imparting specific skills and competencies to participants. Rigorous job task analyses that document work quality specifications for each job or activity and a translation of these specifications into skill standards, are the exception rather than the rule in the energy efficiency sectors. Given the wide variability of the firms entering these activities and the related variability of staffing patterns, as well as lack of widespread industry recognized licenses, certifications and other standards, identifying the specific skills related to the main occupations was far beyond our scope.

If skill standards were in fact specified and documented and a clear certification system were already developed, the WE&T Needs Assessment could have assessed gaps much more precisely. Unfortunately, that is not the case, which is one of the fundamental problems in this labor market. Lacking an objective measure of quality and a methodology to compensate for that, the study relied on self-reporting of the ways in which energy efficiency principles and skills were integrated into curricula.

1.6 IMPACT OF THE CURRENT ECONOMIC CRISIS

It is important to underscore that when the EE Strategic Plan was developed, there was real concern that the state might not have a workforce in place to carry out all the policies and programs designed to promote energy efficiency. Leading up to the adoption of the Plan, some stakeholders identified the lack of a trained workforce as a potential barrier to the achievement of California's aggressive energy efficiency and other demand-side management goals. Newspaper headlines questioned whether there would be a sufficient number of skilled

workers to meet the increased demand for energy efficiency and other green economy workers, including the skilled workers required for environmentally friendly (i.e., energy-efficient) construction.[9]

The world has changed dramatically since 2008, and the deep recession has lowered concerns about the availability of sheer numbers of skilled workers. Instead, there are many unemployed and dislocated workers with years of experience in the broad occupational categories linked to energy efficiency. At the end of 2010, the number of construction jobs in California was down 44 percent from its peak in 2006, while jobs in engineering and architecture firms were down about 10 percent.[10] Though unemployment is much lower in the professional occupations, overall worker shortages are clearly not the issue in the short run. This dramatic change in the economic environment critically impacts the results of the needs assessment in a number of ways, which will be explained both in this introduction and in each chapter where relevant.

1.7 STAKEHOLDER ENGAGEMENT

The research team has engaged stakeholders throughout the project with the objective of making the WET Needs Assessment as useful as possible to those involved in the achievement of California's clean energy and workforce goals. This engagement began before the start of the project, with the participation of stakeholders in the CPUC Energy Efficiency WE&T Task Force in defining the scope and goals for the WE&T Needs Assessment, and continued with individual and group feedback sessions throughout the research process.[11]

The research team also planned and organized the Workforce Summit under the guidance of a high level government and stakeholder planning committee.[12] This committee included senior officials or their staff from the CPUC, the CEC, the legislature, the CWIB and representatives from leading community-based organization, labor, private industry and the education and training community. The Summit, held on December 8, 2010, at UC Berkeley, was structured to present preliminary findings and recommendations from the WE&T Needs Assessment and obtain feedback through participatory workshops and solicitation of comments. Representatives from the CPUC and utilities staffs have also managed the project, participating in monthly project update meetings, providing information and contacts, reviewing proposed methodologies, and reviewing the final project report for accuracy and clarity.

The research team appreciates the input provided by the various stakeholder groups and is confident that this report reflects broad (though not universal) agreement among stakeholders from both the workforce and clean energy communities. Despite the extensive input received, the research team remains solely responsible for the contents of this report.

1.8 NEXT STEPS

This report presents recommendations for policymakers and program implementers in both the energy and workforce communities, including, but not limited to the CPUC and utilities. As part of the continued effort to

[9] Krieger, S. Green Gap—As environmentally friendly construction takes off, a question looms: Who's going to do all the work? (2008, Nov. 17). Wall Street Journal. p. R12.

[10] Calculated from California Employment Development Department industry employment data: http://www.labormarketinfo.edd.ca.gov/?pageid=166.

[11] The Task Force was formed following the adoption of the EE Strategic Plan and includes representatives from the utilities, public agencies, educational institutions, community-based organizations, and private industry and unions.

[12] See Appendix N for a description of the Workforce Summit.

involve stakeholders, the IOUs in conjunction with CPUC staff will be hosting a public meeting within a month of the release of this report. The purpose of this meeting will be to disseminate the results of this report and to obtain public input on how best to incorporate the findings into existing IOU WE&T programs, which are the focus of Chapter 12.

From the perspective of the research team, this workshop should only be the beginning of efforts to fully integrate workforce issues into programs focused on achieving the state's clean energy goals. Efforts should be made to match the specific relevant components of this report to the appropriate proceedings. The research team encourages the use of this report by other energy and workforce agencies, policymakers, and stakeholders, and looks forward to supporting these efforts.

1.9 ORGANIZATION OF REPORT

This report is divided into two main sections: Part One gives an overview of the state of California's labor market and the prospects for green jobs in the energy efficiency, distributed generation of renewable energy, and other demand-side energy management related sectors. The analysis presented in this section takes into account both the investments and the labor market dynamics in these industries. Part Two examines the existing workforce education and training infrastructure in the state and assesses how well it is prepared to meet the labor demand projected in Part One. The final chapter presents the implications of this research and puts forth recommendations for strengthening and improving the existing workforce education and training infrastructure, as well as for directing new investments in this area.

PART ONE: POLICY IMPACT ON JOBS AND ECONOMIC RESTRUCTURING

- CHAPTER 2: PROSPECTS FOR GREEN JOBS AND THE CALIFORNIA ECONOMY presents the current economic and labor market context in the state, including an overview of how the current economic recession has affected employment trends.
- CHAPTER 3: IMPACT OF ENERGY EFFICIENCY POLICIES AND PROGRAMS ON JOBS: LABOR DEMAND AND SUPPLY presents projections for employment trends based on the estimated aggregate public and private investment in target industries through the year 2020.
- CHAPTER 4: SECTOR CASE STUDIES analyzes work quality and job quality issues through an in-depth qualitative look at three energy efficiency related sectors—Residential Retrofits, Heating, Ventilation, and Air Conditioning (HVAC), and Commercial Lighting—that illustrate how market and policy conditions impact workforce and energy savings outcomes.

PART TWO: WORKFORCE AND EDUCATION INFRASTRUCTURE

- CHAPTER 5: CALIFORNIA'S WORKFORCE DEVELOPMENT INFRASTRUCTURE provides an introduction to the context and framework of our training survey and the workforce system as a whole, including an overview of the various parts of the workforce infrastructure, best practices in training strategies, the role of certification, the specific venues for green workforce planning and coordination in California, and a summary of the survey methodology.
- CHAPTERS 6–12 present the findings from our in-depth SURVEY OF SEVEN TYPES OF TRAINING PROVIDERS, including Four-Year Colleges and Universities, Certified Apprenticeship Programs, Community Colleges, Private Organizations, Community Based Organizations, Regional Occupational Programs, and Utility Training Centers.

- CHAPTER 13: ANALYSIS OF WORKFORCE EDUCATION AND TRAINING SURVEY compares the survey results presented in the previous chapters in order to provide a better understanding of the role of each type of training institution, its scale and training niche, as well as to provide an analysis of the gaps and shortcomings of the existing training system.

- CHAPTER 14: K-12 EDUCATION AND TRAINING describes career education programs relevant to energy efficiency occupations at the elementary and high school levels, which were not included in the training survey.

- CHAPTER 15: EMPLOYMENT INFORMATION SYSTEMS presents information about the job matching services available to assist job seekers and employers in energy efficiency related industries.

- CHAPTER 16: PIPELINES FOR DISADVANTAGED WORKERS looks at the barriers that prevent low income, minority and other disadvantaged individuals from entering energy efficiency careers, as well as the policy solutions and best training practices that can help create access to good jobs in these sectors.

- CHAPTER 17: IMPLICATIONS, CONCLUSIONS, AND RECOMMENDATIONS draws out the policy implications from the research presented in this report and recommends a future course of action for energy-efficiency related workforce policy.

CHAPTER TWO:

2. PROSPECTS FOR GREEN JOBS AND THE CALIFORNIA ECONOMY[1]

2.1 INTRODUCTION

Two major problems plague the California economy: The first stems from the Great Recession of 2007–09 and the subsequent very weak recovery, which have plunged the state into an economic crisis that is much more severe than in most other states. Of course, at some point economic recovery will resume and employment levels will return to pre-crisis levels, but it is difficult to forecast when that will occur. The second problem stems from the decades-long pattern of rising pay inequality in California. The growth of professional jobs has not been matched by the growth of the state's college-graduate population, while the elimination of many middle-paying jobs and the growth of low-paying jobs, which are also high-turnover and low-productivity jobs, have reduced living standards in California and kept the state's economic growth well below its potential level.

The expected growth of green jobs will help the state's employment problems. However without public policy support, green jobs are likely to resemble other private sector jobs in California. That is, the green sector will generate some good professional jobs and many low-wage jobs, but not enough of the middle-wage jobs that the state needs. Training programs for green jobs therefore are necessary to overcome the state economy's two major problems. But investments in training will not solve these problems unless they are accompanied by labor demand policies to grow the economy and to support job quality.

This context frames our study of the future California labor market for green jobs. Forecasts of the demand for and supply of workers of various skill levels who work in green jobs are affected by a number of factors. On the labor demand side, the key variables are: the rate at which the aggregate California economy will grow, the changing relation between economic growth and the demand for workers, the growth rate among specific economic sectors that are green-job intensive, and how business policy will respond to the demand for green jobs. On the labor supply side, the key variables include workers' projected entry and exit rates from the labor force and public policy, including the entire spectrum of educational and training institutions, both in the green energy efficiency related jobs context and more generally.

We, therefore, first discuss the economic crisis and recent employment trends and their implications for forecasts of green jobs in the coming decade. Section 2.3 examines the functioning of the California education system and the implications for the supply of workers of different skill levels, as well as the implications for pay inequality trends. Until the Great Recession, the economic return to a four-year college degree was increasing, and most college graduates obtained employment once they received their degree. However, the cost of college has been increasing faster than pay for college-level jobs, reducing the economic return to college degrees, while also creating higher mobility barriers for disadvantaged and asset-constrained households. As a result, the growth of enrollment levels among college-age cohorts has slowed down. Even if these trends are reversed by market forces, it already appears that the number of new college graduates will be insufficient to replace the large baby boom cohort of college graduates that are expected to retire in the next decade.

[1] Although the scope of this study includes only particular subsectors of the green economy, we use the term green throughout this chapter to allow a broader survey of the economic literature and to provide context for the more specific analysis to follow.

For those with high school and some college, the returns to middle skill jobs are often not as high. This labor market does not function as well, because of a lack of recognized credentials and certifications, lack of wage ladders, and a lack of links between training programs and employers. These deficiencies, however, can be ameliorated by public policy.

Section 2.4 discusses what we know about recent trends in the quantity and quality of green jobs, with special emphasis on California. A key policy issue here concerns whether business and public policy will follow what is referred to in the economic development literature as a high road or a low road. High road development consists of business competitiveness strategies built on quality and on jobs that pay well, use training to increase skills, and provide wage ladders to encourage learning and tenure within the same employer or industry.[2] In contrast low road development consists of business strategies based on cutting costs and jobs that do not pay as well, do not use training, do not have career ladders and result in high turnover. Section 2.5 examines labor standards that successfully encourage high road development. We briefly outline some policy measures with proven track records that could improve both the quantity and the quality of jobs within green sectors.

2.2 THE ECONOMIC CRISIS, RECENT EMPLOYMENT TRENDS AND FORECASTS

2.2.1 THE SOURCES OF THE CRISIS

The Great Recession began in December 2007 and ended in July of 2009, using the standard dating scheme that relies heavily on movements in gross domestic product. This recession was the deepest and longest of any of the post-WWII U.S. recessions. The recovery thus far has been extraordinarily anemic, even compared to the very weak recovery after the dotcom bust of 2000–01. The damage has been so great that most forecasters do not expect the unemployment rate to return to its pre-recession levels until late in the current decade.

For the U.S. as a whole, the Great Recession began with the collapse of house prices and residential construction, spread quickly to finance and then to the entire economy However, these developments only delineate the proximate causes. Rajan has argued persuasively that the cause of the crisis lies ultimately in a decades-long pattern of stagnating pay despite steadily rising productivity, and the accompanying concentration of income, especially at the very top of the income distribution.[3] Saez has documented the extraordinary run-up of the concentration of top incomes in the U.S, to levels not seen since 1929.[4] Those who received the largest income gains invested much of those gains in increasingly speculative mortgage markets, while those whose income fell or did not increase incurred increased debt to maintain their living standards.

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[2] According to the business and economic development literature, a high road economic development strategy is one in which businesses compete by investing in a committed workforce that is both highly skilled and rewarded for those skills. JRank.org's online Encyclopedia of Business Management states, "The 'high road' to competitiveness is based on the cultivation of employee commitment and an exchange of high wages for high productivity." For a more thorough discussion see: Parker, E. & J. Rogers (2001). Building the High Road in Metro Areas: Sectoral Training and Employment Projects. Rekindling the Movement: Labor's Quest for Relevance in the 21st Century, eds. L. Turner, H. Katz and R. Hurd. Ithaca: ILR Press.; Bernhardt, Annette, Laura Dresser and Joel Rogers (2004). Taking the High Road in Milwaukee: The Wisconsin Regional Training Partnership. In Partnering for Change: Unions and Community Groups Build Coalitions for Economic Justice, ed. D. Reynolds. Armonk, NY: ME Sharpe.; Schweke, B. (2006). A Progressive Economic Development Agenda for Shared Prosperity: Taking the High Road and Closing the Low. Washington DC: Corporation for Enterprise Development.

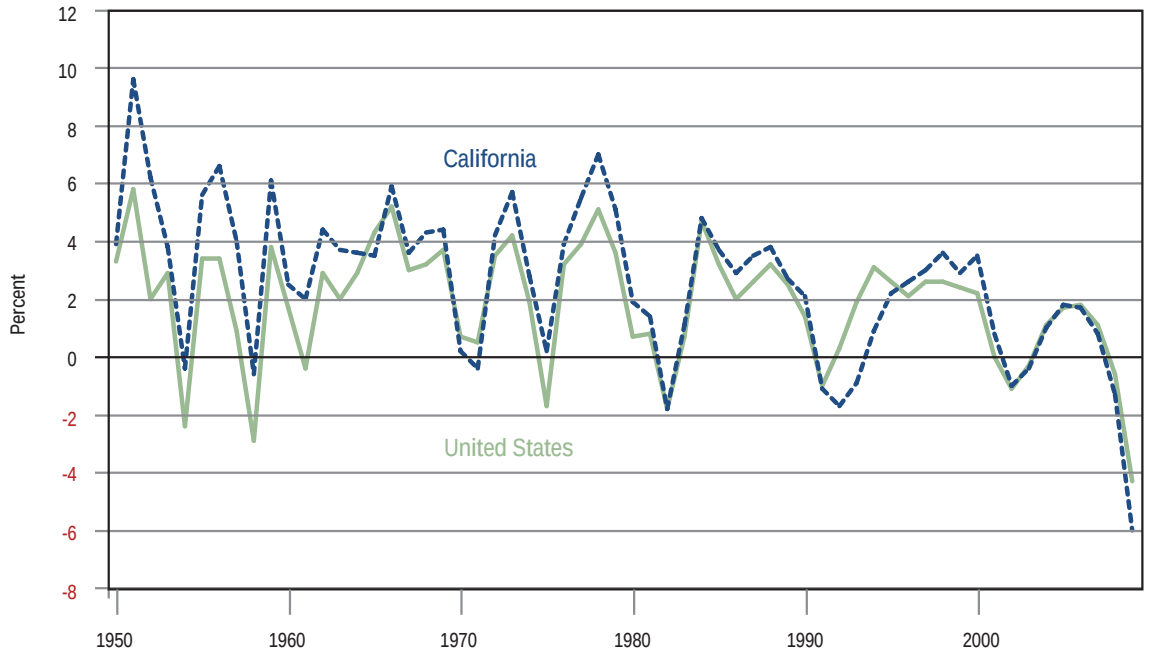
[3] Rajan, R. (2010). *Fault Lines: How Hidden Fractures Still Threaten the World Economy*. Princeton NJ: Princeton University Press.

[4] Saez, E. (2010). "Striking it Richer: The Evolution of Top Incomes in the United States." http://elsa.berkeley.edu/~saez/saez-UStopincomes-2008.pdf.

Deregulated financial markets—especially but not exclusively mortgage markets—thereby came to play a larger role in the U.S. economy. At the same time, financial institutions created, on a massive scale, an increasingly more speculative set of instruments whose greater risk levels were hidden from view. The resultant twin financial and economic crises have made the recovery process for the U.S. especially lengthy and difficult.

If we think of the U.S. economy as a sick patient, clearly in need of further healing, what is the health of the California economy? State-level indicators suggest that the California economy is very sick and will need an even longer period to recover. Usually, as Figure 2.1 shows, California employment trends closely track national employment trends. But this crisis has been more severe in California. Why? The same factors that led to the national crisis are not only present in California, they are also stronger. As Table 2.1 and Figure 2.2 show, these trends occurred in California as well. As we document below, the growth of income inequality in California has been greater than in the U.S. as a whole. Moreover, as documented by a University of North Carolina study, the deregulation of financial and mortgage industries proceeded farther in California than in most other states.[5] The current prognosis is that California will need substantially more time to recover than was previously predicted.

Figure 2.1 Annual Change in Nonfarm Employment, California and the U.S.



Source: Public Policy Institute of California (2010). *California 2025: Planning for a Better Future.* Using data from the California Employment Development Department and the Bureau of Labor Statistics.

[5] Ding, L., R. Quercia, C. Reid, A. White (2010). "The Impact of State Anti-Predatory Laws on the Foreclosure Crisis." Research Report. Center for Community Capital, University of North Carolina.

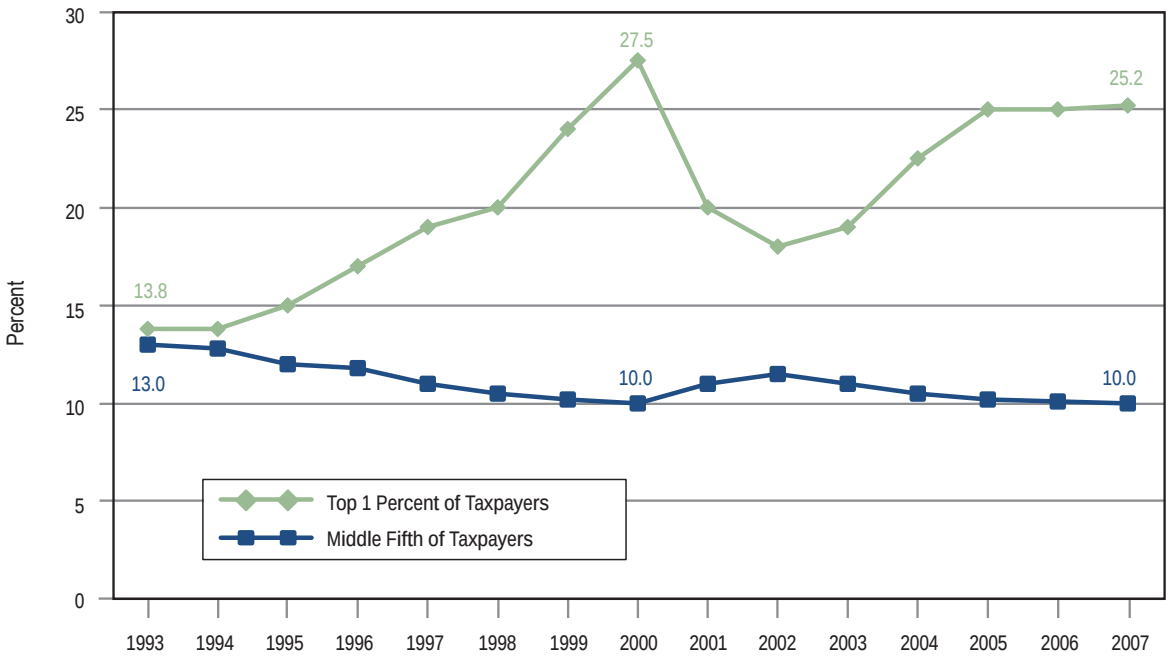
Table 2.1 Uneven Growth in Income in California

Income Category	Percent Change in Average Adjusted Gross Income	
	1995 to 2007	2006 to 2007
Bottom fifth	7.7	−2.8
Second fifth	8.7	−0.7
Middle fifth	9.1	0.5
Fourth fifth	11.3	2.2
Top fifth	51.0	4.2
Top 10 percent	64.1	4.2
Top 1 percent	117.3	4.3

Source: California Budget Project (2009, June). New Data Show that California's Income Gaps Continue to Widen, *Policy Points*, p. 2. Retrieved from: http://www.cbp.org/pdfs/2009/0906_pp_IncomeGaps.pdf. Analysis of California Franchise Tax Board Data.

Note: Inflation-adjusted dollars.

Figure 2.2 Gains for Californian's Wealthiest Taxpayers More than Double those of Middle Class, 1993 to 2007



Source: California Budget Project (2009, June). New Data Show that California's Income Gaps Continue to Widen, *Policy Points*, p. 3. Retrieved from: http://www.cbp.org/pdfs/2009/0906_pp_IncomeGaps.pdf. Analysis of California Franchise Tax Board Data.

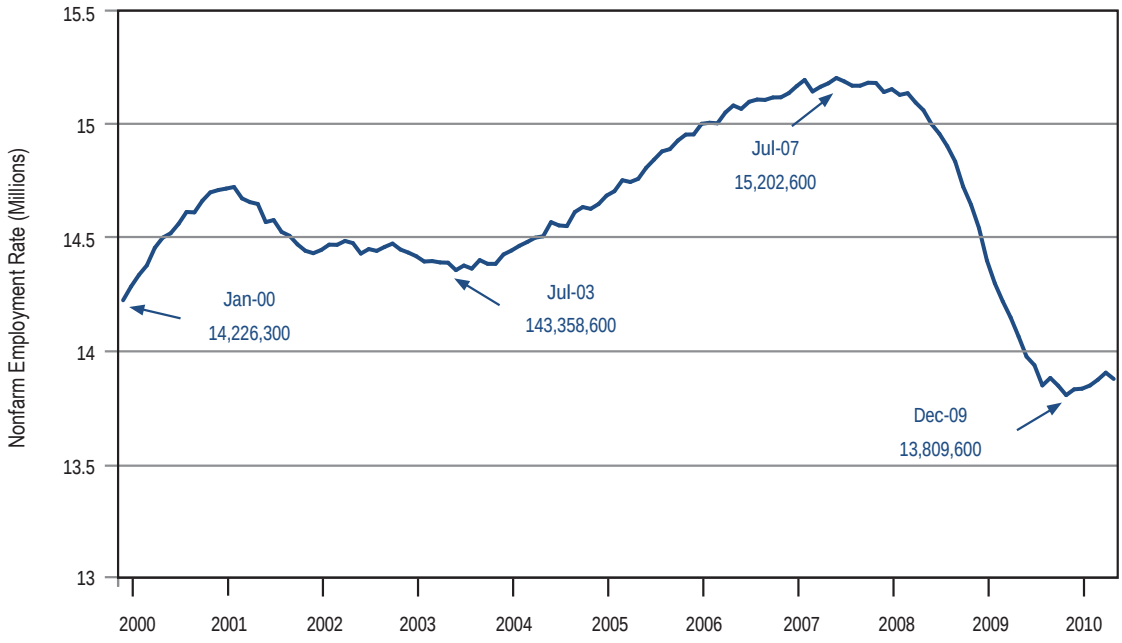
Note: Inflation adjusted dollars.

This context is critical for the California Workforce Education and Training Needs Assessment, which was initially proposed before the onset of the Great Recession. At that time, there was palpable concern about worker and skills shortages. In the current context, many highly skilled construction and other workers are unemployed or underemployed and turnover rates are much lower than in normal times. On the other hand, the February 2009 American Recovery and Reinvestment Act (ARRA) has provided a huge amount of short-term funds, including support for green training programs. ARRA also contains other key programs, such as support for housing retrofits and for development of new technologies, which affect the clean energy sectors. The high levels of unemployment in construction and the role of ARRA influence both the demand for green jobs and training, as well as the supply of trained workers for the green economy. However, since ARRA funds will run out in 2011, it remains to be seen whether the short-term support for green jobs will generate a long-term demand for those jobs.

2.2.2 EMPLOYMENT TRENDS IN THE RECOVERY

In 2000, the California unemployment rate stood at 4.9 percent, its lowest point since the 1980s. It then rose slightly to 5.3 percent in 2007. The national recession began in December 2007; the recovery, as measured by GDP, began by July of 2009. Since the economic recovery, at current writing, is now well over a year old, one would expect employment also to be recovering. However, as Figure 2.3 indicates, employment thus far has not grown to any substantial extent, either in the U.S. or in California. Job losses in California during the recession have been very severe. The current level of employment equals that of 1999, representing more than a decade of lost job growth.

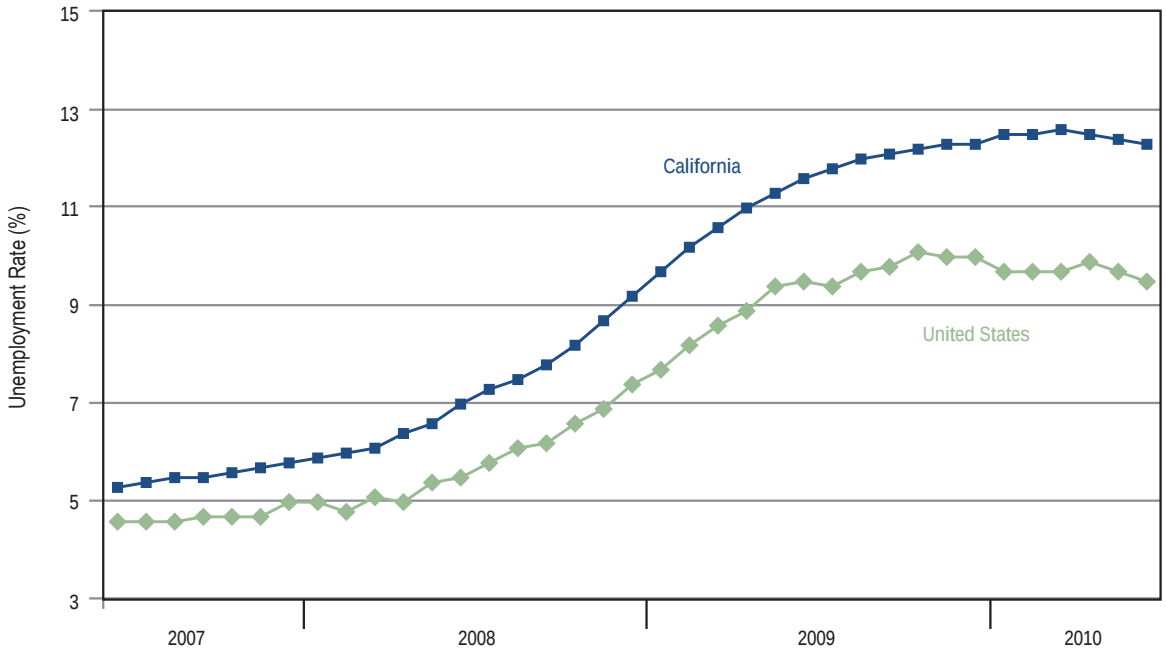
Figure 2.3 California Employment has Fallen Below the 1999 Level



Source: California Employment Development Department, Labor Market Information Division, Historical Industry Employment Data Files: http://www.labormarketinfo.edd.ca.gov/?pageid=166.

Figure 2.4 compares California's unemployment rate to the U. S. rate, from June 2007, six months before the recession began, through June 2010. Prior to the recession, the California unemployment rate was less than one percentage point higher than the national rate. This differential had generally remained stable since the 1970s. It results primarily from the greater inflow of workers into the state, relative to the U.S. as a whole. The greater California inflow reflects domestic and international migration into the state, as well as the resulting larger proportion of adults in California, relative to the nation as a whole.

Figure 2.4 California and U.S. Unemployment Rates, Seasonally Adjusted Data



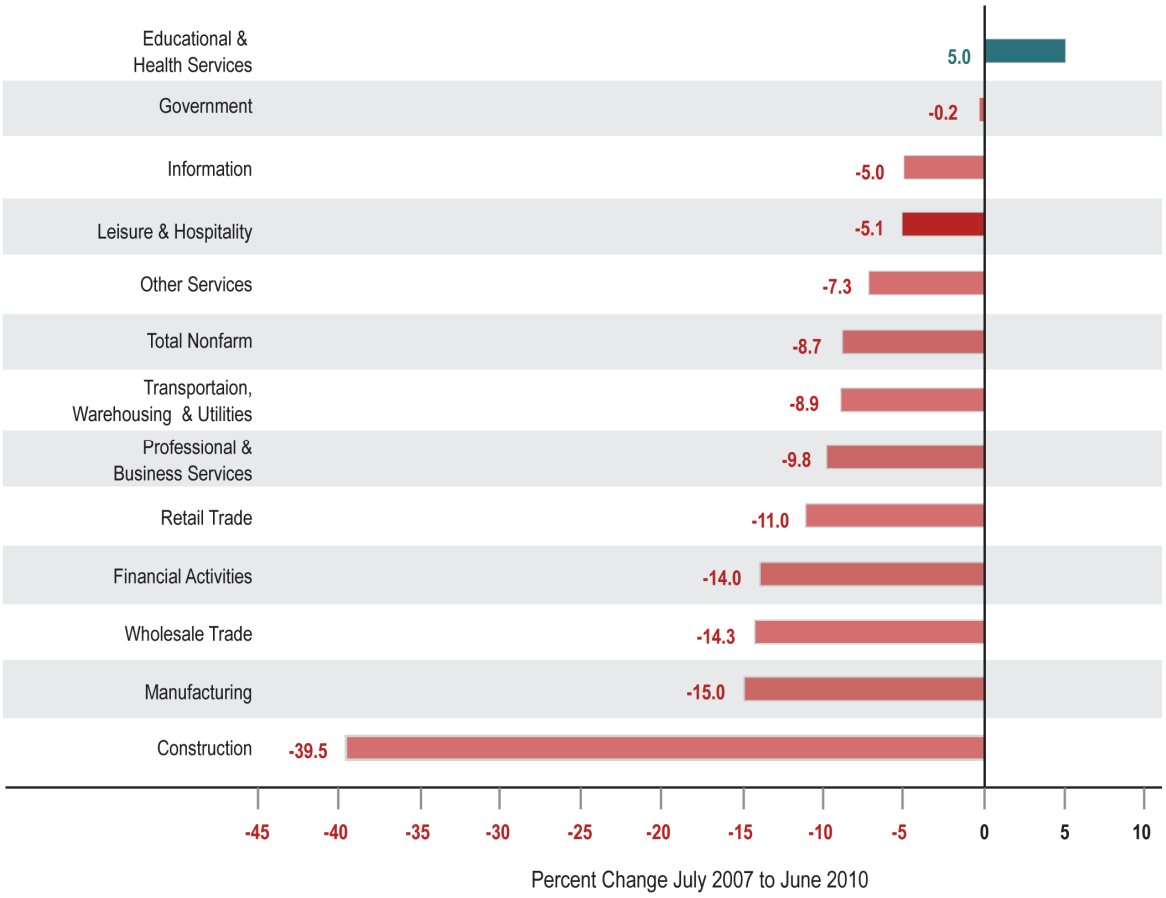
Source: California Employment Development Department, Labor Market Information Division, Labor Force and Unemployment Data: http://www.labormarketinfo.edd.ca.gov/?pageid=164.

But beginning in late 2007, when the U.S. unemployment rate increased rapidly, the California unemployment rate increased even faster. The CA–U.S. unemployment differential grew to about 2.6 percentage points by 2009 (about 12. 2 percent in California and about 9.6 percent in the U.S.) and the differential has remained at about 2.6 points during the recovery. Unemployment rates in the U.S. and in California have remained essentially unchanged during the recovery, leading many observers to label it as a jobless recovery.

Compared to previous recessions, the current recession is much broader, affecting nearly all sectors except health and education. As Figure 2.5 shows, construction experienced the biggest decline, due primarily to the bursting of the housing bubble and the subsequent steep decline in construction of new homes, with a loss of nearly 30 percent of jobs in this sector.[6] Since employment in the 1930s fell about 25 percent, one can characterize the downturn in California construction as at Great Depression levels. Financial services, manufacturing, and retail trade have the highest jobs losses after construction. Excluding construction, California job losses in declining sectors ranged from 3 to 11 percent.

[6] Nationally, construction employment fell by about 20 percent.

Figure 2.5 California Job Loss by Sector, July 2007 to June 2009



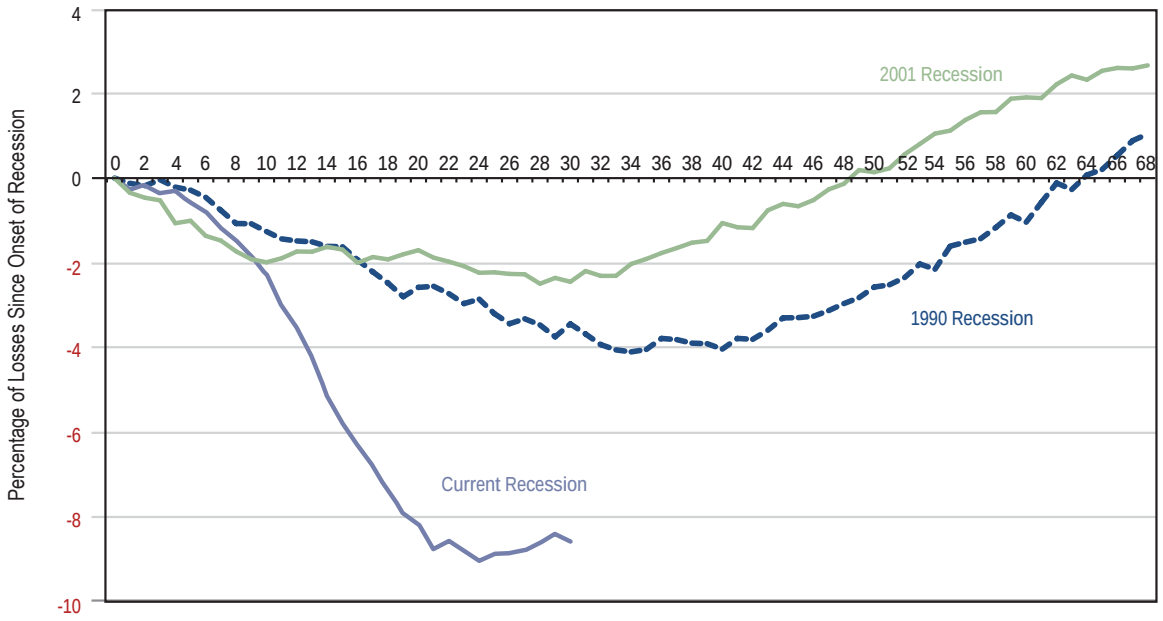
Source: Authors' calculations using California Employment Development Department, Labor Market Information Division, Historical Industry Employment Data Files: http://www.labormarketinfo.edd.ca.gov/?pageid=166.

Figure 2.6 compares job losses with the previous two recessions. Job losses from the current recession are significantly greater than either of the previous two recessions. The largest job losses in this recession reached approximately 8.5 to 9 percent at the deepest point, while job losses fell 2 and 4 percent in the 2001 and 1990 recessions, respectively.

Nevertheless, at some point the economy will recover and economic growth will resume. As Figure 2.7 shows, Department of Finance forecasts suggest that the economy will grow steadily from 2009 on, with nonfarm employment increasing from about 14 million in 2010 to about 15.25 million by the year by 2015.

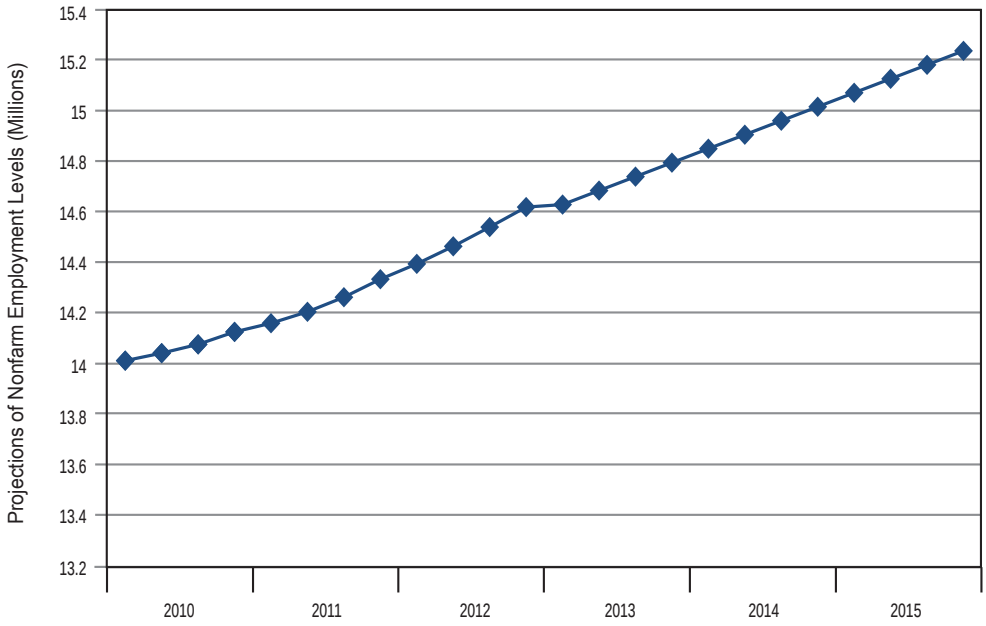
How long will it take for unemployment to fall to prerecession levels? Figure 2.8 shows our projections of unemployment rates and levels from 2010 to 2015, as extrapolated from the Department of Finance 2010–2012 projections. Figure 2.8 suggests that the unemployment in 2015 will be approximately 8 percent. This projection might be overly optimistic since unemployment in California has hovered at above 12 percent since July of 2009. The unemployment rate may not decline to 8 percent until 2020. Yet an 8 percent unemployment rate is quite high and indicative of a surplus labor supply.

Figure 2.6 Job Losses in California Compared



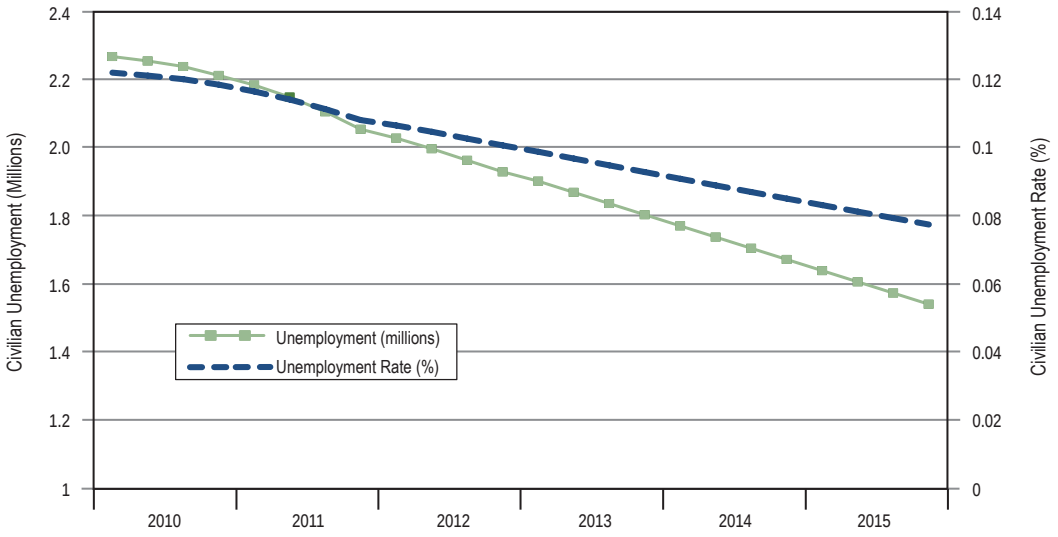
Source: Analysis of Current Employment Statistics data by Sylvia Allegretto, IRLE.

Figure 2.7 Projection of California Nonfarm Employment Growth, 2010 to 2015



Source: Extrapolated by the authors using the California Department of Finance 2009 Economic Forecasts. Projections for the years 2013 to 2015 were extrapolated using the parameters of a linear projection onto the CA DOF data for 2010.

Figure 2.8 Projections of California Civilian Unemployment, 2010 to 2015



Source: Extrapolated by the authors using the California Department of Finance 2009 Economic Forecasts. Data were extrapolated using the parameters of a linear projection onto the CA DOF 2010 to 2012 figures.

2.2.2.1 IMPLICATIONS FOR THE BLS TEN-YEAR EMPLOYMENT FORECASTS

Figure 2.9 displays the 2006–16 projections from the BLS ten-year forecasts of California job growth, disaggregated by industry.[7] But the economic recovery is already proceeding much more slowly than the rate used by BLS to generate these forecasts. What are the implications? We divide our brief discussion into three parts: one focuses on the construction industry, as many green jobs depend upon it; a second on the aggregate forecasts; and a third focuses on workforce aging and retirement issues.

2.2.2.2 CONSTRUCTION AND GREEN JOBS

As we will see below, many green jobs are dependent upon the residential and commercial construction industries. However, both the residential and commercial construction industries have been especially hard hit by the recession. High levels of inventory in the residential housing market in California and high vacancy rates in commercial buildings imply that there will not be as much new residential and commercial construction in the near future. Since these sectors are closely related to green jobs, the rate of green job growth may be slower.[8]

The boom years of 2001–07 are not likely to return. At the same time, a substantial number of the unemployed, especially those with prior experience in construction, possess skills needed in the green economy. Therefore,

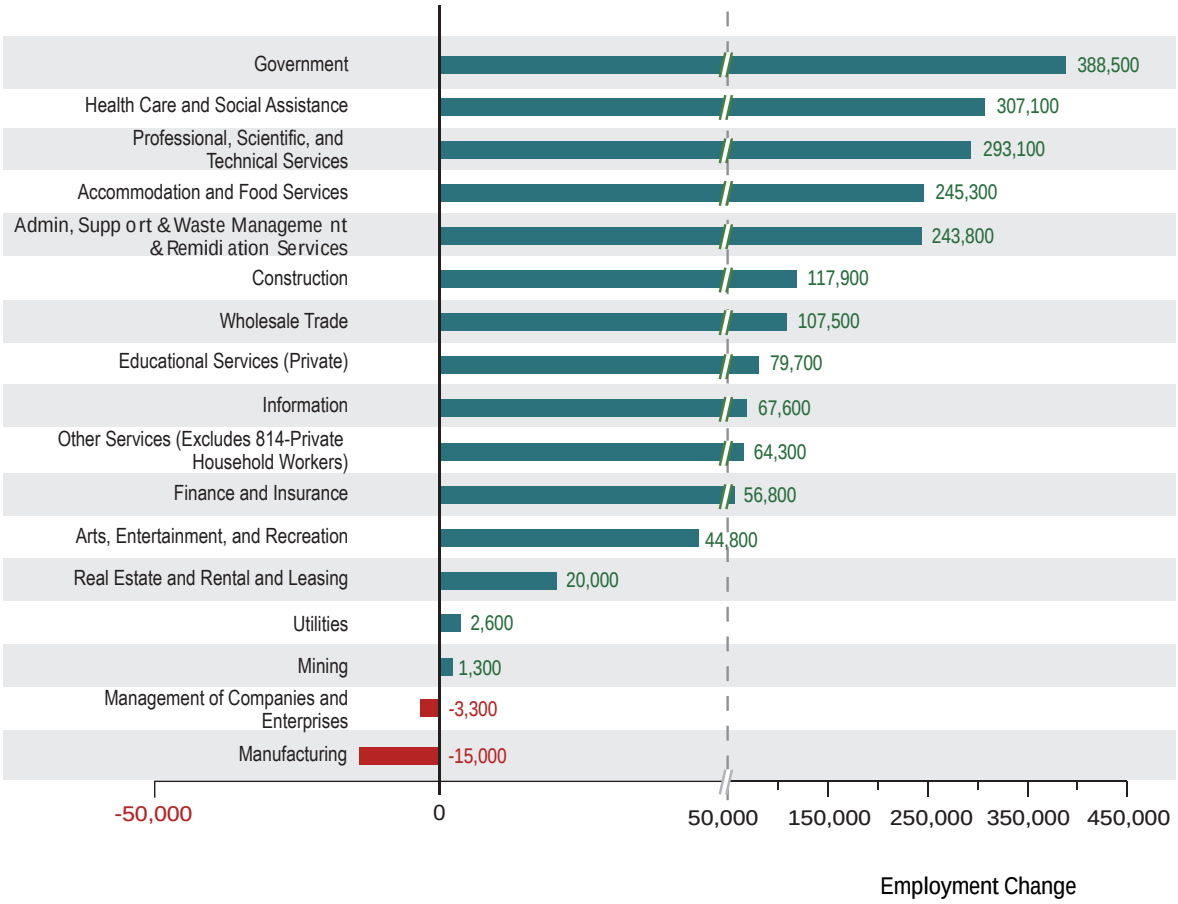
[7] The BLS released projections for 2008-2018 in July, 2010, after this chapter was written.

[8] The construction industry has been partly assisted by ARRA and other public policy programs that have targeted infrastructure projects and energy retrofits of existing buildings. Thus far, however, ARRA-financed infrastructure and retrofit projects are running well behind schedule in California. To replace a substantial portion of *residential* construction demand, retrofits would have to occur on a significantly larger scale, demanding substantial financing from taxpayer or ratepayer dollars. These do not seem likely to be forthcoming.

forecasts of green jobs and the supply of workers with green job skills should recognize that we can expect a sizeable surplus of skilled workers for much of this decade.

Once the economy recovers to the point that substantial job growth begins again, and the skilled unemployed find jobs, an excess demand for skilled construction labor may again develop. As shortages develop, pay for workers with those skills will increase, but at that point it will necessarily take time for the supply of workers with those skills to increase. These shortages can be prevented if public policies for education and workforce development do not wait for them to appear.

Figure 2.9 California Employment Change Projections by Industry, 2006 to 2016



Source: California Employment Development Department, Labor Market Information Division, Projections of Employment by Occupation: http://www.labormarketinfo.edd.ca.gov/?pageid=1011.

2.2.2.3 AGGREGATE EMPLOYMENT

What are the implications of the economic crisis for the growth of overall employment? First, the most recent Bureau of Labor Statistics forecasts were released in 2007, before the crisis began.[9] These forecasts of job growth by occupation and industry for the period 2008–16 therefore are likely to be too optimistic. Employment forecasts

[9] Franklin, J. (2007, Nov.). Employment Outlook 2006-2016: An overview of BLS projections to 2016. *Monthly Labor Review* 130, 11. Retrieved from: http://www.bls.gov/opub/mlr/2007/11/art1full.pdf.

depend substantially upon forecasts of economic growth. However, economic growth in the near future is likely to be much slower than was projected because of the length and depth of the Great Recession.

Economic growth will also be lower because labor force participation rates, except for the older part of the work force, are falling more rapidly than was forecast. The economic slowdown increases the number of workers leaving the labor force and then, in turn, the smaller labor force reduces the potential rate of economic growth. Furthermore, we will have fewer immigrant workers and therefore slower population growth. In other words, since employment growth forecasts are, in part, a function of forecasts of economic growth, and the post-recession rate of economic growth will be slower than expected, the forecast estimates of job growth are likely to be too large.

A second issue that calls for downward adjustments to the BLS forecasts relates to recent changes in the relationship between economic growth and employment growth. Employment forecasts are based in part upon a relationship called Okun's law, which predicts the rate of employment growth as a function of the rate of economic growth. However, the quantitative relationship between economic growth and employment growth specified by Okun's Law broke down in the Great Recession, when unemployment nationally increased by over 2 percentage points more than the law predicted.[10] If this change in Okun's Law persists, employment growth will be even smaller than was predicted, even if economic growth were to occur at the predicted rate. This change would then provide another source of upward bias to the BLS projections.

The breakdown in the reliability of Okun's law as an employment estimator is related to unforeseen changes in productivity growth, in the rate of adoption of technological change during a recession, and possibly, as well, to outsourcing of economic activity abroad. Forecasts of technological change by industry and skill level are based upon observations of recent patterns of technological change and concomitant job growth by industry and skill level. Labor productivity has grown faster in this recession than in previous ones, leading to the overestimates of job growth by industry. Since aggregate employment growth and aggregate productivity growth are inversely related, the recent increases in productivity will lead to lower employment growth.

2.2.2.4 WORKFORCE AGING AND RETIREMENT ISSUES

The BLS projections of future labor demand are based not only on the expected number of jobs, but also on the forecast of job openings due to replacement needs from growing numbers of retirements. As Table 2.2 indicates, the California working-age populations will age significantly by 2018, especially among those approaching retirement ages. (This table also documents the growing Latino share of the California workforce.) Moreover, for several decades, retirement ages have been falling, especially among men.

But since the mid-1990s, previous trends have reversed and the retirement age has been rising—for both men and women. Figure 2.10, for example, shows that increasing numbers of men and women work past the ages of 55 and 65. Estimated replacement needs are therefore more likely to be lower than was once expected. While the BLS forecasts do take this trend into account, they believe that it will subside. The argument is that the recession is discouraging workers who lose their jobs to continue to search for work and stay in the labor force. A contrary argument suggests that labor force participation will continue to increase because the recession has placed a growing number of people in financial crisis. In particular, with the trend away from defined benefit pension plans and toward defined contribution plans, many workers have lost substantial portions of their retirement savings due to the recession and they can be expected to continue working past their planned retirement age.

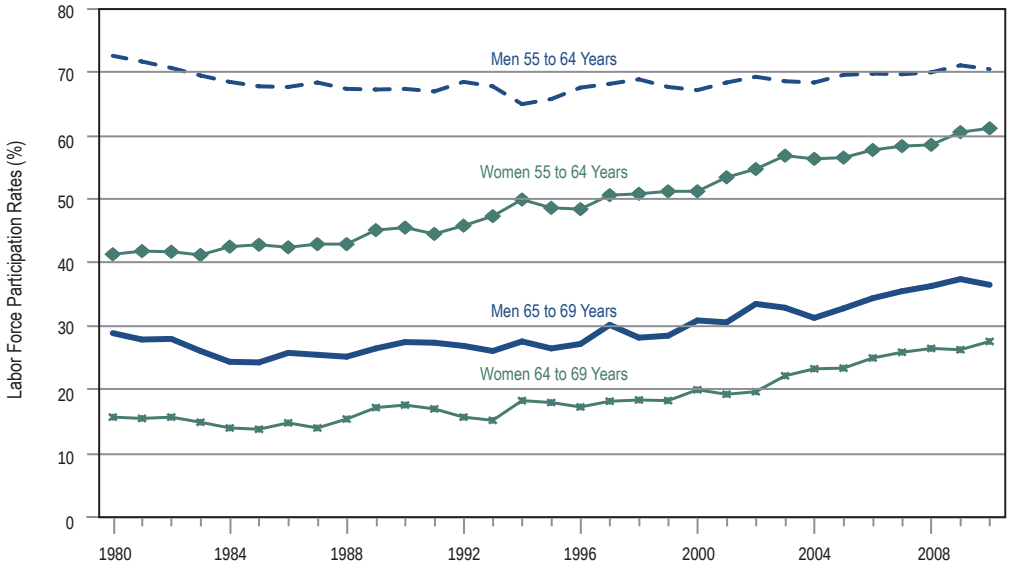
[10] Reich, M. (2010). "High Unemployment after the Great Recession Why? What Can we Do?" Policy Brief, Center on Wage and Employment Dynamics, IRLE, UC Berkeley.

Table 2.2 Demographics of California's Working-Age Population Age 16 and Over, 2008 and 2018

Demographic	Percentage of Persons 2008	Percentage of Persons 2018
Ethnicity / Race		
White	46.6	41.1
Hispanic	32.3	37.3
Asian	12.4	12.9
Black	6.0	5.5
All others	2.6	3.1
Total	100.0	100.0
Age		
16 to 24	17.5	16.1
25 to 54	54.8	50.8
55 and older	27.6	33.1
Total	100.0	100.0

Source: California Budget Project citing California Department of Finance: http://www.dof.ca.gov/research/demographic/data/race-ethnic/2000-50/.

Figure 2.10 Trends in Labor Force Rates, Ages 55 to 64 and 65 to 69, by Gender



Source: Current Population Survey through the Bureau of Labor Statistics: http://data.bls.gov/pdq/querytool.jsp?survey=ln.

It is likely that the trend toward later retirement will be partly counteracted by higher rates of labor force withdrawal among the *very* long-term unemployed—those who have been unemployed for one year or more.[11] This effect may be higher among workers in construction, where overall unemployment and very long-term unemployment remain especially high. Thus, while many older workers may remain in the workforce longer due to financial issues, discouraged workers, especially in the construction industry, may choose to quit looking for work, pushing the supply of skilled workers in the other direction. Given the opposing trends and uncertainty about their magnitudes, substantial uncertainty surrounds forecasts of labor force participation rates.

In summary, by all indications California will take longer to recover from the recession and the mortgage crisis than the U. S. as a whole. Forecasts of employment growth by industry and occupation, for both the overall U.S. and California economies, and for the green economy, therefore require some downward adjustments. Forecasts are not a guarantee and are subject to substantial uncertainty. There can also be unexpected events, which can change outcomes. Equally important, public policy at state and federal level can make a difference, both positively and negatively. For example, a large cut in California's state budget will most likely weaken further the state's recovery, while more aid from the federal government to support teachers or in the form of aid for Medicaid spending can be expected to spur economic growth and ease unemployment.

2.3 CALIFORNIA'S EDUCATIONAL AND TRAINING SYSTEM AND LABOR MARKET SKILL SEGMENTS

We turn now to a discussion of California's educational system. While California's educational system worked extremely well in providing a high quality and highly educated workforce from the 1950s to the 1970s, the same cannot be said of the past three decades. Problems in the educational system have had direct, but avoidable, deleterious effects on living standards in California. We review briefly trends in pay and pay inequality, then discuss trends in the college wage premium, and then the workings of the middle skill component of the labor market.

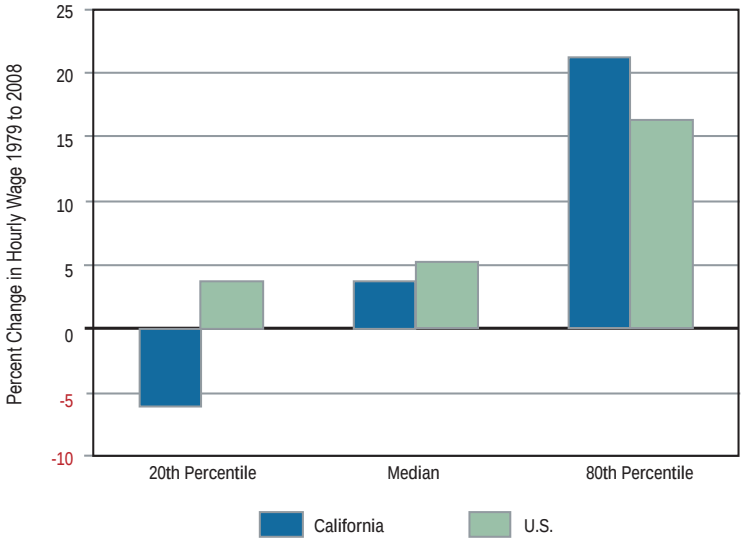
Wages in California have been stagnating for three decades, with very little increase in earnings for the median worker. In the same period, pay inequality in the state has increased substantially. Indeed, pay inequality in California is greater than in any other industrial country and exceeds that in the rest of the U.S. As Figure 2.11 shows, from 1979 to 2008 real wages in the U.S. for workers at the 20th percentile of the wage distribution increased by less than 4 percent, while pay for workers at the 80th percentile increased by 16 percent. In contrast, in California over the same period, hourly pay for workers at the 20th percentile declined five percent, while pay for workers at the 80th percentile increased by more than 20 percent.

2.3.1 THE LABOR MARKET FOR COLLEGE GRADUATES

A substantial part of the growth in pay inequality results directly from the rising college wage premium—the percent increase in pay of those with a bachelor's degree relative to those with a high school diploma. Figure 2.12 depicts trends for California from 1970 to 2006. As Figure 2.12 shows, the college wage premium declined from 1970 to 1980, a decade with rapid increases in college enrollments. In subsequent decades the premium increased substantially. In 1980, male college graduates earned 40 percent more than male high school graduates. By 2006, this wage differential grew to 86 percent. This trend was similar for women, although in a smaller amount.

[11] Reich, 2010.

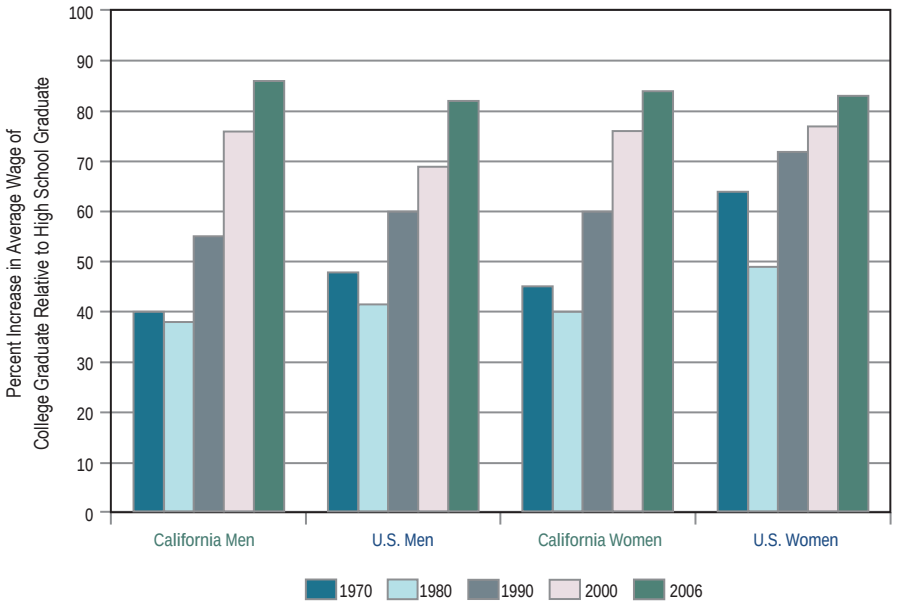
Figure 2.11 Change in Hourly Wages for Low- and High-Wage Workers, 1979 to 2008



Source: California Budget Project (2007, August). *A Generation of Widening Equality: The State of Working California, 1979 to 2006*. Retrieved from: http://www.cbp.org/pdfs/2007/0708_swc.pdf.

Note: Inflation-adjusted dollars.

Figure 2.12 Trends in the Earnings Gap between College and High School Graduates in California



Source: Reed, D. (2008). *California's Future Workforce: Will There Be Enough College Graduates?* Retrieved from: http://www.ppic.org/content/pubs/report/R_1208DRR.pdf. A Public Policy Institute of California report based upon the decennial Census and the 2005 and 2006 American Communities Survey.

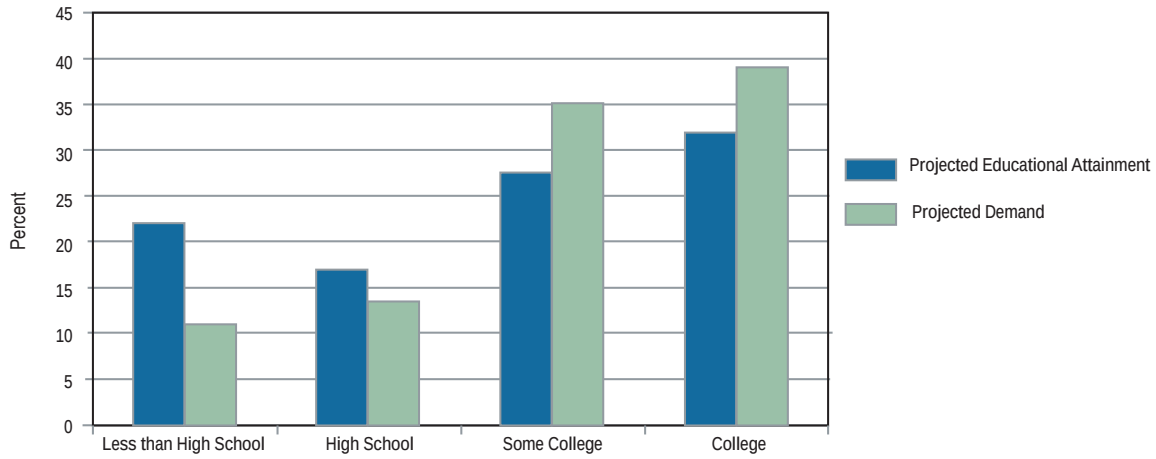
Note: The vertical axis depicts the percentage increase in average hourly wage for College graduates relative to high school graduates.

However, for both men and women in California, the growth in the college wage premium was even greater than in the U.S. as a whole.

Trends in the college wage premium are likely to continue to increase, absent public policies that would significantly and rapidly increase higher education attainment rates among working-age Californians. Projections cited by PPIC estimate that by 2020, 33 percent of the working age population will have a four-year degree, while 39 percent of jobs will require one, resulting in an even larger skills gap than today (Figure 2.13).[12]

Nonetheless, the share of college-educated workers in California increased from 33 percent in 1980 to 37 percent in 2006 (Figure 2.13). Why then did the college pay premium grow? A simple supply and demand framework suggests that demand growth for college-educated workers outstripped the increase in supply, resulting in a rising wage premium for these workers.

Figure 2.13 Demand for College-Educated Workers Projected to Outstrip Supply by 2020 in California



Source: Reed, D. (2008). *California's Future Workforce: Will There Be Enough College Graduates?* Retrieved from http://www.ppic.org/content/pubs/report/R_1208DRR.pdf.

According to this logic, if California had increased the number of spaces in its higher education system more rapidly, as it did in the 1960s and 1970s, the growth in the supply of college-educated workers would have held down the growth in the college pay premium. Equally, important, given the growing demand for college-educated labor, an increase in the supply would have made the California economy grow more rapidly.

The number of new college graduates could have increased if more families had been able to afford paying for a college education. Instead, support for financial aid fell, while the price of going to college rose faster than family incomes. These trends particularly affected low-income families, many of them minorities, who are not able to obtain or pay for student loans.

As for jobs that demand more skills, California higher education institutions have not expanded sufficiently to keep up with the demand for educated workers.[13] The increasing skills mismatch has several causes. On the demand

[12] Reed, D. (2004). "Wage Trends in California." San Francisco: Public Policy Institute of California.

[13] College enrollment rates also slowed down in the U.S. as a whole. In the 1980s the slowdown was partly the result of slowdowns in Federal grants for college students. This slowdown is also visible among graduate students support. For example, NSF graduate fellowships would

side, the trends contributing to the growth in the demand for college-educated workers discussed above are likely to continue. On the supply side, college attainment rates for the working age population are likely to decrease, because of retirements of highly educated groups in the workforce and faster growth in demographic groups who are historically underrepresented in the higher education system. For example, while educational attainment rates among Latinos, the fastest-growing demographic group, are improving, they are not growing quickly enough. In 1990 only 7 percent of Latinos had attained a bachelor's degree. This rate is expected to grow to 12 percent by 2020, still well below the state average and below the rates of other ethnic or racial groups.[14]

Even with significant increases in college attainment rates, the state is likely to experience an excess demand in jobs requiring a college education. PPIC estimates that if college graduation rates increased immediately to 50 percent for adults aged 25 to 29, and then continued at that rate, the share of workers with a college degree would reach 38 percent by 2020, just under the share—39 percent—needed to meet demand (Reed, 2008). Therefore, even with continuing growth in the college/high school pay differential, and even with swift, immediate, and strong public policy action today, it will take some time to close the educational attainment–jobs mismatch.

2.3.2 MIDDLE SKILL JOBS

Recently there has been significant growth in middle skill level jobs that require some technical skill and that cannot be fully outsourced. These middle skill level jobs require less than a BA degree but do require some college, apprenticeship or other technical training and are found in the health care, construction, transportation, and green technology industries. Examples of middle skill occupations include imaging specialists, lab technicians, respiratory specialists, air traffic controllers, electricians, and carpenters.

Middle skill level jobs represent 49 percent of all jobs, and they are expected to account for 43 percent of all new job openings in 2016.[15] A large percentage of green-related jobs are middle skill jobs and these occupations are expected to grow into the future. For example, 66 percent of jobs in energy efficiency, 77 percent of jobs in wind power, and 56 percent of jobs in the bio-fuels industry require middle skill level training.

However, there is already a shortage of workers with sufficient training for these jobs. Too few working age adults are attaining these degrees and certificates to meet the growth in these types of occupations, resulting in an emerging skills mismatch for this group. Market forces are unlikely to remedy this shortage, since expanding training capacity takes considerable time. A report by a coalition of non-profit organizations focusing on workforce development needs in the state, including Skills2Compete, the Workforce Alliance, and the California Edge Campaign, argues that while ARRA will generate a significant number of new jobs in middle skill occupations within the construction, manufacturing and transportation industries, governments and policymakers have placed disproportionate focus on increasing college and graduate level education relative to education and training needs for growth in middle skill occupations.

In 2007, 50 percent of jobs were classified as requiring less than a BA degree but requiring some college, apprenticeship training, or vocational certification; however, only 38 percent of all workers in the U.S. had attained

have to triple in number to match the proportions to college seniors in the 1970s. Increasing the number and benefit levels of scholarships and fellowships grants has been shown to be the best stimulus to increasing enrollments, especially among disadvantaged populations.

[14] As Card (2005) notes, the educational distribution of foreign-born workers in the U.S. is bimodal, meaning that both college graduates and those with less than high school education are overrepresented relative to native-born workers.

[15] The Workforce Alliance, Skills2Compete and the California EDGE Campaign (2009). "California's Forgotten Middle-Skill Jobs, Meeting the Demands of a 21st Century Economy." October 2009. Retrieved from: http://www.nationalskillscoalition.org/assets/reports-/skills2compete_forgottenjobs_ca_2009-10.pdf.

this level of skills certification. Many of these training programs are provided at the community college level and particularly in construction, in state-certified apprenticeship programs.

As others have argued, the middle-level job market in the U.S. suffers from several problems that lower the value of training in this segment of the labor market.[16] A greater connection between training programs and employers would improve the curricula in these programs and is necessary to better link their graduates to jobs. Equally important, middle skill jobs often lack adequate wage ladders to provide an incentive for employees to remain with the same employer or in the same industry. High turnover rates, in turn, discourage employment-based training, as employers are not able to capture the benefits of training employees who are likely to leave the firm.

2.3.3 LOW SKILL JOBS

Many analysts have expected that low skill jobs would shrink as a proportion of all jobs, for the same reasons that the demand for college-educated workers would grow.[17] In particular the computer revolution in the workplace was said to have increased the demand for skilled labor and reduced the demand for unskilled labor.[18] Increasing automation has especially supplanted routinized work that could be done by computers and smart machines. Economists also refer to the growth in international trade, which increased the demand for goods and services produced by more educated workers in the U.S. while less-educated American workers were increasingly replaced by lower-paid counterparts abroad. Both these explanations—technological change and growing international trade with low-wage countries—suggest that low-wage jobs should be shrinking in number.

More recently, economists have increasingly recognized that low-wage jobs have instead increased in large numbers in the U.S., contrary to the technological change and international trade explanations.[19] These growing jobs—restaurant workers, janitors, hotel employees, security guards, landscapers and others—are located in service industries and occupations. They cannot be reduced to repetitive routines, often because they involve interpersonal interaction, and therefore they are not as subject to automation or outsourcing abroad.

But why are these expanding jobs low-wage jobs? Three primary explanations have been offered; the decline in inflation-adjusted minimum wage standards; the low and declining levels of unionization in these occupations; and the growth in the supply of less-educated workers, many of them immigrants. As Table 2.3 shows, unions have declined in California and in the U.S. as a whole. Much research suggests that low-wage jobs do pay much more when labor standards are in place.[20] Clearly, if public policy on education and on labor standards were to respond appropriately, wage levels in these jobs would be higher and wage inequality would be much lower.

[16] Holzer, H., & R. Lerman (2007). America's Forgotten Middle Skill Jobs. Washington, DC: The Workforce Alliance.

[17] For a survey, see Acemoglu, D., & D. Autor (2010, June). Skills, Tasks and Technologies: Implications for Employment and Earnings. NBER Working Paper Series, Vol. w16082.

[18] Goldin, C.,& L. Katz (2008). The Race between Education and Technology. Cambridge, MA: Harvard University Press.

[19] Acemoglu & Autor, 2010.

[20] Gautie, J., J. Schmitt, eds. (2010). Low-wage Work in the Wealthy World: Case Studies of Job Quality in Advanced Economies. New York: Russell Sage Press.

Table 2.3 Unionization Rates of Workers in the U.S. and California

Year	U.S.	California
1989	24.8	21.4
2000	19.6	16.9
2006	18.9	14.8
2009	12.3	17.2

Source: California Budget Project (2007). *A Generation of Widening Equality: the State of Working California, 1979 to 2006*. Retrieved from: http://www.cbp.org/pdfs/2007/0708_swc.pdf.

2.4 TRENDS IN THE NUMBER OF GREEN JOBS

2.4.1 DEFINITION OF GREEN ECONOMY AND JOBS

How large is California's green economy? The California Employment Department defines the green economy to include businesses that are involved in generating or storing renewable energy, recycling, producing, distributing, maintaining, or implementing products that increase energy efficiency, environmental education, compliance, and training, and production of natural and sustainable products. Other studies have used alternative definitions, including some that focus on energy efficiency and renewable generation. Since the California Workforce Needs Assessment addresses only a subsector of the green economy, our focus is limited to energy efficiency, demand response, and distributed generation, or what is sometimes termed "demand-side management."

Studies that examine the green economy distinguish between goods that are *produced* specifically to reduce environmental impacts or "green goods," such as energy-efficient lighting or windows, versus businesses that revamp their processes to be more environmentally friendly, and thus are becoming greener in their practices. To capture most of the green economy, both types of activities should be included in measuring the green economy. As generalizable activities, such as improving energy efficiency or recycling resources, become more widespread, the number of green jobs can increase far beyond the companies that produce green products.

This distinction is similar to one commonly made in the Information Technology (IT) industry. Although only a select group of businesses produce IT-related products, in the past two decades the use of IT has changed organizational practices in almost every economic sector. Thus, in addition to specialized sectors that have emerged to address environmental concerns, environmental measures and policies are increasingly permeating a broad spectrum of the economy and traditional occupations, such as electricians and plumbers, are increasingly incorporating practices that save energy, conserve water, or reduce pollutants. This trend is likely to increase as the pressures of climate change and other environmental issues grow and bring environmental laws and policies to the forefront of the public policy sphere.

2.4.2 STUDIES ESTIMATING THE SIZE OF CALIFORNIA'S GREEN JOB ECONOMY

Despite the tremendous emphasis on and public policy around green jobs and measures to address environmental concerns, the numbers of green jobs in California and in the U.S. constitute a small proportion of their respective labor markets. As we discuss below, however, the available studies do suggest that green jobs are growing rapidly. Three studies have attempted serious assessments of the size of California's green economy. The most detailed study is by the Center for Community Innovation at UC Berkeley.[21] The two others were conducted by Collaborative Economics[22] and by the California Employment Development Department.[23] Of course, the size of the sector depends on how it is defined. The range in these three studies indicate that green jobs comprise between one and four percent of total employment, a small part of California's total economy. Nevertheless, as we discuss below, green jobs are growing much faster than jobs overall.

Innovating the Green Economy, a report by the Center for Community Innovation at UC Berkeley, examines the green economy in the context of innovation in California and its role in regional economic development within the state. Chapple et al. surveyed 34 metropolitan regions within California, ranging from the most economically vibrant regions, such as San Francisco and Los Angeles, to more distressed regions, such as Riverside–San Bernardino and the Upper San Joaquin Valley. The study defines the green economy as any "economic activity that reduces energy use and/or improves environmental quality." This definition includes new and traditional industries, as well as industries further up the production chain, such as clean tech manufacturing, and those that make green consumer products and services, such as household cleaning products.

Chapple et al. combine data analysis, business surveys, and interviews to identify green industries and innovation. They estimate the number of green establishments and jobs through an inductive and iterative process, drawing from green businesses, using lists from local cluster initiatives and from the National Employment Time-Series (NETS) database, which provides information on businesses at the detailed eight-digit SIC level. These industries are then grouped into six main green sectors: (1) energy research and services, (2) environmental services, (3) green building, (4) green manufacturing, (5) green transportation, and (6) recycling. This method results in a broader list of industries (194) compared to a previous study by Collaborative Economics (75).

Chapple et al. identify 12,253 green establishments employing 163,616 people in California in 2008. They find that green establishments on average employ more workers per business than do all businesses in the state (13.4 compared to 7.5 per establishment). The largest share of green employment was found in the environmental services sector (38,042 jobs), followed by the green transportation sector (36,107 jobs) and recycling (33,529 jobs). Growth in the environmental services sector far outpaced any other green sector, growing by 98 percent, from a base of 19,229, from 1990 to 2008. Green jobs are geographically concentrated in the largest five metropolitan areas, Los Angeles, the San Francisco Bay Area, San Diego, Orange County, and Riverside–San Bernardino, accounting for 70 percent of the jobs in the state.

Chapple et al. estimate that overall green employment accounts for less than one percent of total state employment. They attribute the small figures, in part, to the study's conservative definition of the green economy. But Chapple et al. emphasize that growth in green economic activity from 1990 to 2008 far outpaced overall growth (79 percent sales growth compared to 47 percent overall).

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[21] Chapple, K., M. Hutson and A. Saxenian (2010). Innovating the Green Economy in California Regions. U.S. Economic Development Administration, Retrieved from: http://communityinnovation.berkeley.edu/publications/ige_karen-chapple_cci-ucb.

[22] Collaborative Economics, & Next10 (2009). *Many Shades of Green: Diversity and Distribution of California's Green Jobs.*

[23] Employment Development Department (2009, May). *California Labor Market Analysis 2009.* Labor Market Information Division, Employment Development Department.

The Collaborative Economics study examines self-identified green businesses and counts the number of people employed in those businesses to estimate green jobs. This approach thus examines only businesses that are specialized in green products (or the supply of green goods as discussed above). Collaborative Economics finds that these jobs are diverse, dispersed widely across the state, and offer a broad range of occupational opportunities. They identify 15 segments in the green economy. The largest number of green job opportunities is located in Energy Generation, Air and Environment, Recycling and Waste, Waste and Wastewater Treatment, Energy Efficiency, and Green Buildings. A majority of the green jobs they identified are found in the areas of Air and Environment, Energy Generation, and Recycling, Waste management, and Energy, accounting for roughly 110,000 of the total 160,000 direct green jobs in 2008.

The estimated 160,000 direct green jobs account for approximately one percent of total nonfarm jobs in California. While green jobs are still a small part of total jobs, the Collaborative Economics study also found that these jobs are growing much faster than the rest of the economy, in both California and the U.S. From 1995 to 2007, green jobs in the U.S. grew by 17 percent, compared to 9 percent for all employment.[24] In California, growth in the green economy is even more marked. In just one year, 2007 to 2008, green jobs increased by an estimated five percent, while total employment declined by one percent. From 1995 to 2008, the number of green establishments in California grew by 45 percent, from a base of approximately 9,000, and green jobs grew by 36 percent, from just under 117,000 to 160,000. In the same period, total nonfarm employment grew by just 13 percent (from roughly 13.6 million to 15 million jobs) in the state. As we discuss below, the faster growth of green jobs in California reflects the earlier adoption of green activities in the state. If the recent growth rate continues, these jobs are likely to become a significant part of the California economy in the near future.

The California Employment Development Department (EDD) study takes a broader approach to estimating the size of the green economy. EDD conducted an employer survey, ending in January 2010, to collect information on all green industries, including jobs generated through the supply of green-related products, as well as a result of businesses implementing green practices. Using this method, green jobs comprise a larger percentage of the whole economy, compared to the previous study—approximately 3.4 percent (433,000 jobs) of all jobs in California.

As Figure 2.14 shows, the green jobs identified by the EDD study are concentrated in manufacturing (88,815) and construction (61,300). Specifically, more than three fourths of all workers identified were employed in industries related to recycling, (27 percent), Energy Efficient Product Manufacturing, Distribution, Construction, Installation, and Maintenance (27 percent), or Natural and Sustainable Product Manufacturing (24 percent). Common green-related occupations include carpenters, hazardous materials removal workers, sustainable farmers, assemblers, recycling center workers, electricians, plumbers, architects, industrial production managers, and construction managers.

2.4.3 JOBS CREATED BY ENERGY SAVINGS

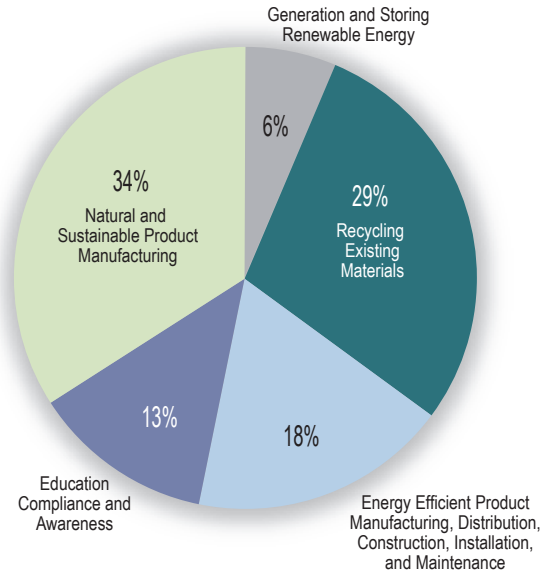
Since the early 1970s, California has implemented significant energy efficiency mandates and incentives, such as higher mileage requirements on vehicles, building energy efficiency standards, and a wide range of utility programs aimed at reducing the demand for energy and increasing the efficiency of energy supply. As a result, today California's consumption of energy per dollar of economic output is more than 40 percent below the national average, giving it an important competitive edge. The savings generated by these policies were spent primarily on increased consumption of services, which are relatively labor-intensive and produced almost entirely within the

[24] Grose, T. (2010, Jan. 21). "Progress and Promise: Trends in the Emerging Green Economy." Presentation to Innovating in the Green Economy Conference, UC Berkeley. Retrieved from: http://communityinnovation.berkeley.edu/publications/ige_tracey-grose_ce.pdf.

state. Consequently, the number of new in-state jobs that were created far outweighed the number that were destroyed in California's traditional energy sector.

Moreover, as a result of the same policies, California also gradually reduced its dependence from traditional energy sources outside of the state and increased its consumption of renewable sources within the state. In 1970, California drew most of its energy from traditional energy sources, which were and remain highly capital-intensive and more than two-thirds of it came from outside the state, generating jobs in Bahrain and Beaumont, Texas but not in Bakersfield.[25] This shift to renewable in-state sources thereby created many more in-state jobs than it destroyed.

Figure 2.14 Total Green Employment by Category



Source: Graybill, B. (2010, March 17). *California's Green Economy.* Presentation to the Green Collar Jobs Council. Retrieved from: http://www.labormarketinfo.edd.ca.gov/contentpub/GreenDigest/CA-Green-Economy-GCJC-032010.pdf.

A study at the University of California at Berkeley by David Roland-Holst reviews these policies and provides quantitative estimates of their effects on job growth in California over a 35 year period.[26] Roland-Holst's analysis accounts for both the shift to using less energy and the shift to consuming renewables from within the state. Roland-Holst estimates that over the 35-year period of the study, consumers and businesses realized $56 billion in energy savings. These savings, spent on other goods and services, led to a cumulated 1.5 million additional full-time equivalent jobs and an additional $45 billion in earnings over the period. Roland-Holst's forecasts, like any

[25] As Roland-Holst observes, crude oil and natural gas production within California have been steadily declining to the point where collectively they supply only 21 percent of state energy consumption. In contrast, renewable energy, which includes hydroelectric, geothermal, solar, and wind power, has been increasing but at a relatively slow 1.9 percent annual rate since 1970, supplying 13 percent of the state's energy. See Roland-Holst, D. (2008). *Energy Efficiency, Innovation, and Job Creation in California.* Research Papers on Energy, Resources, and Economic Sustainability, Center for Energy, Resources, and Economic Sustainability (CERES), UC Berkeley.

[26] (Roland-Holst, 2008) This study looks at induced job creation as a result of green measures. The term "induced" refers to job growth due to economic activity that is stimulated from green measures that results in a greater demand for labor whether or not the specific occupation involves the production of a green product itself. In contrast, "direct" refers to jobs specifically created in occupations that involving producing goods and services that increase sustainability of their consumption or reduces environmental impacts relative to their conventional counterparts. "Indirect" refers to jobs created through the spread of environmentally related concepts.

forecasts, are subject to uncertainty about the future. In particular, his assumptions about the extent of household savings from reduced energy expenditures may lead to overly optimistic estimates of job growth. Although we do not know the scale of this effect of energy savings, Roland-Holst presents a convincing argument that it is an additional stimulus from clean energy investments that policymakers should be aware of.

2.4.4 THE ROLE OF VENTURE CAPITAL INVESTMENTS

The growth of green jobs is closely related to innovation and investments in clean technologies. California is a leader in green technology development adding to its competitive edge in the world and national economy. Its energy productivity, defined as gross domestic product (GDP) per unit of energy consumed, has been on an upward trend since the early 1990s, and was 70 percent higher than that of the United States in 2007. In 2008, California's clean technology investments totaled $3.3 billion for the entire year.[27] California receives the lion's share of all capital investments in clean technology, amounting to $980 million in the second quarter of 2010 alone and accounting for two-thirds of all clean technology venture capital investments in North America.[28] Unfortunately, venture technology investment in California, including in clean technology, has been hard hit by the recession. Although such investments grew 14 percent from 2007 to 2008, these clean technology investments declined 36 percent from 2008 to 2009.

California's proactive stance on energy and environmental issues and its leadership in the area of green technology investments, incentives, and mandates, has played an important role in creating a burgeoning green economy. Rekindling these investments will be an important strategy in fostering the state's recovery and the creation of green jobs.

2.4.5 THE QUALITY OF GREEN JOBS

Job quality depends to a large extent on labor market standards attached to the job. While the growth in the environmental and sustainability sectors, along with venture capital investments, can be expected to generate jobs in the long run and contribute to California's recovery, not all green jobs are necessarily quality jobs. To date, however, the wage, benefit and other quality indicators of green jobs has not been the subject of much research.

The quality of green jobs has been examined in a study by Good Jobs First.[29] This study examined jobs in wind and solar energy component manufacturers, green buildings construction companies, and materials recycling facilities, finding that labor standards vary widely among green industries. Many jobs are in low wage labor markets such as residential construction and many are not covered by collective bargaining agreements. Hourly wages ranged from a low of $8.25 in a recycling processing plant, to $11 per hour in a manufacturing facility related to renewable energy. Wages in many wind and solar manufacturing facilities were below the average paid for other types of durable goods, and many of these jobs were not covered by collective bargaining agreements. Among non-unionized construction workers, such as laborers, carpenters, painters, and roofers, a majority make less than $12.50 an hour and a third make less than the federal poverty wage for a family of four ($10.19 an hour). The

[27] Next10 (2009). California Green Innovation Index. Retrieved from: http://www.next10.org/pdf/GII/Next10_GII_2009.pdf.

[28] Clean Tech Group (2010). "Global Clean Technology Venture Investment Increases 65 Percent in 1H 2010 Finds Cleantech Group and Deloitte." Retrieved from: http://cleantech.com/about/pressreleases/Q2-2010-release.cfm.

[29] Mattera, P. (2009). *High Road or Low Road: Job Quality in the New Green Economy*, Washington, DC: Good Jobs First.

study found many higher paying green jobs as well, including plumbers making $36 an hour, solar panel assemblers at $22 an hour, and some at a recycling plant earning $20 an hour.[30]

A key finding of the study: government policies made the difference between low and high quality jobs. For example, the highest wages were found where state and local governments had conditioned subsidies for green technology production on high labor standards and then enforced those standards.

2.5 LABOR MARKET STANDARDS

A growing research literature has shown that higher labor standards can lead to more productive workers, less turnover, and a more stable workforce.[31] When employers and employees are engaged in long-term employment relations, each has an interest in training and other learning activities that result in higher worker productivity as well as higher worker pay. One example of broader-based skills standards consists of industry-based agreements or policies that specify the skills that are needed in a particular occupation. When they are mandated, such skill standards are known to create higher quality jobs and worker output among workers who have acquired these skill standards.[32] Such standards result in better quality, higher paying jobs and allow for more broadly based prosperity and economic growth. Skill standards could be applied, for example, to occupations that involve the installation of heating and ventilation systems and solar panels.[33] Of course, developing skills standards in often fragmented industries can be challenging, but still worthwhile.[34]

Examples of mandated labor standards that are common, although by no means ubiquitous in California include living and minimum wages, prevailing wages, and project labor agreements. Some economists maintain that living wage and minimum wage standards reduce employment. Other economists have challenged such findings. Numerous rigorous research studies have demonstrated that both living wage laws and minimum wage laws raise earnings without leading to job losses, in part because they substantially reduce employee turnover.[35]

Living wage laws, which have been adopted by over 140 local governmental entities, apply to government-funded or subsidized contracts, and often, as well, to service providers located on government-owned property, such as a stadium or airport. Such laws are particularly common in California, in all of its large cities and many of its smaller ones, and also at many of the state's major airports.[36]

In the past two decades, over thirty states have enacted minimum wage standards that exceed the federal standard. Currently, typical state minimum wage laws set a standard of $7.50 to $8.00 per hour, and ten states

[30] We defer discussion of the skill sets and training requirements for green jobs to a later chapter in this report.

[31] For two examples, see Reich, M., P. Hall, P., K. Jacobs (2005). Living Wage Policies at the San Francisco Airport: Impacts on Workers and Businesses. *Industrial Relations: A Journal of Economy and Society*, 44: 106–138. doi: 10.1111/j.0019-8676.2004.00375.xy.; Dube, A., W. Lester, M. Reich (2010b, October). "Do Frictions Matter in the Labor Market? Accessions, Separations and Minimum Wage Effects." IRLE Working Paper.

[32] On industry-based skill standards, see: Marshall, R., & M. Tucker (1992). *Thinking for a Living*. New York: Basic Books.; or studies done by the Center on Wisconsin Strategy at the University of Wisconsin.

[33] Skills standards can have downside risks if they are not modernized as technology changes or if they are inflated and thereby used to exclude groups who lack certification in those standards.

[34] See the case studies in later sections of this report.

[35] Dube, A., W. Lester, M. Reich (2010a). "Minimum Wage Effects Across State Borders: Estimates Using Contiguous Counties." *Review of Economics and Statistics*. 92, 4: 1-20.; Dube, A., W. Lester, M. Reich (2010b, October). "Do Frictions Matter in the Labor Market? Accessions, Separations and Minimum Wage Effects." IRLE Working Paper.; Fairris, D., & M. Reich (2005). "A Survey of Living Wage Research." *Industrial Relations*.

[36] For a survey of California living wage ordinances and their impacts, see: Reich, M. (2002). "Living Wage Ordinances in California." In *The State of California Labor*, Ruth Milkman ed. University of California, Los Angeles, Institute for Research on Labor and Employment.

index the minimum wage to the consumer price index. Citywide minimum wage laws in Santa Fe, NM and San Francisco, which provide a minimum of $9.65 per hour, have also been found not to have had negative employment effects.[37]

Labor standards form a key component of Project Labor Agreements (PLAs), which are often present in large construction projects. They involve labor–management cooperation to solve problems related to coordination issues among a multiple of contractors and job requirements on large projects. Although the literature contains conflicting claims, the most rigorous and credible research is by Belman et al.[38] They conducted a careful analysis of construction costs among similar projects, such as construction of public school buildings, and were able to control for differences in the complexity buildings. They find that the costs and time to completion are smaller at PLA projects relative to non-PLA sites, despite the higher union pay rates in place at PLA sites.

Prevailing Wage Standards in construction provide an example of labor standards that promote higher labor productivity by coupling the standards with training programs. So while labor costs are higher, the offsetting increases in worker productivity often leave unit labor costs unchanged.[39]

In summary, a variety of labor standards have been shown to be highly effective in increasing pay, while also improving worker productivity, often by reducing employee turnover and with support from training programs. These programs are especially common in California, although by no means ubiquitous. The most effective programs provide mandated rather than voluntary participation. Although such programs are found in the green economy, they typically are not mandated.

2.6 SUMMARY AND CONCLUSIONS

The current economic crisis has deeply affected California's labor market and it is not expected to recover to pre-recession conditions for some time. According to our extrapolations of the Department of Finance's projections, California unemployment rate is expected to remain above 8 percent until 2020. While lower than the present unemployment rate, an unemployment rate above 8 percent is substantially higher than the 6 percent unemployment rate of 2007 for California. These projections suggest that it will take more than a decade to return to pre-recession unemployment levels. Consequently, employment forecasts that were made prior to the recession need considerable downward adjustments.

The California construction industry, in which many green jobs are located, has been more deeply affected than any other industry. Indeed, the decline of roughly 30 percent in state construction employment exceeds national employment declines in the Great Depression. The continuing overhang in both residential and nonresidential construction is likely to dampen the number of new green jobs for the near future. Many of the currently unemployed construction workers already possess skills applicable to the green economy and will need only limited additional training when they return to work.

Job training will still be important in the long run. In particular, increasing access to and levels of job training, certification and AA degrees can go a long way toward not only meeting future labor demand, but also increasing the quality of jobs and reducing income inequality in the state.

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[37] Dube, A., S. Naidu, M. Reich (2007, January). "The Economic Effect of Citywide Minimum Wage Laws." *Industrial and Labor Relations Review,* 60, 4: article 4. Available at: http://digitalcommons.ilr.cornell.edu/ilrreview/vol60/iss4/4.

[38] Belman, D., M. Bodah, P.Philips (2007). Project Labor Agreements. Retrieved from: http://www.onlinecpi.org/downloads/PLA-report.pdf.

[39] Reich, M. (1996). "Prevailing Wages and the California Economy." UC Berkeley Institute of Industrial Relations. Available online at: http://sbctc.org/default.asp?id=170; Mahalia, N. (2008). "Prevailing Wages and Government Contracting Costs: a Review of the Research." Briefing Paper no. 215.Washington, DC: Economic Policy Institute.

Income inequality is greater in California than in the rest of the U.S., and greater than in any other industrial country. Since 1979, earnings for the lower end of the distribution have been stagnating or declining, while earnings for the top twenty percent of workers have grown substantially. The growth in the number of professional jobs has not been met with sufficient matching investments in higher education at the two and four year degree levels. As the demand for workers with higher education levels has outstripped the supply, wages for college educated workers have grown faster than those of workers with lower educational attainment, resulting in a growing skills–job mismatch and college wage premium. This trend is likely to worsen without immediate increases in higher education investments as well as efforts to increase access to higher education for underrepresented demographic groups.

The green economy has been defined to include industries that directly produce products and services that reduce the environmental impact of economic activity, as well as activity indirectly created as a result of becoming more environmentally sustainable. To date, the size of the green economy is still small, but the growth rate of green jobs is substantially higher than the overall growth rate for all California jobs. Since California has been a leader in environmental initiatives, the state receives a large share of clean technology venture capital investments. For these reasons the green economy is likely to continue to grow at a faster rate than other sectors.

Given the growing importance of environmental issues, combined with the pressures of climate change, the green sector is likely to grow and will comprise a more significant share of all jobs in the long run. Moreover, as California's economy continues to become more energy-efficient and less dependent upon fossil fuels, which are capital intensive and require a large share of foreign inputs, many jobs will be created indirectly through the substitution of consumer purchases toward more labor intensive goods and services produced within the state.

The future economic growth of California in large part depends on decisions in Washington D.C. and Sacramento. We can take different growth paths: A high-road path would involve more rapid growth, and would foster shared prosperity and the growth of high quality good paying jobs. A low-road path would foster slower growth, higher inequality, and poor quality jobs.

The policy path that the U.S. and California have been on for three decades has been the low road; one of deregulated financial and mortgage markets and greater inequality, which resulted in slower economic growth compared to the high road path of the earlier postwar decades. The low road policy path culminated in the Great Recession and the continuing jobless recovery. In earlier decades the U.S. and California each invested more in education, training and infrastructure, and maintained regulations that fostered higher labor standards.

California can pursue a high road again—with the green economy and green jobs as one of its foundations. However, as we stated at the outset, the California economy suffers from two large problems: the economic crisis, which although temporary will be protracted, and the decades-old problem of increasing wage inequality. The growth of green jobs will provide an important source of new employment. But without appropriate public policies, the quality of these jobs will resemble those of other private sector industries—some high-paying professional jobs and many more low-wage jobs, but not enough high quality middle skills jobs. In this context training investments are necessary to expand the supply of middle skilled workers. By themselves, though, training programs are not sufficient. The state also needs public policies to generate economic growth and labor demand and employment policies that support job quality.

CHAPTER THREE:

3. QUANTIFYING LABOR DEMAND AND SUPPLY

3.1 INTRODUCTION

In order to assess the need for workforce education and training, it is necessary to quantify present and future labor demand. This chapter develops labor demand and supply projections for this Workforce Education and Training (WE&T) Needs Assessment as the first step toward understanding how the potential demand for workers in energy efficiency, distributed generation, and demand response ("energy efficiency and related activities" or "energy efficiency") matches the current and future California workforce.

This chapter addresses five main questions:

1. What are the existing energy and environmental policies and programs that are expected to result in job creation in energy efficiency, distributed generation, and demand response through 2020?
2. How much funding (both government dollars and private investment) is currently being provided by these policies and programs, and how much is expected to be provided in 2010, 2015, and 2020?
3. How many jobs are expected to be created as a result of this investment, and in which industries and occupations?
4. How many workers are currently employed in energy efficiency occupations, and how many are expected to be employed in the future in these occupations?
5. Given this projected future labor demand and supply, what are the needs for workforce education and training?

These five questions all attempt to describe the nature and scale of labor demand and supply for energy efficiency, distributed generation (including solar, wind, fuel cells, and storage but not combined heat and power), demand response, and other demand-side management activities.

The first step in projecting future labor demand in the energy efficiency and related sectors is to determine what activities are likely to drive the increased demand, and where funding for these activities comes from. To develop our projections, we analyze increased demand that stems from public and utility investments as well as from the private market. Public investments, which accounted for over 60 percent of the total projected investments in energy efficiency and related sectors in 2010, come from state sources, federal sources, investor-owned utilities (IOUs), and publicly owned utilities (POUs). Private investment, almost 40 percent of the 2010 total, is of two distinct types. The first type is *participant costs*, or the amount that businesses (commercial, industrial, agricultural, and municipal) and households pay directly for energy efficiency improvements that are linked to a publicly supported policy or incentive. Examples include IOU/POU appliance rebate programs, IOU/POU equipment incentives, and solar power subsidies. (Tax incentives are *not* included in this analysis; see note 2.) The second type of private investment that we analyze comes from purely private sources, meaning this investment is not subsidized by, matched by, or in any way tied to public or utility moneys. These include investments in energy efficiency resulting from compliance with increased codes and standards found in Title 24[1] and through implementation of

[1] Title 24 Part 6 of the California Code of Regulations is the Energy Efficiency Standards for Residential and Nonresidential Buildings, established in 1978 in response to a legislative mandate to reduce California's energy consumption. The standards are updated periodically to

the Big Bold Energy Efficiency Strategies (BBEES) in the California Long Term Energy Efficiency Strategic Plan (EE Strategic Plan), which was adopted by the CPUC in 2008. Taking both private components together, we refer to this source of investment in energy efficiency as *leveraged private investment.* Thus, our analysis of the sources of increased demand for energy efficiency and related investment incorporates the impact of major public sector and utility programs and policies, as well as shifts in private spending that can be directly attributed to these programs and policies. A comprehensive consideration of all possible private investments was beyond the scope of this study.[2, 3]

In this chapter we describe our methodology for developing labor demand and supply projections for the WE&T Needs Assessment and then present the summary results. Since the WE&T Needs Assessment requires an analysis of broad shifts in demand on the one hand, and a detailed description of employment growth for key occupations on the other, we developed a unique, hybrid "investment" methodology that meets both needs. While this method is necessarily more complex than either a bottom-up (micro) case study of an individual policy, or a statewide macro-level modeling exercise, it can be divided into seven distinct steps that, when taken together, bring to the WE&T Needs Assessment a relatively balanced and realistic estimate of future training needs. We present enough detail on the methodology for replication and regular updating of forecasts.

Below is a brief overview of the seven steps we used to project labor demand.

STEP 1. POLICY AND PROGRAM IDENTIFICATION: The first step in our analysis was the identification of all utility, state, and federal policies that were directly or indirectly designed to promote energy efficiency and other demand-side management activities. This step required a clear definition of the scope of policies to be analyzed and a division of policies into primary "target sectors" (e.g., residential, commercial/public, and agricultural/industrial).

STEP 2. MEASURING INVESTMENT LEVELS: After identifying the set of policies and programs that will influence demand for energy efficiency by sector, we then researched individual policy budgets. After having determined the investment levels for the baseline year of 2009, we used a variety of techniques to estimate the dollar amount of the predicted public and private investments associated with each of these policies and/or funding streams for three different years: 2010, 2015, and 2020. These different methodologies were required because of differences in the type of information available for the various policies and programs. For each policy/year combination, we estimated the investments under three different scenarios: low funding, medium funding, and high funding.[4]

STEP 3. INDUSTRY ALLOCATION: For each program or policy, we developed a method to allocate expenditures to detailed industry categories as defined by the North American Industrial Classification system (NAICS).[5] *These results are referred to as dollars per NAICS.*

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allow consideration and possible incorporation of new energy efficiency technologies and methods. The 2008 Standards went into effect January 1, 2010, and supersede the 2005 Standards.

[2] It is important to emphasize that our analysis of future private investment in energy efficiency and related activities excludes investments resulting from tax incentives, changes in market prices, changes in consumer preferences, and new technologies. We do not account for investments that are undertaken without a connection to some type of policy or program. Thus, the estimates for private investment rely exclusively on information on program participant costs (based on prior program experience, where available). In the case of the Big Bold goals, we only include private investment related to existing programs.

[3] The study's assumptions about policy-driven investment had to be finalized by June 2010 in order to conduct the rest of the analysis; any changes after June 2010 are not reflected in the estimates. Updating the investment numbers could be expected to change the specific expenditures in the short term (e.g., 2010). However, the overall conclusions would not be modified unless the reductions (or increases) in expenditures were known to be much different than projected for 2015 and 2020.

[4] Appendix A provides a detailed description of the first two steps.

[5] NAICS is the standard hierarchical coding system that classifies all economic activity into specific industry sectors.

STEP 4. JOBS CREATED BY PROGRAMS AND POLICIES: Next we used the E-DRAM model to provide an overall projection of the number of jobs created by increased demand in energy efficiency and related industries. The expenditures allocated to individual industries, as computed in step 3, were used as input. The E-DRAM model accounts for the indirect and induced impacts of the investments and also takes into account job creation (and destruction) due to energy savings.

STEP 5. DIRECT JOBS BY INDUSTRY: While the outputs of the macro-modeling conducted in step 4 are important for the big pictures, an accurate needs assessment requires details on job creation in individual industries. We used the "input-output" model IMPLAN to estimate the number of "direct jobs created by the energy efficiency investments in the relevant industries, using the dollars per NAICS figures from step 3 as inputs. The IMPAN model allowed us to account for which jobs will stay in California and which will be transferred outside the state. In step 5 we estimated the net new number of jobs by NAICS industry sector for each year (2010, 2015, 2020) for all three funding scenarios.

STEP 6. DIRECT JOBS AND WORKERS BY OCCUPATION: In step 6 we first estimated the number of *job person-years* in each occupation (classified by the Standard Occupational Code (SOC)). To do this, we applied the average distribution of jobs by occupation in the relevant industries using staffing patterns data from the California Employment Development Department (EDD), as well as the EDD Green Economic Survey. We next estimated the number of workers needing training for each job person-year.

STEP 7. GEOGRAPHIC DISAGGREGATION: The final step in this methodology was estimating the distribution of the number of workers requiring training by occupation needing training across California counties, metropolitan areas, and IOU regions.

3.1.1 CLARIFICATION OF KEY ASSUMPTIONS

Net new job creation due to energy efficiency and related investment occurs in many different industries. We refer to those industries in which jobs are *directly* generated from these public and private investments as *energy efficiency and related industries*. These *direct jobs* are in such industries as construction, administration, manufacturing, and technical services such as engineering and architecture. Others, such as accounting firms, also gain jobs, because they are providing goods and services to the direct beneficiaries of energy efficiency and related investment. These are called *indirect jobs*. A third group of industries, such as grocery stores, also experience job growth, primarily because the workers holding the direct and indirect jobs, as well as their employers, spend more money on consumption goods. Such newly created jobs are called *induced jobs*. Finally, some industries (such as fossil fuels) lose jobs, because households are substituting more energy efficient goods and services for their products. While we produced statewide projections for total jobs (direct + indirect + induced – jobs lost), we only developed detailed occupational projections and training needs assessments for the direct jobs.

Additionally, not every new job will require new education and training. For the purposes of this analysis, we conservatively assume that only the industries that engage directly in energy efficiency related activity (such as sheet metal working or photovoltaic panel manufacturing) will need to train their workers in energy efficiency and related skills. Within the energy efficiency and related industries, there are hundreds of occupations, from secretaries to CEOs to construction laborers. Some of these occupations need energy efficiency related training, but others do not. Given the objective of the Needs Assessment, we only examine in detail the job projections for occupations that need some sort of training.

Our analysis calculates new jobs in the form of full-time equivalents per year (hereafter *job person-years*). However, workers in most occupations do not spend all of their time on energy efficiency related activity. For instance, sheet metal workers may work on HVAC systems (which are central to energy efficiency), but also on rain gutters, roofs, outdoor signs, and other products that may not involve energy efficiency. If a sheet metal worker spends one-fourth of his or her time (hypothetically) on energy efficiency activity, then four sheet metal workers (whether new or incumbent) will need energy efficiency training for every one job person-year created. Thus, based on previous empirical work (described further below), this analysis translates the projections of job person-years into the numbers of workers that will need training.

Another set of assumptions underlies the development of funding scenarios. We base scenarios on a range of assumptions about the levels of investment, the rates at which state, federal, and IOU/POU money will be allocated and spent, and the pace at which the state's energy efficiency and related goals will be met. The report compares these scenarios in 2010, 2015, and 2020 to the baseline economy in 2009 – a year by which considerable energy efficiency and related programs and activity had already been launched.

These job projections are for a *subsector* of California's green economy, and are limited to energy efficiency and other related demand-side management activities for residential, commercial, industrial, agricultural, and municipal pumping. Thus the analysis excludes activities and related jobs commonly included as part of the green economy, including utility scale renewable generation, transportation, and environmental services (e.g., recycling). As a result, these job projections, including both the direct job projections for specific occupations and the overall job projection for direct, indirect, and induced jobs, are not directly comparable to those produced by studies examining the broader green economy.

Our analysis should be carefully interpreted with regard to the recession. Since our projections are based on jobs generated by public (including ratepayer) dollars, they may not be affected by the slowdown in growth in the overall economy. However, political changes and fiscal constraints may alter funding patterns in ways we cannot anticipate, and if our scenarios about continued public investment funding levels are too optimistic, our projections of job demand will be too optimistic as well. Further, for the projections of jobs generated by private investment, the business cycle may affect the projected private investments, as consumers may be less willing or able to contribute participant costs or pay the extra cost associated with new construction built under tightened codes and standards.

The recession is also addressed in our analysis of labor supply. Given the high levels of unemployment, a queue of experienced workers exists that can fill the projected new jobs. We estimate this supply of unemployed workers for each forecast year, as well as net new jobs after this queue has been absorbed.

As with any set of assumptions used to develop projections, ours have limitations. There are substantial uncertainties related in particular to private investments, i.e., how they are affected by public investments, electricity and natural gas prices, the availability and prices of new technologies, and various other conditions.

3.1.2 SUMMARY OF FINDINGS

Based on these assumptions, we estimate that energy efficiency and related annual investments in California will increase from approximately $6.6 billion in 2010 to $11.2 billion in 2020, assuming the scenario of medium funding. These increases are due largely to projected increases in ratepayer-funded programs. Under the medium scenario, investments generate a total of 38,937 additional job person-years in 2020 when compared to job person-years in

2009.[6] Approximately one-fourth of the workers needing training for the new jobs that will result from this investment are in construction and other industries directly related to energy efficiency and related industries. The principal directly affected industries (with over 1,000 new workers in 2020) include HVAC and electrical contractors; residential and nonresidential building construction; administrative services; engineering, and other scientific and technical consulting services; and semiconductor manufacturing.

The number of additional job person-years (after subtracting job person-years in the 2009 baseline) projected in these directly affected industries for the year 2020 ranges from approximately 23,000 in the low scenario, to 39,000 in the medium scenario, and 42,000 in the high scenario. For comparison, the California Employment Development Department (EDD) anticipates an average of 165,200 permanent (not one-year) new jobs per year from 2008 to 2018 in the California economy as a whole.

Our analysis shows that the full-time jobs generated for a particular year are not all in occupations working directly in energy efficiency and related activity. However, approximately 70 percent are expected to require some form of energy efficiency and related job training. But since energy efficiency activities comprise only a share of a worker's job, there will be about 2.5 workers needing training for every full-time job created. Because the number of incumbent workers in affected occupations (such as electricians and sheet metal workers) is much higher than the number of new job person-years created by policy-driven energy efficiency investment, these existing workers create most of the need for energy efficiency training.

The remainder of this chapter is organized as follows. Section 3.2 provides a brief conceptual overview of the overall methodology selected and describes why our "hybrid" modeling choice is the best fit for the WE&T Needs Assessment. In section 3.3, we describe in detail the policies and programs that are relevant to achieving California's goals for energy efficiency, demand response, and distributed generation. These policies and programs include those funded by ratepayers of the IOUs and POUs, those funded by federal and state sources, and those concerning building codes and appliance and equipment standards. Also in this section is a discussion of the scenarios developed (i.e., low, medium, and high) for each broad policy category. Section 3.3 thus covers the first two steps in our analysis. Section 3.4 describes how we developed labor demand projections for the industries and occupations that stem from the investment inputs. This section covers steps three through six above. Section 3.5 presents our methodology for allocating statewide job estimates to individual California metropolitan regions and to the service territories of the four major IOUs. Section 3.6 describes the methodology for and results of projecting California's energy efficiency labor supply, and section 3.7 discusses the match between projected labor demand and supply. Section 3.8 summarizes the results.

3.2 METHODOLOGICAL APPROACH

To develop our overall conceptual approach for the labor demand methodology, we reviewed many studies that describe or forecast green jobs, and developed a hybrid methodology that builds upon existing work while meeting the objectives of the Needs Assessment. As described below, the methodology makes some important advances over previous studies.

Green jobs forecasts typically rely on either a micro or macro approach. The micro approach uses small-scale surveys or interviews with businesses to examine past hiring patterns and identify likely future job creation in the short term. In contrast, the macro approach starts from an overall picture of a region's economy, using the best available data on all sectors of the region's economy. This approach relies on macroeconomic models that are designed to consider the interactions among the major sectors of the region's economy over multiple time

[6] We refer to these additional job person-years in projection years 2010, 2015, and 2020 as "net of 2009."

periods. These models yield an aggregate picture without information on how specific industries and particularly specific occupations are affected. For the Needs Assessment, it was necessary to develop a methodology that, using both macro and micro approaches, could provide long-term employment projections (through 2020), which in turn could be used to determine training needs for specific occupations.

The strength of the micro approach lies in its empirical basis, utilizing recent data from actual firms from specific regions. Two examples of using the micro approach to study employment in California's green economy are the 2009 surveys of both the California Community Colleges Centers of Excellence (COE) and the EDD.[7] The COE study, conducted in 2009, surveyed several thousand firms from across the state in three broad industry sectors (utilities, building design and construction, and facility maintenance) to determine the energy efficiency occupations in demand and the future hiring plans of employers. The EDD survey, also conducted in 2009, surveyed over 51,000 California employers from a broad cross-section of industry sectors in order to estimate the number of green jobs in California and identify emerging green occupations.

Yet this micro approach may misrepresent actual employment patterns, as employers' decisions about hiring may change as conditions change. Further, short-term hiring preferences of a sample of current employers are not an appropriate basis on which to project long-term job growth, particularly when industries are undergoing rapid change and when public policy is driving industrial development. Many employers, particularly in small firms, base hiring decisions on current local conditions and are not a reliable source for projecting overall employment changes resulting from policies or other macro-economic forces. Finally, employer surveys are not able to take into consideration the interactions within the economy, including the indirect job creation due to changes in demand for intermediate products up the supply chain, and induced job creation due to changes in demand for products and services resulting from changes in household income induced by policy or other macroeconomic changes.

Macro models analyze how past policy expenditures or other shocks (e.g., a crisis such as an oil shortage, a war, a recession, or a natural disaster) have altered economic patterns and use such information to build assumptions about how the economy will create jobs in response to future changes. The models examine how new policy-related expenditures are expected to generate indirect and induced spending (and jobs) in other sectors, within and outside of the state or region under consideration, due to changes in demand for inputs (e.g., the material used to build photovoltaic panels) and changes in household expenditures. The Environmental Dynamic Revenue Analysis Model (E-DRAM), which was employed in this study, is one of two such California-focused computable general equilibrium models that are being used to model the effects of energy policy. Such dynamic models are considered appropriate because, unlike simple input–output models, they are able to incorporate labor market changes such as in-migration, as well as price changes and their impact on demand and supply. These labor market changes are especially critical for accounting for the total jobs created and/or destroyed by energy efficiency and related investments.

Our approach, which combines elements of both micro and macro approaches, allows us to consider the implications on economic growth and employment of increased investments in policies designed to promote energy efficiency (i.e., policy-driven effects) while sacrificing as little important detail as possible on changes in specific green subsectors and occupations. The approach we selected, which we refer to as the *investment methodology*, ties job projections directly to policy initiatives, and provides a means of developing job projections

[7] California Community Colleges Centers of Excellence, Economic and Workforce Development Program (2009). *Understanding the Green Economy in California: A Community College Perspective*. Retrieved from: http://www.coeccc.net/Environmental_Scans/GreenEcon_Scan_SW_09.pdf. For the most recent release of the results from the California 2009 Green Economy Survey see: California Employment Development Department (2010, July 12). "Green Analyses of Occupations and Industries." http://www.labormarketinfo.edd.ca.gov/article.asp?articleid=1229.

for alternative views (or scenarios) of future developments. It also relies on the results of the aforementioned green economy surveys conducted by the EDD and the COE to help clarify which industries and occupations are affected by investments (see Appendix B).

In its detailed focus on investments and occupations, our methodology is similar to the first comprehensive national study of the energy efficiency workforce by Chuck Goldman of the Lawrence Berkeley National Laboratory.[8] However, it differs in several respects. First, the E-DRAM model, a general equilibrium model developed specifically for California, is used to calculate the total jobs that will be created as opposed to only the direct jobs. Second, we use empirical data sources on the specific industries that receive investments, the regions where these industries are distributed, and the affected occupations; this allows us to link investments to employment and job projections by sector, occupation, and geographic area for the direct jobs. In section 3.7, we compare this detailed information to the future labor supply in California.

Figure 3.1 illustrates our seven-step, "hybrid" methodology for estimating labor demand stemming from energy efficiency investments. While this chapter presents considerable detail on the analysis of public and private investments, the development of scenarios, and the steps used to estimate job figures by detailed industry and occupation, it explicitly reserves the more technical steps for presentation in Appendix A, *Task 2 Methodology*, which provides additional detail about the data sources and assumptions throughout this analysis.

3.3 POLICIES, PROGRAMS, SCENARIOS, AND INVESTMENTS

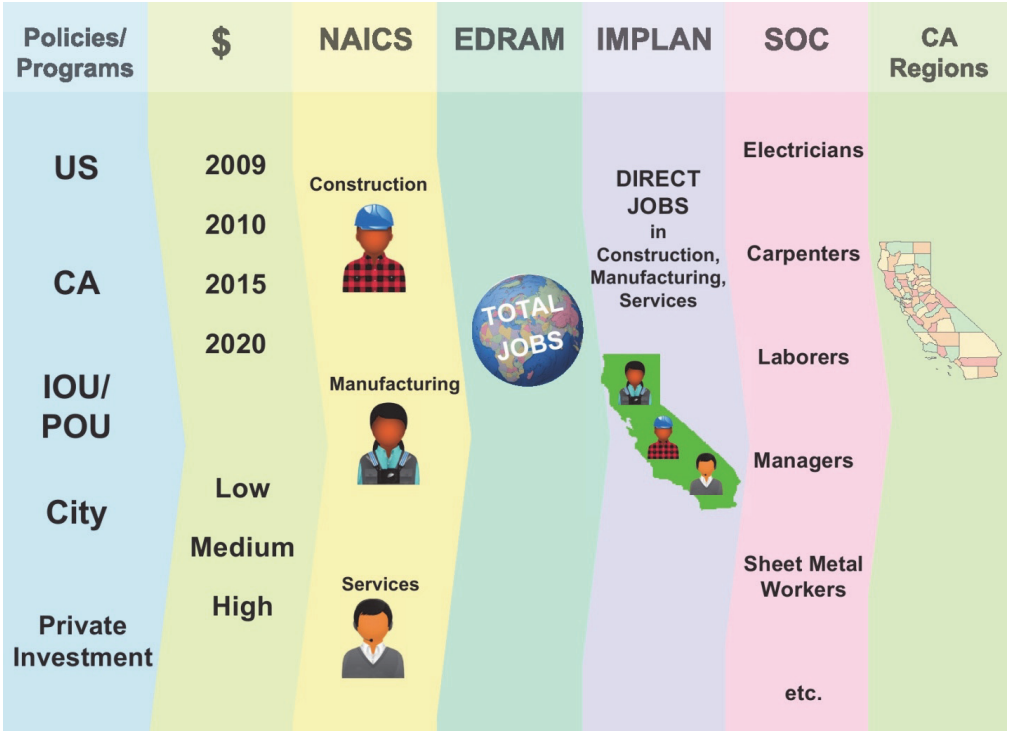
The first step in developing job projections is to identify the policies and programs, by sector, that contribute to achieving the cost-effective energy efficiency and other demand-side management potential as described in the *EE Strategic Plan*. Consistent with the scope of the WE&T Needs Assessment, the analysis identifies (step 1) and estimates (step 2) investments for programs and policies associated with energy efficiency, demand response, and distributed generation, with distributed generation limited to the customer-side of the meter facilities (excluding combine heat and power).

The energy efficiency programs include (1) incentive and education programs funded by utility ratepayers, state and federal government expenditures, and participant costs; and (2) state and federal codes and standards, which are funded almost exclusively by leveraged private investments. These energy efficiency programs also include weatherization programs for low-income customers. In addition, we also consider the CPUC's Big Bold Energy Efficiency Strategies (BBEES) and develop a methodology that measures the additional leveraged private investment that would be needed to meet specified goals. The demand response programs include expenditures for implementation and utility investments in smart meters. Within the demand response programs we only consider private investments that are participant costs associated with specific utility-run programs; other private investments resulting from demand response, such as the wages paid to building managers hired to take advantage of special demand response programs, are not explicitly addressed. As mentioned previously, there is considerable uncertainty about the extent and type of private investment, so we conservatively exclude investments not related to specific public programs and policies. The distributed generation programs include financial incentives and subsidized rates for photovoltaic installations, wind turbines, fuel cells, and energy storage at customer facilities. The demand response and distributed generation programs are funded by both government expenditures and

[8] Goldman C., M. Fuller, E. Stuart, J. Peters, M. McRae, N. Albers, S. Lutzenhiser, and M. Spahic (2010). *Energy Efficiency Services Sector: Workforce Size and Expectations for Growth*. LBNL-3987E. Retrieved from: http://eetd.lbl.gov/ea/emp/reports/lbnl-3987e.pdf.

utility ratepayers, however participants also contribute funds to the distributed generation and demand response programs.[9]

Figure 3.1 Methodological Approach



The "target sectors" we identified in step 1 are consistent with energy-using sectors addressed in the EE Strategic Plan (i.e., residential, commercial, industrial, agricultural, and municipal pumping sectors). These sectors are classified based on usage (and not ownership), with commercial including schools, hospitals, prisons, and other institutions. Since state and federal programs group such public uses under the "public sector," this analysis henceforth combines commercial and public into one sector. We also group the goods-producing sectors (industrial and agricultural) together. The following sectors were excluded: transportation, distribution and transmission (e.g., electric distribution and transmission systems, pipelines), and utility-scale generation. Distributed generation was restricted to the customer-side of the meter facilities relying on solar, wind, and fuel cells; combined heat and power was excluded. The geographical scope is California (i.e., the projections are not limited to the IOU service territories) and the time horizon is 2020. Projections are also provided for 2010 and 2015. Although projections could be developed for each year through 2020, these projections would provide little or no additional information and would take resources away from other important tasks.

Our job projections are incremental to the 2009 baseline year. We obtained funding levels for 2009 using the same policy-specific sources we used for 2010.[10] For codes and standards, we assumed that the economic effects were already accounted for in the base year of 2009, since the standards were already several years old by then. Both

[9] As mentioned previously, tax incentives are not included, in part because of the lack of data on their use, and in part to avoid double counting.

[10] In some cases we were able to find direct budget information from a previous funding cycle. For instance the IOU portfolio of programs had a 2006-2008 funding cycle (and a 2009 bridge year) with detailed budgets by year. However, the specific programs changed from 2009 to the 2010-2012 funding cycle, not allowing direct funding comparisons for specific programs. In other cases, such as the California Solar Initiative (CSI), the program existed since 2006 and continued through 2016. We estimated an annual average public and private investment for all years, resulting in a 2009 investment that was identical to annual investments for 2010-2016.

the 2008 Standards (implemented in 2010) and future year changes are incorporated into the model.[11] For a detailed description of data sources for each individual policy, see Appendix A.

The federal government, state government, and utilities, including both the IOUs and POUs, administer a complex array of programs, some overlapping or combined, all designed to achieve the cost-effective energy efficiency and demand-side management potential. Table 3.1 shows the policies examined by sector, and organized by major program area and/or regulator (federal, IOU/POU, and state). For energy efficiency, these policies include customer information, customer incentives, upstream incentives for manufacturers and suppliers, and building codes and standards for appliances and equipment.[12] Distributed generation includes similar policies, as well as subsidized rates to encourage solar installations in residential and commercial establishments. For demand response, policies include dynamic rates (e.g., rates that are tied to prices or load conditions), direct load control, and incentives for permanent load. Smart meters will enable some demand response programs.

Since the effects of these policies and programs will depend, in part, on funding and implementation decisions to be made in the future, we developed three funding scenarios that describe different levels of penetration for these policies. Scenarios generally depend on whether or not the policy or program is proposed or approved, the amount of money allocated for a program, past and current expenditure rates, and whether or not it is meant to meet related approved goals (such as the Big Bold Energy Efficiency Strategies in the CPUC's Energy Efficiency Strategic Plan). We constructed each scenario independently with explicit assumptions that can be replicated. (Appendix A provides more detail on scenario development.)

We first illustrate the three scenarios by funding source and by program. We then provide a detailed explanation, by program, of how we derived the investment numbers and the specific assumptions for each scenario. As Figures 3.2, 3.3, and 3.4 show, energy efficiency and related annual investments in California (generated by both government programs and market activity) are projected to increase from approximately $6.6 billion in 2010 to a 2020 total of $7.3 billion in the low scenario, $11.2 billion in the medium scenario, and $11.7 billion in the high scenario. These increases are due largely to projected increases in ratepayer-funded programs under all scenarios, as well as leveraged private investments in the medium and high scenarios.

Figure 3.5 presents an overview of public and private investments in 2010 according to the medium scenario. For the estimates developed for this study, public investment dominates, at 62 percent of investment ($4.1 billion), while private investment contributes 38 percent ($2.5 billion). IOU and POU energy efficiency programs, as well as demand response and smart meter programs, dominate investment in this year, despite the influx of American Recovery and Reinvestment Act (ARRA) funds. Leveraged private investments figure most prominently in the IOU/POU energy efficiency programs, as well as Title 24 (California's building code) and the distributed generation programs such as the California Solar Initiative. Private investments are not estimated for all programs both because the private investments are not part of the program (LIEE programs) and because developing private investment estimates would likely result in double counting (ARRA program).

[11] Issues of non-compliance were not addressed in the macro analysis.

[12] We intentionally exclude taxes and subsidized loans in order to minimize the risk of double-counting participant costs.

Table 3.1 Study Sectors and Policies Analyzed

Policy Area / Sector	Residential	Commercial / Public	Industrial / Agricultural
Federal Programs			
Retrofits	X	X	X
Low-Income Weatherization	X		
Appliances and Equipment	X	X	X
Energy Efficiency and Renewable Energy Programs	X	X	X
ARRA Programs	X	X	X
Utility Energy Efficiency Programs			
IOUs Energy Efficiency Related Portfolio	X	X	X
Water-Energy Nexus	X	X	X
Low-Income Programs (LIEE)	X		
POUs Energy Efficiency Related Portfolio	X	X	X
Title 24 Codes & Standards and CPUC Big Bold Energy Efficiency Strategies			
Title 24 Codes and Standards	X	X	
Big Bold Energy Efficiency Strategies	X	X	
Distributed Generation			
California Solar Initiative	X	X	X
New Solar Homes Partnership	X		
POU Solar Programs	X	X	X
Other Renewable (SGIP and ERP)		X	
Demand Response and Smart Meters			
Pricing and Direct Load Control	X	X	X
Demand Response Device Rebates	X	X	X
Smart Meters	X	X	X

In the medium scenario, investments in energy efficiency increase substantially over the ten years, more than tripling over 2009 baseline levels of $3.6 billion. The share of private investment increases over time, from 38 percent of the total in 2010 to 46 percent in 2015 and 44 percent in 2020. Figures 3.6 and 3.7 show the changes by program area for 2015 and 2020. By 2015, increases in IOU/POU funding more than compensate for the loss of federal stimulus dollars. Over time, energy efficiency funding is projected to grow much more rapidly than distributed generation funding. Demand response and smart meter programs will shrink considerably after 2015. This reduction in expenditures is due to the completion of the initial installation of new smart meters by the utilities. As smart meters are installed, the penetration of demand response programs is expected to increase. Private investment responding to the increased penetration of demand response programs has not been addressed. State funding, largely for distributed generation programs, also will decline rapidly after 2015.

Below is a description of the programs, policies, and regulations at the federal, state, and IOU/POU levels that will foster investment in energy efficiency, demand response, and distributed generation in the next ten years. We also detail the assumptions behind the scenarios developed for each policy or program area. For simplicity in presentation, we present numbers for the medium scenario only.

Figure 3.2 Investment in Low Scenario by Source and Year

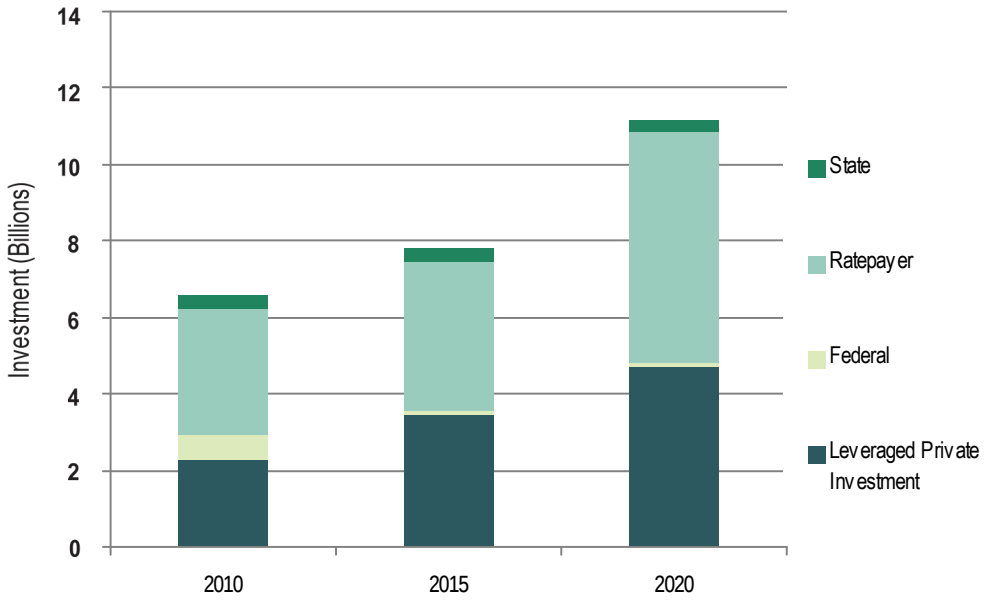


Figure 3.3 Investment in Medium Scenario by Source and Year

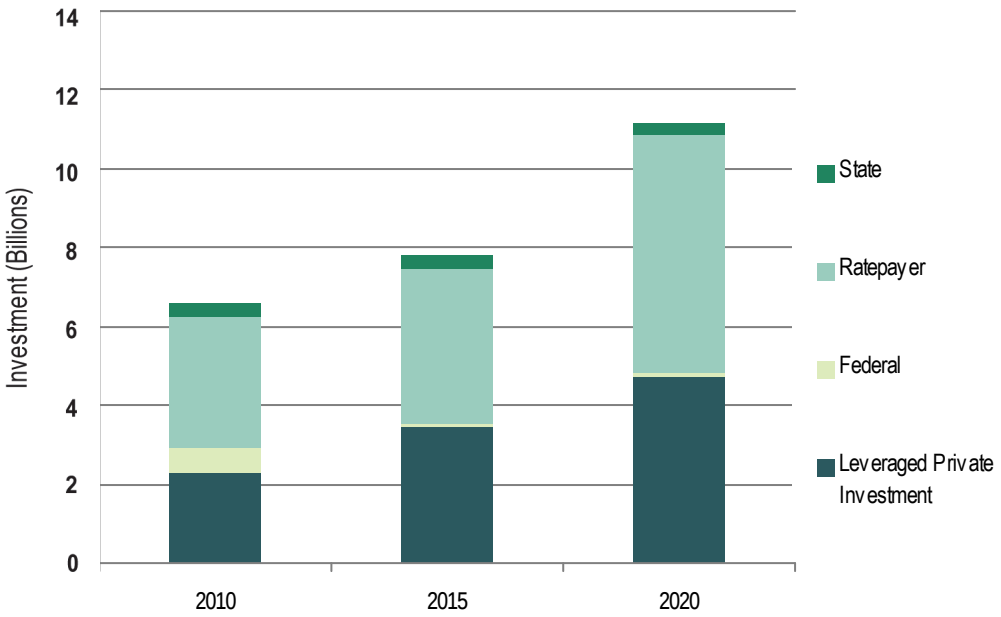


Figure 3.4 Investment in High Scenario by Source and Year

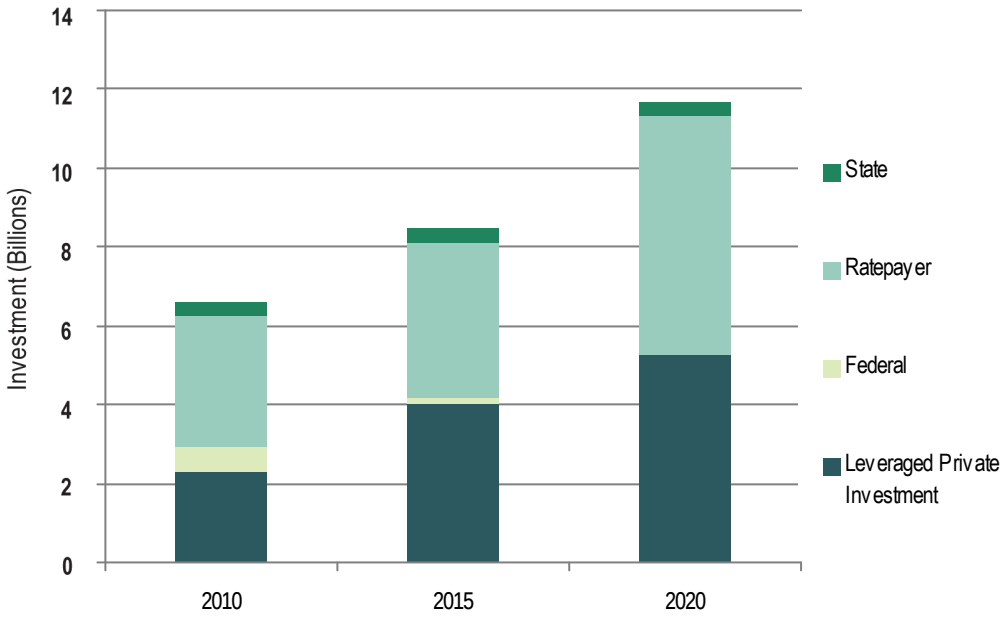
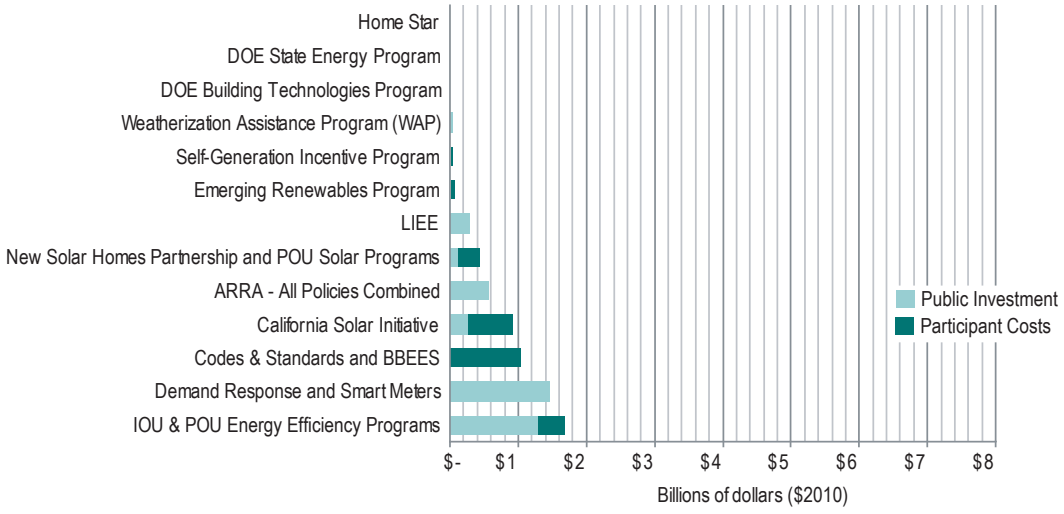
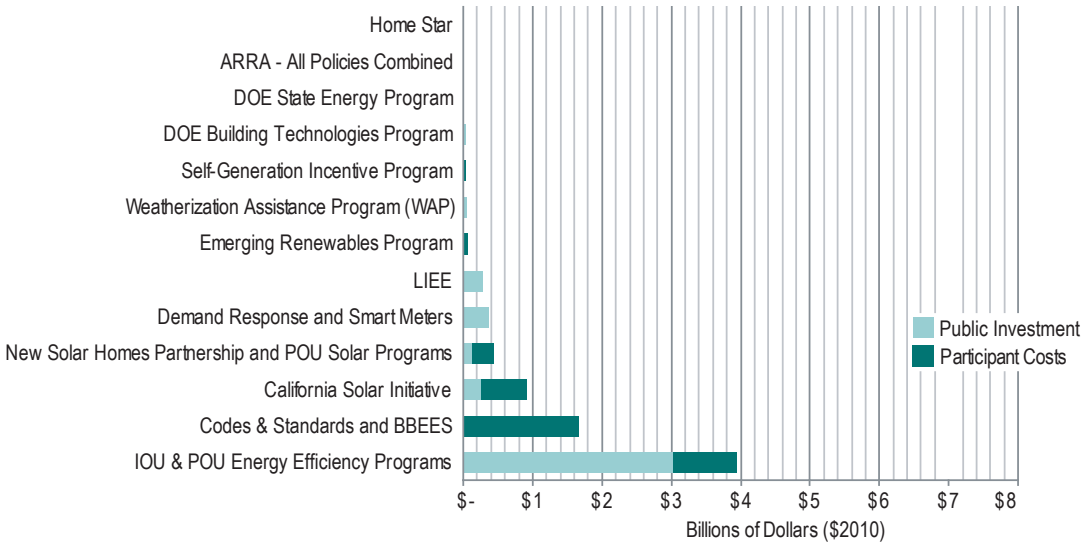


Figure 3.5 Summary of Policy Budgets and Leveraged Participant Costs by Major Program Area, 2010 Medium Scenario



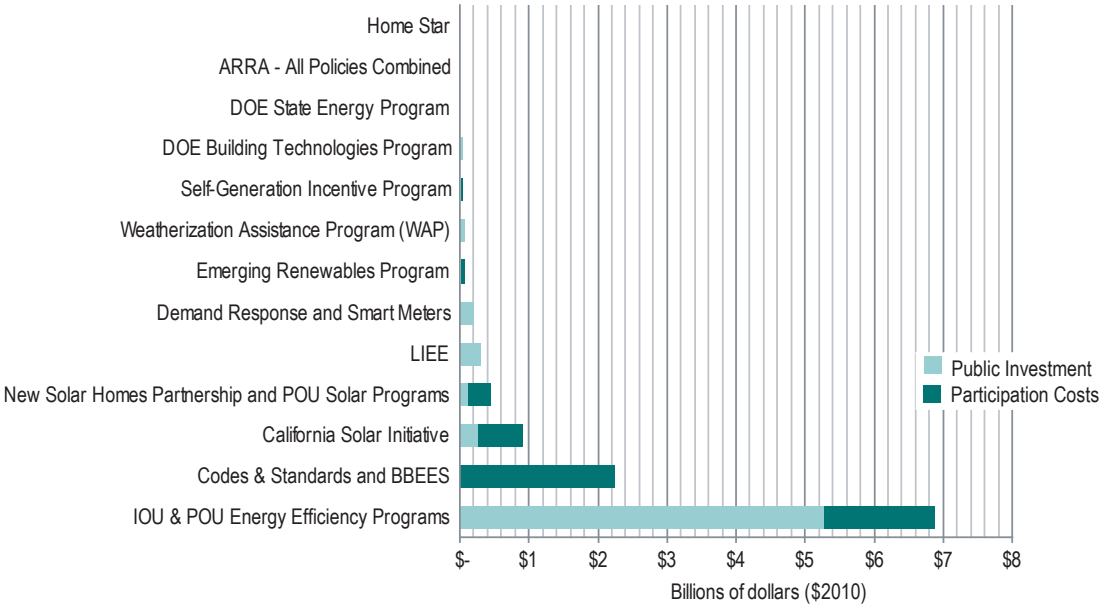
Note: No participant costs are included for ARRA to avoid potential double-counting of participant costs included in state programs.

Figure 3.6 Summary of Policy Budgets and Leveraged Participant Costs by Major Program Area, 2015 Medium Scenario



Note: No participant costs are included for ARRA to avoid potential double-counting of participant costs included in state programs.

Figure 3.7 Summary of Policy Budgets and Leveraged Participant Costs by Major Program Area, 2020 Medium Scenario



Note: No participant costs are included for ARRA to avoid potential double-counting of participant costs included in state programs.

3.3.1 ENERGY EFFICIENCY

Energy efficiency investment (narrowly defined) comes from a complex array of federal, state, IOU/POU, and local programs, incentives, and standards. (For the data sources relied upon, see Appendix A.)

3.3.1.1 FEDERAL PROGRAMS

Federal spending in energy efficiency and distributed generation in California comes mainly from the Department of Energy (DOE) annual budget for Energy Efficiency and Renewable Energy and the American Recovery and Reinvestment Act (ARRA), which fund DOE and several other agencies. Further, the proposed Home Star program would provide families with up to $3,000 per home for investments in energy saving home improvements. Home Star alone could bring about $700 million to the energy efficiency sector in California in the coming years.

DOE funds for energy efficiency and renewable energy are mostly channeled through its Office of Energy Efficiency and Renewable Energy (EERE); the following EERE programs are within the scope of the WE&T Needs Assessment (described by sector):

- → BUILDING TECHNOLOGIES PROGRAM: The BTP funds research and technology development to reduce commercial and residential building energy use. We estimate that funding goes half to the residential sector, half to the commercial sector.
- → INDUSTRIAL TECHNOLOGIES PROGRAM: The ITP seeks to reduce energy intensity and carbon emissions by changing the way industry uses energy. ITP sponsors cost-shared R&D and supports advanced technologies and energy management best practices. This program is 100 percent for the industrial sector.
- → FEDERAL ENERGY MANAGEMENT PROGRAM: The FEMP facilitates the federal government's implementation of sound, cost-effective energy management and investment practices in federal buildings to enhance the nation's energy security and environmental stewardship. FEMP guides federal agencies to use funding more effectively in meeting federal and agency-specific energy management objectives. This program funds public sector projects exclusively.
- → WEATHERIZATION ASSISTANCE PROGRAM: The WAP enables low-income families to reduce their energy bills by making their homes more energy efficient. Eligible residents must have incomes at or below 200 percent of the 2009 Federal Poverty Income Guidelines. This program is entirely residential.
- → STATE ENERGY PROGRAM: The SEP provides grants to states and directs EERE technology program funding to state energy offices. States use grants to address their energy priorities and program funding to adopt emerging renewable energy and energy efficiency technologies. SEP is intended to promote both energy efficiency and renewable energy. This program funds public sector initiatives.
- → OTHER WEATHERIZATION AND INTERGOVERNMENTAL PROGRAMS: The WIP programs are composed primarily of the Weatherization Assistance Program (WAP) and SEP. There are some other subprograms such as the International Renewable Energy Program or the Tribal Energy Activities that relate to energy efficiency. This funding supports both residential and public sector projects.

The American Recovery and Reinvestment Act (ARRA), the $787 billion economic stimulus package approved in February 2009, provides generous funding for energy efficiency and renewable energy programs in an effort to decrease U.S. dependence on foreign fossil fuels, fight climate change, and create green jobs in the construction and energy sectors. This study estimates that ARRA will invest almost $1.6 billion in energy efficiency related projects in California.[13] The EERE and most of the ARRA funding that comes to California goes through the federal

[13] Our estimate is consistent with recent literature and reports in the field. (1) Goldman et al., 2010. (2) U.S. Department of Energy (2010). "Recovery and Reinvestment Funding Breakdown." http://www.energy.gov/recovery/breakdown.htm; (3) California Energy Commission (2010).

Department of Energy. However, we also identified relevant programs in the General Services Administration, the Department of Defense, the Department of Veterans Affairs, and the Department of Housing and Urban Development.

Some of the largest ARRA programs are managed at the state level, including the expanded WAP and a variety of energy efficiency and renewable energy programs run through the California Energy Commission (CEC). Specifically, the CEC administers three ARRA programs included in the analysis:

- STATE ENERGY PROGRAM: ARRA augments the SEP with funding in the following areas:
  - → **Energy Efficiency Program**
    Funding supports three areas: Residential Building Retrofit, Municipal and Commercial Building Retrofit, and the Municipal Financing District Program.[14] This funding supports projects in the residential, commercial, and public sectors.
  - → **Department of General Services**
    The Energy Efficient State Property Revolving Loan Program retrofits state buildings. Funding is 100 percent for the public sector.
  - → **Energy Conservation Assistance Account One Percent Low-Interest Loans Program**
    These one percent loans are for energy conservation fund public sector projects.
  - → **Clean Energy Business Financing Program**
    These low-interest loans to private companies in the clean energy sector fund commercial projects.
  - → **Clean Energy Workforce Training Program**
    The Clean Energy Workforce Training Program supports regional partnerships in developing regional plans for training workers in new green technologies.
  - → **Contracts and Program Support**
    Auditing, measurement, and evaluation or ARRA contracts and programs
- THE ENERGY EFFICIENCY AND CONSERVATION BLOCK GRANT PROGRAM (EECBGP): Funded for the first time under ARRA, this program provides funds to units of local and state government, Indian tribes, and territories to develop and implement projects to improve energy efficiency and reduce energy use and fossil fuel emissions in their communities. This "Retrofit Ramp-Up" program, now called the Better Building Program (and part of Energy Upgrade California), has funded innovative models for rolling out energy efficiency improvements to hundreds of thousands of homes and businesses in a variety of communities across the country. California has received $30 million under this program. For the purposes of this analysis, we estimate that the program is 38 percent residential 29 percent commercial, and 34 percent public sector.
- THE ENERGY EFFICIENT APPLIANCE REBATE PROGRAM: Three residential appliance categories receive rebates: clothes washers ($100 rebate), refrigerators ($200 rebate), and room/window air conditioners ($50

"California Economic Recovery Energy-Related Programs." http://www.energy.ca.gov/recovery/ (4) California Energy Commission (2011). *2010 Integrated Energy Policy Report Update*. CEC-100-2010-001-CMF. Retrieved from: http://www.energy.ca.gov/2010publications/CEC-100-2010-001/CEC-100-2010-001-CMF.PDF; (5) National Association for State Community Services Programs (2009). *Weatherization Assistance Program PY 2008 Funding Survey*. Retrieved from: http://www.nascsp.org/data/files/weatherization/py%202008%20funding%20survey.pdf.

[14] The Municipal Financing District Program was cancelled July 28, 2010.

rebate). These rebates, which go fully to the residential sector, are in addition to existing rebates funded by ratepayers and offered through California's utilities or appliance manufacturers.

Additional ARRA funding for energy efficiency comes through the HUD Green Retrofit Program for Multifamily Housing. HUD's Office of Affordable Housing offers grants and loans to make retrofit investments in multifamily housing projects.

In addition, President Obama's proposed Home Star energy efficiency rebate program would spur demand for insulation, water heaters, and energy audits in the residential market. His latest proposal, which had yet to pass through Congress as of June 2010, would devote $6 billion for residential retrofits in the US.[15]

This analysis incorporates assumptions about federal ARRA funding allocation and expenditures based on information that was available by June 2010. Subsequent information about ARRA spending could not be incorporated into the study. Because it seemed highly likely that Home Star would pass in summer 2010, the analysis incorporates that program into the medium and high scenarios, beginning in 2011.

Table 3.2 outlines the specific scenarios for the federal energy efficiency and related programs. Together, this investment totals $795 million in 2010 (including ARRA), but is projected to decline to $107 million by 2020 under the medium scenario.

Table 3.2 Scenarios for Federal Energy Efficiency and Renewable Energy Programs

Low Scenario
75% of ARRA money is spent (2010-2012)
DOE Energy Efficiency and Renewable Energy Program (EERE) annual budgets continue constant until 2020 (no increase)
Home Star is not passed
Medium Scenario
100% of ARRA money is spent (2010-2012)
DOE Energy Efficiency and Renewable Energy Program (EERE) annual budgets increase according to congressional budget expectations
Home Star is passed (50% of the initially announced $6 billion)
High Scenario
100% of ARRA money is spent (2010-2012) and an extra 25% is spent/rolled over to the 2013-2015 period
DOE Energy Efficiency and Renewable Energy Program (EERE) annual budgets increase according to congressional budget expectations
Home Star is passed (100% of the initially announced $6 billion)

Federal programs, along with associated participant costs, help to create jobs in many different industries and occupations. The primary industries within California that benefit include: electrical contractors; plumbing, heating, and air conditioning contractors; engineering and architectural services; and nonresidential building construction. These in turn mean jobs needing energy efficiency training primarily for electricians; plumbers, pipefitters, and steamfitters; sheet metal workers; heating, air conditioning, and refrigeration mechanics and installers; and construction managers and supervisors.

[15] The White House, Office of the Press Secretary (2010, March 2). Fact Sheet: Homestar Energy Efficiency Retrofit Program. Retrieved from: http://www.whitehouse.gov/the-press-office/fact-sheet-homestar-energy-efficiency-retrofit-program.

3.3.1.2 IOU/POU PROGRAMS

The state's investor-owned utilities (IOUs) and publicly-owned utilities (POUs) provide a wide array of energy efficiency programs, as well as the Low-Income Energy Efficiency (LIEE) programs. These programs are all ratepayer-funded.[16]

In California, ratepayers of the four IOUs in California make the largest investment in energy efficiency programs (excluding LIEE programs).[17] Beginning in 2006, the CPUC has approved, with some modifications, the energy efficiency programs proposed by each IOU on a three-year funding cycle. Each IOU manages an array of programs and partnerships that promote energy efficiency for most of the customers served by the utility (residential, commercial, industrial, agricultural, and municipal pumping). Each IOU designs, implements, and manages a set of specific programs; the number of separately identified programs ranged from 10 to 50 in the 2010–12 funding cycle. Each individual program has a specific energy efficiency goal and target sector. Examples include appliance rebate programs, HVAC equipment subsidies, energy audits, and the direct installation of energy efficient appliances and materials (e.g., insulation). In addition, increased attention has recently been given to the relationship between water efficiency and energy efficiency.[18]

The major public energy programs aimed at low-income ratepayers are Low Income Energy Efficiency (LIEE) programs and California Alternative Rates for Energy (CARE), both for the residential sector. The LIEE program provides no-cost weatherization services to low-income households. Services provided include attic insulation, energy efficient refrigerators, energy efficient furnaces, weather stripping, caulking, low-flow showerheads, water heater blankets, and door and building envelope repairs, which reduce air infiltration. Low-income customers that are enrolled in the CARE program receive a 20 percent discount on their electric and natural gas bills.

In 2007, the CPUC adopted a programmatic initiative to provide all eligible customers the opportunity to participate in Low Income Energy Efficiency (LIEE) programs and, by 2020, to offer all cost-effective residential energy efficiency measures to all eligible customers.[19]

IOUs provide utility service to 73 percent of the California's residential and commercial customers, while POUs serve 27 percent.[20] While the POUs across the state range from very large entities, such as the Los Angeles Department of Water and Power (LADWP), to very small, rural districts, most offer a set of energy efficiency programs similar to those offered by the IOUs. However, information on these programs, approved separately by each POU, is not as readily available. As described further in Appendix A, we use whatever relevant POU data are available to estimate investments for all POUs.

[16] Because little programmatic detail is available on POU programs, we generally extend the modeling methodology developed for the IOU energy efficiency programs to the POUs. See Appendix A for more detail.

[17] Excluding private investments and investments due to codes and standards.

[18] In a 2005 report, the CEC concluded that water-related energy use consumes 19 percent of the state's electricity; water energy use is 28 percent residential, 43 percent commercial/public, and 28 percent industrial/agricultural. California Energy Commission (2005). California's Water-Energy Relationship. Retrieved from: http://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF.

[19] For a summary of recent CPUC policies, including the 2007 decision referenced above, see California Public Utilities Commission (2008, Nov. 10). *Decision on Large Investor-Owned Utilities' 2009-11 Low Income Energy Efficiency (LIEE) and California Alternate Rates for Energy (CARE) Applications* (D.08-11-031). Retrieved from: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/93648.pdf.

[20] California Energy Commission, Energy Consumption Data Management System (ECDMS) (2009 Data). Available at http://www.ecdms.energy.ca.gov/elecbyutil.aspx.

Table 3.3 outlines the specific scenarios for the IOU and POU energy efficiency programs.[21] Overall, public and private investment under the Medium Scenario totals almost $2 billion in 2010, reaching $7.2 billion in 2020.

Table 3.3 Scenarios for Utility Energy Efficiency Programs

Low Scenario
Follows low scenario in the CEC *Incremental Impacts of Energy Policy Initiatives* report (2010)*
LIEE will continue at 25% of the objective for each three-year cycle (2012-14, 2015-17, 2018-20)
Medium Scenario
Follows medium scenario in the CEC *Incremental Impacts of Energy Policy Initiatives* report (2010)
LIEE will continue at 25% of the objective for each three-year cycle (2012-14, 2015-17, 2018-20)
High Scenario
Follows high scenario in the CEC *Incremental Impacts of Energy Policy Initiatives* report (2010)
LIEE will continue at 25% of the objective for each three-year cycle (2012-14, 2015-17, 2018-20)

* California Energy Commission, Electricity and Natural Gas Committee (2010, May). *Incremental Impacts of Energy Policy Initiatives Relative to the* 2009 Integrated Energy Policy Report *Adopted Demand Forecast*. CEC-200-2009-001-CTF. Retrieved from: http://www.energy.ca.gov/2010publications/CEC-200-2010-001/CEC-200-2010-001-CTF.PDF.

IOU/POU energy efficiency programs, along with associated participant costs, help to create jobs in many different industries and occupations. The primary California industries that benefit include electrical contractors; plumbing, heating, and air conditioning contractors; drywall and insulation contractors; corporate, subsidiary, and regional managing offices; office administrative services; and engineering and other scientific and technical consulting services. Although manufacturers see significant job creation as well, most are located outside of California. The workers employed in these industries who need energy efficiency training are primarily electricians; plumbers, pipefitters, and steamfitters; heating, air conditioning, and refrigeration mechanics and installers; drywall and ceiling tile installers; construction managers and supervisors; customer service representatives; general and operations managers; business operations specialists; civil engineers; architects and architectural drafters; and management analysts.

3.3.1.3 CALIFORNIA CODES AND STANDARDS

Unlike the other federal and state policies, codes and standards related to energy efficiency do not involve a dedicated funding mechanism. Rather, the application of tougher building codes is an explicit government mandate on private sector actors such as developers, contractors, and homeowners to change their behavior. The expectation is that these codes and standards will result in a shift of final demand towards energy efficient building materials and methods and away from other goods in the economy. Adjustments to California's Energy Efficiency Standards for Residential and Non-Residential Buildings (Title 24) are made by the CEC, which solicits input from the construction industry, environmental stakeholders, and experts. The Title 24 provisions related to energy efficiency are (usually) revised on a five-year cycle. Since the current 2008 standards took effect on January 1st, 2010, we assumed that the previous 2005 Standards were already included in the base case (i.e., firms and

[21] There is some uncertainty about the degree to which the CPUC will mandate funding levels in future cycles. Thus, we adopt the scenarios developed by the California Energy Commission (Jaske, M. & C. Kavalec (2009). *Incremental Impacts of Energy Policy Initiatives Relative to the 2009 Integrated Energy Policy Report Adopted Demand Forecast* (CEC-200-2010-001-D). Retrieved from: http://www.energy.ca.gov/2010publications/CEC-200-2010-001/index.html.

consumers have already made adjustments to them). Thus we only model the incremental impact of moving from the 2005 Standards to the 2008 Standards in future years (2010, 2015, and 2020).

Based upon documentation provided by the California Energy Commission, we developed a series of limiting and simplifying assumptions to develop a best approximation of the impact of more stringent codes and standards on the California labor market (see Appendix A for details). First, we included only building codes and standards in our analysis and ignored standards for other goods, such as appliance standards or consumer electronics standards.[22] Second, our analysis of stricter building codes is confined to the broad regulations set at the state level by the CEC as part of the update to Title 24; it was not possible to evaluate efforts by some local governments to surpass the standards in Title 24.

New building codes and standards essentially create demand for jobs through the increased work required to meet the stricter codes. The price of the construction also increases. Although final demand shifts toward energy efficient construction, there may also be some long-run negative elasticity effects on housing or commercial space. For this study, we look at these shifts in demand and supply.

The primary industry within California that is affected by codes and standards is new construction. This in turn means jobs needing energy efficiency training are primarily for carpenters and their helpers; construction laborers; construction managers and supervisors; cement masons and concrete finishers; electricians; drywall and ceiling tile installers; cost estimators; and civil engineers.[23]

3.3.1.4 BIG BOLD ENERGY EFFICIENCY STRATEGIES (BBEES)

As part of the Energy Efficiency Strategic Plan, the CPUC established four long-term strategies, which they term Big Bold Energy Efficiency Strategies:

- All new residential construction in California will be zero net energy by 2020;
- All new commercial construction in California will be zero net energy by 2030;
- Heating, ventilation, and air conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California's climate; and
- All eligible low-income customers will be given the opportunity to participate in the low-income energy efficiency program by 2020. [24]

Most of the BBEES do not specify a direct funding mechanism for their attainment. Thus, as with building codes and standards (Title 24), we assume that the private market will respond in such a way that the supply and demand for energy efficient forms of construction will shift upwards. The analysis only modeled these four specified

[22] The following logic dictates this decision. For an appliance or a television, the application of a higher energy standard on the market does not significantly alter consumer behavior; consumers will not change their timeframe for the purchase of these types of goods. However, after the higher energy standards are in place, if they are mandates, the consumer will only have a choice among competing products that already meet the standard (i.e., this is not like a rebate that induces a consumer to choose the more efficient product). Also, appliances and consumer electronics do not typically involve a high degree of labor at the time of purchase or installation.

[23] At present, demand for occupations related to code enforcement is very low, according to the staffing patterns (as modified by the EDD Green Economy Survey for this analysis). However, it is possible that there will be new demand for occupations related to enforcement that is not reflected in the data used for these projections.

[24] While 100% participation in LIEE among eligible households is a Big Bold initiative, we decided to model the LIEE strategy under the utility program section, as this particular strategy had actual funding behind it.

programmatic goals (i.e., it did not include other goals mentioned elsewhere in the *Plan*, like residential and commercial retrofit goals).[25, 26]

A variety of existing and proposed programs could be adopted to help California meet the BBEES goals. The Property Assessed Clean Energy (PACE) bond program was thought by some to have substantial promise until a ruling from the Federal Housing Finance Agency resulted in the cancellation of implementation plans.[27] As proposed, PACE would have provided financing for energy retrofits (efficiency measures and small renewable energy systems) authorized by commercial and residential property owners who repay their loans over 20 years through higher property taxes via the annual assessment on their property tax bill. Municipal financing districts or finance companies would issue these PACE bonds and the proceeds typically would be available to retrofit both commercial and residential properties. If PACE is ever implemented, future research should estimate the expected employment effects of this innovative program.

Table 3.4 outlines the specific scenarios for codes and standards and the BBEES. Overall, investment under the Medium Scenario totals $1.2 billion in 2010, almost doubling (to $2.2 billion) by 2020.

Since this analysis treated the BBEES similarly to codes and standards, the same industry—new construction—and occupations are affected.

Table 3.4 Scenarios for Codes & Standards and BBEES

Low Scenario
10% increase from 2008 Title 24 in 2014
BBEES: 5 to 20% of new units by 2011, 10 to 30% of new units by 2015, 25 to 60% of new units by 2020
Medium Scenario
10% increase from 2008 Title 24 in 2014
Additional 10% increase from 2008 Title 24 in 2017
BBEES: 8 to 30% of new units by 2011, 25 to 60% of new units by 2015, 55 to 80% of new units by 2020
High Scenario
10% increase from 2008 Title 24 in 2011
Additional 10% increases from 2008 Title 24 in 2014 and 2017
BBEES: 10 to 40% of new units by 2011, 40 to 90% of new units by 2015, 70 to 100% of new units by 2020

[25] As stated on p. 11 of the CPUC's 2008 *Energy Efficiency Strategic Plan,* the "goal results" for the goal of whole house retrofit are "Energy consumption in existing homes will be reduced by 20% by 2015 and 40% by 2020 through universal demand for highly efficient homes and products."

[26] Specific goals for the different sectors (commercial, industrial, agricultural, etc.) play a role in how the specific program measures for the IOU portfolio are crafted. These goals are thus already reflected in the projected IOU program budgets. Although we devised estimation techniques – involving making assumptions about the impact of changed private behavior—to analyze the impact of the BBEES, it was beyond our scope to make assumption about behavior within specific sectors.

[27] A dispute with the Federal Housing Finance Agency has placed the program on hold pending a court decision.

3.3.2 DISTRIBUTED GENERATION

Californians can participate in many different distributed generation programs. Distributed generation is defined generally as energy generation that is close to customer load and located on property owned either by the customer, the utility, or a third party. This study focused on distributed generation on the customer's side of the utility meter. The *Go Solar California!* Program, a joint initiative of the CPUC and the CEC to promote solar energy in California, combines most of the state's solar programs including the California Solar Initiative (managed by the CPUC), the New Solar Homes Partnership (managed by the CEC), and the POU solar programs. For most of programs, participants bear some share of the costs. There are also several federal renewable energy programs. However, this study excludes these programs to avoid double counting (since that investment is already included as participant costs).

3.3.2.1 CALIFORNIA SOLAR INITIATIVE

The components of the California Solar Initiative (CSI), funded by the state at $2.2 billion for the 2007–2016 period, included in the analysis are:

- → The Low-Income Single Family Program, managed by Grid Alternatives
- → The Multifamily Affordable Solar Housing (MASH) Program, managed by PG&E, SCE and the California Center for Sustainable Energy (in SDG&E territory)
- → The CSI–Thermal Program, in which homeowners may apply for cash rebates of up to $1,875 on the installation of qualifying solar water heating (SWH) systems.[28] To qualify for the rebate, the SWH system must displace the use of natural gas or electricity. The IOUs serve as the program administrators, with the California Center for Sustainable Energy administering the program in the SDG&E service territory

Overall, rebates cover approximately one-fourth of project costs, while participants (and the federal government) pay the remainder.[29, 30] In total, 41 percent of program expenditures go to the residential sector, 45 percent to the commercial/public sectors, and 14 percent to the industrial/agricultural sectors.

3.3.2.2 NEW SOLAR HOMES PARTNERSHIP AND POU SOLAR PROGRAMS

The New Solar Homes Partnership provides financial incentives and other support to home builders, encouraging the construction of new, energy efficient solar homes. The program is managed by the California Energy Commission and has a budget of $400 million for the period between 2007 and 2016.

In addition, the POUs have established a total of $784 million for the period between 2008 and 2016 for solar incentives in POU regions.

3.3.2.3 SELF-GENERATION INCENTIVE PROGRAM

The CPUC's Self-Generation Incentive Program (SGIP) provides incentives to businesses and individuals who invest in renewable and non-renewable distributed generation (other than solar) energy projects. To be eligible for the

[28] Solar thermal is the technology used in solar water heating, a kind of small version of a solar panel. More information on "California Solar Initiative: CSI-Thermal Program," is available at http://www.cpuc.ca.gov/puc/energy/solar/swh.htm.

[29] California Solar Statistics, available at http://www.californiasolarstatistics.ca.gov/.

[30] The CSI rebates "step down" (i.e., incentives decrease) over time. However, we used an annual average figure in order to project investment. Since we are not projecting jobs every year but only for 2010, 2015, and 2020, this approach does not affect the job projections presented.

program, distributed energy resources must achieve reductions in greenhouse gas emissions. SB 412 (Stats. of 2009, Chap. 182) authorizes annual collections for SGIP in 2010 and 2011 of not more than the amount authorized for SGIP in 2008 ($83 million). The legislation also extends administration of the program until January 1, 2016. There is approximately $310 million from past years that will be spent in the period between January 1, 2012 and January 1, 2016.[31] This funding goes entirely to the commercial sector.

3.3.2.4 EMERGING RENEWABLES PROGRAM

The CEC's Emerging Renewables Program (ERP) provides that a portion of the funds collected from the customers of the three major electric investor-owned utilities be used for statewide public benefit programs, including incentives for non-solar renewable electricity systems. The ERP distributes $65.5 million per year, collected from the ratepayers and held in the Renewable Resource Trust Fund.[32] The Energy Commission is currently seeking reauthorization of ratepayer funding for ERP, which is set to expire in January 2012.[33] This study assumes that 100 percent of ERP funding goes to the commercial/public sector.

Table 3.5 outlines the specific scenarios for the various distributed generation programs. Overall, public and private investment in distributed generation under the Medium Scenario totals $1.5 billion in 2010, tapering to $1.2 billion by 2020 due to the scheduled phasing out of state programs.

Table 3.5 Scenarios for Distributed Generation

Low Scenario
CSI funds continue until 2016 (as currently budgeted)
SGIP funds continue until 2015 (as currently budgeted)
ERP funds continue until 2011 (as currently budgeted)
Medium Scenario
CSI funds continue until 2016 and then stay flat until 2020
SGIP funds continue until 2015 and then stay flat until 2020
ERP funds continue until 2015 and then stay flat until 2020
High Scenario
CSI funds continue until 2016 and then stay flat until 2020
SGIP funds continue until 2015 and then stay flat until 2020
ERP funds continue until 2015 and then stay flat until 2020

Distributed generation programs, along with associated participant costs, help to create jobs in many different industries and occupations. The primary California industries that benefit include semiconductor and related device manufacturers (which make photovoltaic panels); electrical contractors; plumbing, heating, and air conditioning contractors; roofing contractors; corporate, subsidiary, and regional managing offices; and office administrative services. (Again, most of the manufacturers that benefit are located outside of California.) The workers employed in these industries who need energy efficiency training are primarily electricians; carpenters; heating, air conditioning, and refrigeration mechanics and installers; construction managers and supervisors; customer service representatives; general and operations managers; and business operations specialists.

[31] Interview with CPUC staff, 4/28/2010.

[32] Interview and correspondence with CEC staff, 4/9/2010.

[33] Interview with CEC staff, 4/9/2010.

3.3.3 DEMAND RESPONSE AND SMART METERS

Demand response refers to a set of activities and tools that allows electricity customers to reduce their electricity usage in a given time period, or shift that usage to another time period, in response to a price signal, a financial incentive, an environmental condition, or a reliability signal. The EE Strategic Plan calls for demand response policies and programs (such as air conditioning cycling programs, commercial and industrial pricing programs, and information technology programs) to be integrated with California's energy efficiency and other demand-side management policies. The CPUC authorizes funding for demand response programs for California's three major electric IOUs in three-year cycles. The CPUC-approved IOU budgets have a total cost of $350 million over 2009–2011, an average of $117 million per year.[34] Demand response funding is divided among sectors as follows: 11 percent for residential, 25 percent for commercial and public, and 64 percent for industrial and agricultural.

The CPUC has also authorized California's four major IOUs to spend a total of $4.94 billion to install advanced metering infrastructures (AMI), including smart meters for all electric and gas customers, from 2006 to 2015.[35] Advanced metering infrastructure consists of metering and communications infrastructure as well as the related computerized systems and software. Smart meters are capable of two-way information exchange between customers and the utility, allowing customers to have greater control over their energy usage and enabling demand response programs. The POUs have their own smart meter and demand response programs, funded in part by the DOE. Based on the number of customers in each sector, this study estimates that 87 percent of the smart meter funding will go to the residential sector, and the remainder to all the other sectors.

The IOUs have anticipated that there will be significant job loss associated with the smart meters, as the need for meter readers diminishes.[36] Because meter readers are not part of the IOU/POU energy efficiency and related programs (and thus are not included in the budgets analyzed for this study), those jobs are not in the baseline 2009 Scenario. Furthermore, this job loss does not directly affect the assessment of training needs, although of course the meter readers might be retrained for energy efficiency related occupations. Given the lack of precise estimates about the extent of future job loss, it does not make sense to include this in the scenarios in later years.

Table 3.6 outlines the specific scenarios for demand response and smart meters. Overall, investment in demand response and smart meters under the Medium Scenario totals $1.4 billion in 2010, tapering to $0.2 billion in 2020.

Demand response and smart meter programs help to create jobs in many different industries and occupations. The primary California industries that benefit include automatic environmental control manufacturing for residential, commercial, and appliance use; electrical contractors; corporate, subsidiary, and regional managing offices; and office administrative services. The workers employed in these industries who need energy efficiency training are primarily electricians; customer service representatives; general and operations managers; and business operations specialists.

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[34] California Public Utilities Commission (2009, Aug. 20). *Decision Adopting Demand Response Activities and Budgets for 2009 Through 2011* (D.09-08-027). Retrieved from: http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/106008.htm.

[35] California Public Utilities Commission (2006, July 20). *Final Opinion Authorizing Pacific Gas and Electric Company to Deploy Advanced Metering Infrastructure* (D.06-07-0270). Retrieved from: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/58362.pdf; California Public Utilities Commission (2008, Sept. 18). *Decision Approving Settlement on Southern California Edison Company Advanced Metering Infrastructure Deployment* (D.08-09-039). Retrieved from: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/91154.pdf; California Public Utilities Commission (2007, April 12). *Decision Approving Settlement on San Diego Gas & Electric Company's Advanced Metering* Infrastructure Project (D.07-04-043). Retrieved from: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/66766.pdf; Southern California Gas Decision.

[36] SDG&E estimates a workforce reduction of 955 FTE to begin in 2012. Estimates are not available from the other IOUs.

Table 3.6 Scenarios for Demand Response and Smart Meters

Low Scenario
Annual demand response program funding continues indefinitely at 1/3 of 2009-11 approved level for IOUs and at 2012 level for POUs
IOU funding for smart meters continues until 2015 (as currently authorized)
POU funding for smart meters continues until 2013
Medium Scenario
Price-responsive demand response program funding increases by 11% per year through 2017, relative to a baseline of 1/3 of the 2009-11 approved level, then remains constant
IOU funding for smart meters continues until 2015 (as currently authorized)
POU funding for smart meters continues until 2013 (smart grid federal grants to LADWP and SMUD are scheduled to end in 2013)
High Scenario
Price-responsive demand response program funding increases by 11% per year through 2017, relative to a baseline of 1/3 of the 2009-11 approved level, then increases 5% through 2020
IOU funding for smart meters continues until 2015 (as currently authorized)
POU funding for smart meters continues until 2013 (smart grid federal grants to LADWP and SMUD are scheduled to end in 2013)

3.3.4 SUMMARY OF POLICIES AND SCENARIOS

There are several key differences between the scenarios for federal programs, utility energy efficiency programs, codes and standards, distributed generation, demand response, and smart meters. For federal agency programs, the Low Scenario assumes no budget increases, while in the Medium and High Scenarios, the annual budgets increase according to congressional budget expectations. For ARRA and Home Star, the rate at which the allocated money is spent increases across scenarios, with a 25 percent extra ARRA allocation assumed for 2013–2015.

The IOU/POU scenarios continue the low-income programs at 25 percent of the objective under all three scenarios. Otherwise, these scenarios follow the low, medium, and high scenarios developed by the CEC. As described in the CEC report *Incremental Impacts of Energy Policy Initiatives Relative to the 2009 Integrated Energy Policy Report Adopted Demand Forecast*, the Low Scenario uses historical rebate levels and program designs, the low range of savings from various lighting and appliance codes and standards, and no new savings from building code compliance programs. The Medium Scenario is based on higher rebate levels and savings from codes and standards and market transformation efforts, along with more significant revisions to Title 24 and federal appliance standards. The High Scenario assumes aggressive rebate programs and the higher range of savings for Title 24 and other standards.[37]

For codes and standards, the scenario development also follows those in the CEC report, with mandated increases in energy efficiency resulting in higher building costs. The BBEES scenarios assume that the share of new net zero

[37] Jaske and Kavalec 2009.

energy construction increases significantly from the Low to Medium to High Scenario, with the High Scenario share more than double the Low Scenario.

For distributed generation, the Low Scenario uses the current program budgets, which will run out between 2011 and 2016, depending on the program. For the Medium and High Scenarios, these budgets are extended to 2020.

The Low Scenario assumes that demand response funding will continue at its initial levels, while the Medium and High increase it by 11 percent per year through 2017, and the High Scenario increases it by an additional 5 percent per year through 2020. All scenarios for smart meters are the same: as currently authorized, IOU funds continue until 2015 and POU until 2013.

Funding for all three scenarios starts at a similar point in 2010 ($6.4 billion for the Low Scenario and $6.6 billion for the Medium and High Scenarios)—compared to a baseline of $3.6 billion in 2009 (see Figures 3.2–3.4).[38] The Low Scenario increases just five percent from 2010 to 2015 and seven percent from 2015 to 2020, due mostly to projected increases in IOU/POU (ratepayer) and codes and standards (consumers) investment. However, the Medium and High Scenarios see much greater increases: for the Medium Scenario, to $7.8 billion in 2015 and $11.2 billion in 2020, and for the High Scenario, to $8.4 billion in 2015 and $11.7 billion in 2020. These increases occur mostly because of projected increases in IOU/POU and codes and standards related investment. Due to the minimal differences among the scenarios, as well as the likelihood of a slow recovery from the current recession (see Chapter 2), this report focuses mostly on the projections of jobs and worker training needs for the Medium Scenario.

3.4 PROJECTIONS OF LABOR DEMAND AND WORKER TRAINING NEEDS

Having identified the relevant energy efficiency policies and estimated the associated public and private investments, the analysis proceeds to steps 3 through 6 in order to estimate the new jobs created by translating investments into industries (step 3), industries into direct, indirect, and induced jobs (step 4), direct jobs by industry into jobs by occupation (step 5), and jobs by occupation into workers by occupation that need energy efficiency training (step 6). The following provides an overview of the steps, with more detail provided below along with the actual projections.

First, as we will describe in more detail in the next section, research on prior investments yielded a list of the NAICS industries (primarily in construction, manufacturing, administration, and technical services such as engineering and architecture) that would most likely benefit from the investment.[39] We refer to these as the energy efficiency industries (or energy efficiency related industries to emphasize that the investment is for energy efficiency, demand response, and distributed generation). We then estimated the distribution of investments across these industries through empirical sources that provided detail on the allocation of funding across industries and/or estimated the costs of materials and labor.

Translating industries into jobs involved two distinct steps. These steps involved both E-DRAM model, to estimate overall impacts and the IMPLAN model to refine the analysis for direct jobs for the most comprehensive and accurate projections possible. To estimate the total number of jobs that stem from investments, we use the E-DRAM model. Specifically, we used E-DRAM to analyze the impact of the estimated energy efficiency related investment by broad industry and account for shifts in spending due to reduced energy consumption. The direct,

[38] All figures are in 2010 dollars and give the investment for one year only.

[39] The North American Industry Classification System (NAICS) is the standard hierarchical coding system that classifies all economic activity into specific industry sectors.

indirect, and induced jobs created are distributed across hundreds of industries, including the energy efficiency industries. These indirect and induced jobs are the result of energy efficiency related investments and are important to count when quantifying the total job projections due to any given level of government investment. However, since this research task is to estimate the number of direct new jobs for which training and education is needed, the indirect and induced jobs, which are not likely to require specific energy efficiency training, are not relevant.[40] The E-DRAM analysis and the determination of the overall number of new jobs due to energy efficiency investments composed step 4.

To calculate the number of direct jobs, in step 5, we looked at the investment estimated for all the energy efficiency related industries and calculated the amount of investment that is leaked outside of California using the IMPLAN input–output model. In this step we also applied the ratio of output per worker from IMPLAN in order to translate the remaining investment into California jobs in 2010, 2015, and 2020. After subtracting California jobs funded by this investment in 2009, we obtain the net new jobs in energy efficiency related industries. The job totals represent jobs generated in that year, or more specifically person-years of employment

Education and training programs are typically organized around occupations, in addition to, or instead of industries. Thus, for the purpose of the Needs Assessment, it is necessary to translate jobs by industry into jobs by occupation. In step 6 we estimate occupational employment using a tool commonly used in these analyses: the staffing patterns matrix prepared by the California Employment Development Department (EDD), which provides the distribution of occupations employed in energy efficiency activity within a particular industry. Every industry has hundreds of occupations, only a small share of which are actually engaged in energy efficiency activity. For instance, a large construction firm employs not only construction workers but also administrative staff, some of whom, such as customer service representatives, require training, but others, such as secretaries, who do not. Thus, the analysis next determines the subset of jobs that will be held by workers needing energy efficiency training.

Also in step 6, we translate these occupational projections into projections of the numbers of workers who need training. As described above, workers who engage in energy efficiency related activity in most cases do not spend all their hours on these activities, but rather spend just a portion of their time on these activities. If a construction laborer spends 25 percent of his or her time on energy efficiency and related activity, then one construction laborer person-year represents funding for four jobs at 25 percent time.

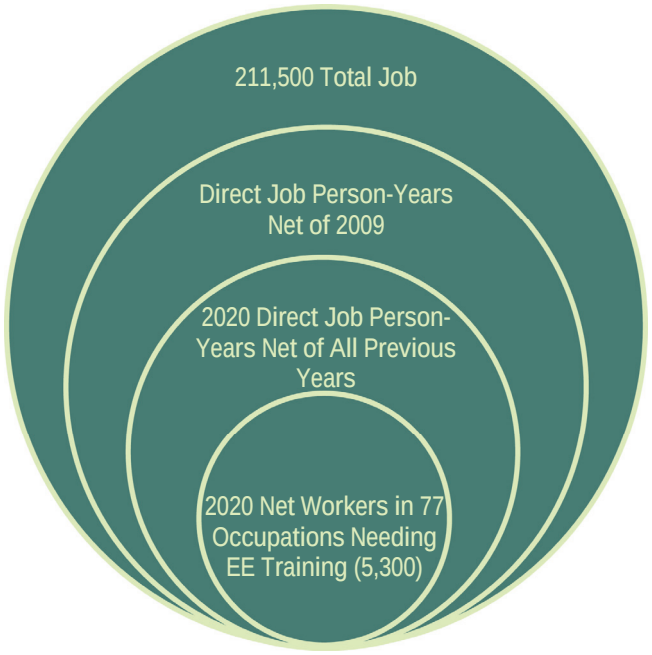
We thus transform the employment projection numbers from the total economic activity generated by energy efficiency and related investment (direct, indirect, and induced job person-years) to the subset of workers who need energy efficiency related training because investment is funding part of their work (Figure 3.8).

From the total job person-years projected to be generated in 2020 (211,500), we first take the subset of direct job person-years only (i.e., subtract the indirect and induced job person-years). We then subtract the subset of existing job person-years funded by energy efficiency in 2009 (based on the assumption that the workers holding these job person-years are already trained). Next, we subtract the subset of jobs generated from 2010–2019.[41] Finally, we translate the job person-years into the number of workers needing training because of the new job person-years generated just in 2020**.**

[40] For instance, a worker harvesting sustainable lumber holds an indirect job supplying construction firms but will not need energy efficiency and related skills. Similarly, a grocery store worker who holds an induced job most likely does not need special energy efficiency training.

[41] Since this analysis did not produce job projections for the intervening years between 2010, 2015, and 2020, we did the following to calculate net 2020 job person-years. First, we subtracted job person-years generated in 2015 from 2020, assuming, again, that workers funded by these job person-years are already trained. Then, we divided this total by five in order to obtain the yearly average, or the estimated increment from 2019 to 2020. This assumes that investment is evenly distributed across the five years – a conservative assumption, since it increases substantially over this period.

Figure 3.8 From Total Job Person-Years to 2020 Net Workers in 77 Occupations Needing Training



Not to Scale

This methodology was designed to be as transparent as possible. Apart from the E-DRAM model code, which is proprietary, the components of the analysis are available for review and are created in such a way that policy scenarios can be modified. The dollar amounts assigned to each policy—and the distribution of the dollars across NAICS codes (see next section)—can readily be changed via a set of spreadsheets that lays out all the policies as well as the ten allocation methods (see table 3.7).

3.4.1 PROJECTING JOBS IN CALIFORNIA

To undertake the third step in our methodology, we assigned the energy efficiency related investment dollars to economic sectors, using four-, five-, and six-digit NAICS codes. Assignment to detailed NAICS codes is a necessary step in order to link to occupations, and ultimately, education and training programs. We assigned investments to NAICS based upon empirical research on similar investments in the past, using ten different methods, described in Table 3.7 (as well as Appendix A). These methods differ depending on the availability of empirical data on the allocation of expenditures. Using previous studies, we tried to identify the NAICS industries receiving investment, the proportion of investment that goes to each industry and to administration, and, where appropriate, the share of investment that goes to labor versus materials.

Table 3.7 Overview of Allocation Methods for Assigning NAICS Codes to Energy Efficiency Related Program Areas

Program Area	Method / Source
Weatherization and Retrofits	Based on a New York State Labor Department study (2009) that identified specific NAICS of industries engaged in weatherization and retrofit activities, plus U.S. Department of Labor's Quarterly Census of Employment and Wages, which was used to identify the industry distribution in the economy as a whole, weighted by wages.[1] Includes weatherization assistance (ARRA and non-ARRA funds), HUD's Green Retrofit Program for Multifamily Housing, and Home Star.
U.S. Dept. of Energy Programs (EERE)	Based on public data for February 17 through December 31, 2009, provided by the Federal Government on ARRA recipients. Because data are organized by activity code (6-digit NAICS) and dollar amount, it is possible to identify both the industries receiving investment and the distribution of investment.[2]
ARRA Energy Efficiency Appliance Rebate Program	Based on public data for February 17 through December 31, 2009, provided by the Federal Government on ARRA recipients. Data are organized by activity code (6-digit NAICS) and dollar amount.[2]
ARRA Energy Efficiency Retrofit Programs	Based on public data for February 17 through December 31, 2009, provided by the Federal Government on ARRA recipients. Data are organized by activity code (6-digit NAICS) and dollar amount (specifically the General Services Administration-Federal Buildings Fund, Recovery Act). [2]
U.S. Dept. of Defense Programs	Based on public data for February 17 through December 31, 2009, provided by the Federal Government on ARRA recipients. Data are organized by activity code (6-digit NAICS) and dollar amount (specifically the Department of Defense funds, Recovery Act). [2]
IOU Energy Efficiency Programs (including LIEE)	NAICS assignment to materials NAICS and labor NAICS based on the authors' judgment of the best match between the measure's description and the standard list of NAICS codes.
Codes & Standards / Title 24	Allocated to NAICS 236, New Construction.
California Solar Initiative	Based on information for the CSI program, plus a 2007 report on solar photovoltaic system costs prepared by Itron for the CPUC, which included the distribution of costs among labor, materials, and administration. [3]
SGIP/ERP	Based upon the New York State Labor Department (2009) study, the CSI website, a fuel cell materials website, a Green Economy report prepared by the Washington State Department of Community, Trade, and Economic Development, and the judgment of the authors. [4]
Demand Response	Based upon a combination of methods: the NAICS allocations from the New York State Labor Department (2009) study; the method used for IOU EE programs; and the division of labor and materials from CSI.
Smart Meters	Based upon the method used for IOU EE programs and the division of labor and materials from CSI.

[1] New York State Department of Labor (2009), *New York State's Clean Energy Industry: Labor Market and Workforce Intelligence*, p. 56. Retrieved from: http://www.labor.state.ny.us/workforcenypartners/PDFs/NYS%20Clean%20Energy%20Jobs%20Report%20FINAL%2006-09-09.pdf (page 56). Five industries are supported by weatherization and retrofit investment (plumbing, heating, and air-conditioning contractors; insulation contractors; window and door installation; boiler and pipe insulation installation; and electrical contractors). Total wages for these five industries in 2009 are about $2.9 billion, but wages in plumbing, heating, and air-conditioning contractors (NAICS 23822) are about $1 billion. Thus this analysis assumes that about 1/3 of the investment will be allocated to this industry.

[2] U.S. Recovery Accountability and Transparency Board, Recovery.gov website. Download Center: Recipient Reported Data. http://www.recovery.gov/FAQ/Pages/DownLoadCenter.aspx.

[3] Go Solar! California website, http://www.gosolarcalifornia.org; and Itron (2007). *CPUC Self-Generation Incentive Program: Solar PV Costs and Incentive Factors Final Report*. Retrieved from: http://www.energycenter.org/uploads/Selfgen_SolarPVCosts_FinalReport.pdf.

[4] New York State Department of Labor (2009), p. 56; Go Solar! California website; Fuel Cell Today website, http://www.fuelcelltoday.com/events/industry-review; and Washington State Department of Community, Trade, and Economic Development, E2SHB Implementation Team (2008, July 15). Initial Washington Green Economy Industry List. Retrieved from: http://www.labormarketinfo.edd.ca.gov/contentpub/GreenDigest/WA-NAICS-Industry-List.pdf.

Through this process we identified 59 four-, five-, and six-digit NAICS industries (equivalent to 41 four-digit NAICS industries) that are likely to receive energy efficiency related investment. We used data from three California studies to verify our selections, including green economy surveys by EDD and the Community College Centers of Excellence, as well as a study on green innovation by the UC Berkeley Center for Community Innovation (see Appendix B).[42] Table 3.8 shows how these industries are associated with the relevant program area(s).

Some of the firms receiving policy-driven investment are located in California, while others are outside the state or country. In general, those providing services tied to a particular place (e.g., construction) are located within the state, while many of those providing goods for export (e.g., communications equipment manufacturing) are located outside the state. We used IMPLAN to calculate the amount of investment (and jobs) that is leaked outside of California.[43] After calculating the amount of investment that is leaked outside of California, The next step was to translate the remaining investment into California jobs (using the ratio of output per worker from IMPLAN), yielding projections of direct jobs.

Table 3.9 presents the Low, Medium, and High Scenario job person-years for 2010, 2015, and 2020. (Job person-years are the appropriate unit of analysis in energy efficiency studies both because of the short-term nature of much of the work and because, as explained previously, one job person-year is not likely to be absorbed by a single worker, but rather divided among several workers who perform energy efficiency related activity as one component of their work.) Job person-years are presented in two ways: (1) job person-years created in a year relative to the 2009 baseline (new job person-years created by the additional funding in 2010, 2015 and 2020 after subtracting the 13,434 job person-years created by energy efficiency funding in 2009) and (2) job person-years created in a year relative to the previous forecast year (for instance, the 8,244 new Medium Scenario job person-years created by the additional funding in 2015 after subtracting both the 13,434 jobs created by energy efficiency funding in 2009 and the 14,284 incremental job person-years from 2010).[44] The totals net of 2009 (#1 above) illustrates the impacts of investment on energy efficiency and related employment generally, while the total for a particular year net of all previous years (#2) is the relevant number for the process of determining workforce training needs in a particular year.

Overall, the projected new jobs comprise approximately 0.2 percent of overall California employment. Given that the energy efficiency and related jobs are a subset of all green jobs, this estimate is consistent with the previous studies of the California green economy that have shown that approximately one percent of all jobs in the state are green.[45]

[42] All of the NAICS identified in this study as receiving energy efficiency related investment were also included in at least one of the other studies. Some of the industries in the other studies were not included in this study but that was expected because the scope of this study (i.e., the green economy sectors included) is narrower than in the other California studies. See: California Community Colleges Centers of Excellence (2009); California Employment Development Department (2010); and Chapple, K., & M. Hutson (2010). *Innovating the Green Economy in California Regions*. Berkeley, CA: UC-Berkeley Center for Community Innovation. Available at: http://communityinnovation.berkeley.edu/publications.html.

[43] This analysis did not calculate the amount of demand generated from out-of-state sources that creates jobs in California (e.g., policy-driven investment in Oregon that funds California photovoltaic panel manufacturers).

[44] These incremental new direct job totals do not include the non- energy efficiency -related jobs created due to AB32 – which are mostly in induced spending in consumption-related industries.

[45] See, for instance, Chapple & Hutson 2010 and Collaborative Economics & Next10 (2009). *Many Shades of Green: Diversity and Distribution of California's Green Jobs*. San Francisco, CA: Next10. Retrieved from: http://nextten.org/next10/publications/green_jobs.html. Note however that the EDD survey of green industries in California adopted a much broader definition of the green economy and thus reported a much higher share of jobs (3.4 percent).

Table 3.8 Industries Receiving Energy Efficiency Related Investment, by Program Area

Industry Description (NAICS)	Weather-ization and Retrofits	US Dept. of Energy Programs (EERE)	ARRA EE Appliance Rebate Program	ARRA EE Retrofit Programs	US Dept. of Defense Programs	Codes & Standards / Title 24	IOU EE Programs	California Solar Initiative	SGIP	ERP	Demand Response	Smart Meters
Fossil Fuel Electric Power Generation (221112)				X								
Other Electric Power Generation (221119)		X										
Electric Power Distribution (221122)		X			X							
Residential Building Construction (2361)						X	X					
Industrial Building Construction (236210)					X							
Nonresidential Building Construction (2362)						X	X					
Commercial and Institutional Building Construction (236220)		X		X	X							
Water and Sewer Line and Related Structures Construction (237110)					X							
Power and Communication Line and Related Structures Construction (237130)		X							X	X		
Other Heavy and Civil Engineering Construction (237990)					X							
Framing Contractors (238130)					X							
Roofing Contractors (238160)					X		X	X				
Electrical Contractors (23821)	X	X		X	X		X				X	X
Plumbing, Heating, and Air-Conditioning Contractors (23822)	X	X		X	X		X	X				
Boiler and Pipe Insulation Installation (23829)	X						X					
Insulation Contractors (23831)	X						X					
Window and Door Installation (23835)	X						X					
All Other Specialty Trade Contractors (238990)		X			X							
Asphalt Paving, Roofing, and Saturated Materials Manufacturing (32412)							X					
Other Nonmetallic Mineral Product Manufacturing (3279)							X					
Industrial Machinery Manufacturing (3332)							X					
Ventilation, Heating, Air-Conditioning, & Commercial Refrigeration Equip. Manf. (3334)							X					
Heating Equipment (except Warm Air Furnaces) Manufacturing (333414)				X				X				
Turbine and Turbine Generator Set Units Manufacturing (333611)									X	X		
Computer and Peripheral Equipment Manufacturing (3341)							X					
Communications Equipment Manufacturing (3342)							X					
Semiconductor and Related Device Manufacturing (334413)								X				

Table 3.8 (continued) Industries Receiving Energy Efficiency Related Investment, by Program Area

Industry Description (NAICS)	Weather-ization and Retrofits	US Dept. of Energy programs (EERE)	ARRA EE Appliance Rebate Program	ARRA EE retrofit programs	US Dept. of Defense programs	Codes & Standards / Title 24	IOU EE Programs	California Solar Initiative	SGIP	ERP	Demand Response	Smart Meters
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing (33451)											X	
Automatic Enviro. Control Manufacturing for Residential, Commercial & Appliance Use (334512)												X
Other Measuring and Controlling Device Manufacturing (334519)								X				
Electric Lighting Equipment Manufacturing (3351)							X					
Residential Electric Lighting Fixture Manufacturing (335121)								X				
Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing (335122)								X				
Household Appliance Manufacturing (3352)			X				X					
Other Major Household Appliance Manufacturing (335228)							X					
Storage Battery Manufacturing (335911)									X			
All Other Miscellaneous Electrical Equipment and Component Manufacturing (335999)									X	X		
Used Household and Office Goods Moving (484210)							X					
Offices of Real Estate Appraisers (531320)				X								
Other Activities Related to Real Estate (531390)				X								
Architectural Services (541310)				X								
Engineering Services (541330)		X		X	X		X				X	
Building Inspection Services (541350)				X			X				X	
Surveying and Mapping (except Geophysical) Services (541370)				X								
Administrative Management and General Management Consulting Services (541611)		X		X								
Environmental Consulting Services (541620)		X		X			X				X	
Other Scientific and Technical Consulting Services (541690)							X				X	
Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology) (541712)		X									X	
Advertising and Related Services (5418)			X				X				X	
Corporate, Subsidiary, and Regional Managing Offices (551114)			X				X		X	X	X	X
Office Administrative Services (5611)			X				X		X	X	X	X
Facilities Support Services (561210)		X										
Professional and Management Development Training (611430)				X								

Table 3.8 (continued) Industries Receiving Energy Efficiency Related Investment, by Program Area

Industry Description (NAICS)	Weather-ization and Retrofits	US Dept. of Energy Programs (EERE)	ARRA EE Appliance Rebate Program	ARRA EE Retrofit Programs	US Dept. of Defense Programs	Codes & Standards / Title 24	IOU EE Programs	California Solar Initiative	SGIP	ERP	Demand Response	Smart Meters
Commercial & Industrial Machinery & Equip. (exc. Auto. & Electronic) Repair & Maint. (811310)							x					
Executive Offices (921110)		x										
Executive and Legislative Offices, Combined (921140)		x										
Other General Government Support (921190)		x										
Administration of General Economic Programs (926110)		x										
Regulation and Administration of Communications, Electric, Gas, and Other Utilities (926130)		x						x	x	x	x	x

Table 3.9 Direct Job Person-Years by Scenario, Net of 2009, Total and Per Year

Scenario	Total Direct Job Person-Years (For 2010, 2015, and 2020, Net of 2009)				Direct Job Person-Years Per Year (Net of All Previous Years)		
	2009	2010	2015	2020	2010*	2015	2020
Low	13,434	13,482	17,779	22,926	13,482	860	1,029
Medium	13,434	14,284	22,528	38,937	14,284	1,649	3,282
High	13,434	14,284	26,336	42,208	14,284	2,411	3,174

*Note: 2010 job person-years are significantly higher than in other years for two reasons: first, they include approximately 6,500 jobs in new construction resulting from the implementation of new Title 24 building codes; and second, they result from ARRA and smart meter funding that disappears later in the decade. Due to the economic slowdown, the Title 24 New Construction jobs are most likely to be created over several years, rather than in just one year.

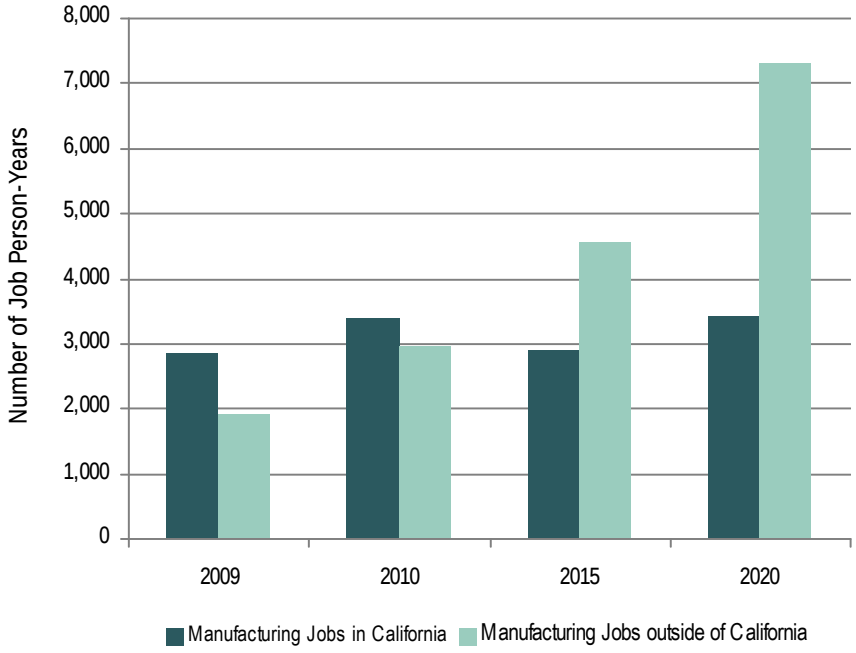
The most important factor differentiating the scenarios is the growth in IOU programs in the Medium and High Scenarios and the implementation of the CPUC BBEES in the High Scenario. However, federal spending tends to smooth out the differences among the three scenarios. In particular, ARRA funding inflates even the Low Scenario for 2010, and other federal spending differs little between the Medium and High Scenarios. ARRA tends to fund industries with relatively more jobs per dollar of spending (e.g., weatherization occupations) than some of the other programs. It is because of this that the Low Scenario produces a disproportionate share of jobs relative to investment.

The E-DRAM model produced projections for indirect and induced incremental job creation as well as direct. As noted previously, these projections are less relevant for this WE&T Needs Assessment and thus are only discussed in detail in Appendix C. Overall, most of the new jobs will be in consumption-related sectors, because the main driving force for job growth is the cost savings from reduced energy use that is pocketed by consumers and spent on a wide variety of goods and services. By 2020, more indirect and induced jobs will be created in California by

energy efficiency investment than direct energy efficiency jobs. By 2020, the Low Scenario will generate 179,950 total (direct, indirect, and induced) job person-years, while the Medium creates 211,471 total job person-years and the High Scenario results in 217,191.

As is described in more detail below, the vast majority of the new direct jobs are in construction and services, not manufacturing. Over time, the number of manufacturing jobs is projected to increase significantly due to increased purchasing of HVAC equipment, electric lighting, and other inputs related to energy efficiency investment. Manufacturing jobs come not just from these direct purchases (e.g., the solar photovoltaic panel purchased under the California Solar Initiative) but also from indirect purchasing (e.g., the purchase of inputs by the photovoltaic manufacturers). Figure 3.9 looks at the total incremental job creation in the energy efficiency-related manufacturing industries. Over three-quarters of manufacturing jobs in these industries are expected to be located outside of California, so this job creation will take place mostly out of state.

Figure 3.9 Total Manufacturing Job Person-Years in Energy Efficiency Related Industries Inside and Outside of California



3.4.2 PROJECTIONS BY INDUSTRY

The industries most affected by energy efficiency related spending are in the construction sector, professional services related to construction, administration, and manufacturing. Table 3.10 presents the direct job person-year projections by industry group for the Medium Scenario. Appendix D presents the detailed results for all energy efficiency industries. Construction-related jobs, particularly specialty contractors, dominate the projections, followed by administration, consulting services, and manufacturing.

Table 3.10 Total Direct Job Person-Years, Medium Scenario, by Industry Group, Total and Per Year

NAICS	Industry Group Description	Total Direct Job Person-Years (Net of 2009)		Direct Job Person-Years Per Year (Net of 2009)	
		2015	2020	2015	2020
2361	Residential Building Construction	5,072	7,104	486	406
2362	Nonresidential Building Construction	5,342	6,924	72	316
23821	Electrical Contractors	319	1,649	(110)	266
23822	Plumbing, Heating, and Air-Conditioning Contractors	4,859	9,407	653	909
23831	Drywall and Insulation Contractors	451	840	54	78
32412, 3279, 3332, 3334, 3336, 3341, 3342, 3344, 3345, 3351, 3352, 3353, 3359 (part)	Manufacturing	51	574	(96)	105
5418	Advertising and Related Services	956	1,794	131	168
541 (part)	Engineering Services, Architectural Services, Environmental Consulting Services, Other Scientific and Technical Consulting Services	2,118	4,026	92	382
5511, 92 (part)	Management of Companies and Enterprises, Public Administration	1,231	2,449	137	244
5611	Office Administrative Services	2,021	3,958	259	387
Multiple	All Other Industries	108	212	(29)	21
Total		22,528	38,937	1,649	3,282

Some industries experience a steady increase in jobs due to the energy efficiency related investments examined here throughout the ten-year projection periods, while others peak much earlier (usually due to ARRA funding). For instance, Plumbing, Heating, and Air-Conditioning Contractors (23822)—the five-digit NAICS industry that will see the most jobs in all three scenarios—will see steep increases over 2009 levels in 2010, 2015, and 2020 due largely to its inclusion in weatherization, retrofits, solar, and other energy efficiency programs funded by the IOUs and the federal government. Other Scientific and Technical Services (541690), an industry that gets funded because of demand response programs, sees significant increases over the projection years. In contrast, the increase in other industries, such as Drywall and Insulation Contractors (23831), is much more incremental, since it is funded only by weatherization and IOU energy efficiency programs.

The job projections show that many industries experience increases in the early part of the decade with very little growth in the latter part. For instance, Architectural Services (54131) and Engineering Services (54133) bump up in 2010 due to a combination of ARRA programs and demand response. Automatic Environmental Control Manufacturing (334512) has no job creation in 2020 because all of the new smart meters will have been installed prior to that year.[46] Semiconductor and Related Device Manufacturing (334413) stays the same in the 2020 Medium Scenario because of the assumption that the California Solar Initiative will continue at level funding.

[46] Undoubtedly new smart meters will be installed on an ongoing basis, requiring additional manufacturing. New buildings will require smart meters, and defective smart meters will have to be replaced. However, since the replacement rate is unknown, as well as the future labor needs, the analysis excludes this future investment.

The projections show that residential and nonresidential construction industries also increase steadily, though mostly in the early part of the decade. (Again, codes and standards are not included in 2009 because they are already in the baseline scenario.)

3.4.3 COMPARISONS TO CALIFORNIA PROJECTIONS

To provide some context to the scale of our labor demand projections, we compare our results to the overall projected new jobs in energy efficiency industry sectors for the California economy as a whole. This is important because, in addition to the jobs generated by the specific policies analyzed here, California will likely experience growth in jobs in the same industries, in occupations that may have similar training needs to those for the policy-driven new jobs.

A direct comparison cannot be made between the EDD projections, which are for permanent jobs, and these job person-year projections. However, for perspective, the EDD anticipates that the California economy will be composed of a total of almost 19 million jobs by 2018. In the medium scenario, the projected number of new direct job person-years comprises only 0.2 percent of that total. The EDD anticipates creating an average of 165,320 jobs per year from 2008 to 2018. Thus the 38,937 net new energy efficiency jobs in 2020 are equal to almost one-fourth of that yearly average.[47] In terms of permanent jobs, 14,284 energy efficiency jobs will last the entire period from 2010 through 2020, compared with the EDD's 2008–2018 estimate of 1.65 million jobs created throughout the entire economy. That is to say, over the long term, energy efficiency jobs make up about 0.9 percent of all permanent jobs.

3.4.4 JOB PROJECTIONS BY OCCUPATION

For the purposes of the WE&T Needs Assessment, the final output of the employment projections needs to be in terms of jobs in specific occupations, not jobs in entire industries, because education and training programs offer skills curricula tailored towards specific occupations (which may be concentrated in specific industries). Typically researchers and policymakers use the staffing patterns matrices (produced by the EDD and available at the four-digit level) to determine the occupational distribution (by Standard Occupational Classification [SOC] code and at the four-digit level) in each industry. These matrices offer average staffing levels across all of the state's firms in each four-digit sector. So, for instance, according to the staffing patterns, a residential construction firm with 100 workers will have 25 manual laborers, 50 semi- and high-skilled laborers (including on-site managers), six other managers, 18 administrative staff, and one staff architect. A four-employee residential construction firm will have one manual, two semi- or high-skilled laborers, and one administrative staff.

Some of the occupations involved in energy efficiency related activity are considered new and emerging—and thus are not included in the staffing patterns matrices. For instance, the US Bureau of Labor Statistics only recently recognized wind turbine technicians as its own occupation, and other occupations described in the Green O*NET as new and emerging (such as climate change analysts) are not yet included in official statistics.[48] To deal with this omission, we drew from the EDD green economy survey, which provides insight into the share of eight new

[47] EDD projections use a different methodology that does not account for specific investments in energy efficiency and related activities. Thus, it is not possible to determine whether these jobs are additional to the EDD projections or are accounted for within that figure.

[48] The National Center for O*NET Development has identified green economic sectors, green increased demand occupations, green enhanced skills occupations, and green new and emerging (N&E) occupations. For more information, see http://www.onetcenter.org/green.html.

occupations related to energy efficiency in industries at the three-digit NAICS level (see Appendix B for more detail).

Across the state, each industry comprises hundreds of occupations. Not every firm in a particular industry will hire workers in every occupation that is found in the industry; for instance, as noted above, not every small residential construction firm will hire in-house administrative staff. But several firms in an industry may support an administrative worker in another industry by purchasing administrative services instead of supporting an in-house worker. The EDD staffing patterns matrix provides an average occupational distribution across all industries, allowing us to translate industries into occupations. Although energy efficiency investment will affect job levels in hundreds of occupations, this analysis focuses on just the 77 occupations in energy efficiency and related industries that (1) are expected to grow by at least 100 jobs by 2020 and (2) are judged to require at least minimal energy efficiency related job training. This excludes workers in occupations like receptionists and truck drivers who, though employed by energy efficiency employers, perform work that is no different from that of similar workers in other industries.[49] Table 3.11 shows those 77 occupations, grouped into nine broad occupational groups. Within the 77 occupations, the top 18 occupations (those with job creation of more than 400 jobs statewide in 2020) are general and operations managers; construction managers; cost estimators; other business operations specialists; civil engineers; sales representatives, services, all other; first-line supervisors/managers of office and administrative support workers; customer service representatives; first-line supervisors/managers of construction trades and extraction workers; carpenters; construction laborers; drywall and ceiling tile installers; electricians; plumbers, pipefitters, and steamfitters; sheet metal workers; helpers, electricians; helpers, pipelayers, plumbers, pipefitters, and steamfitters; and heating, air conditioning, and refrigeration mechanics and installers.

Table 3.12 shows the job projections (total person-years of employment) for these nine occupational groups, as well as the group of occupations not requiring training, by residential, commercial/public, and industrial/agricultural sectors in 2020. More than half of all job person-years will be in the residential sector (with the remaining in the commercial/public and industrial/agricultural sectors), and occupations working in mechanical and electrical trades and the construction of building envelopes, including retrofitting of existing buildings as well as new construction, dominate job creation. The complete list of affected occupations by sector is in Appendix E.

Workers in most occupations do not spend all of their time on energy efficiency-related activity. Whether the occupation is in sheet metal work, architecture, or customer service, only a percentage of total work time will be spent doing the energy efficiency tasks that require training. Thus, this analysis next translates the projections of job person-years into the numbers of new workers that will need training, again relying upon the EDD Green Economy survey.

The EDD survey asked how many workers did any kind of EE work, and then how many spent over 50 percent of their time on EE work (i.e., are full time). These data allow us to estimate the share of each occupation that will benefit from energy efficiency investment. For instance, if, in engineering services, all workers are doing energy efficiency work full time, then a job person-year is equivalent to a worker. However, if just half of the workers are working full time on energy efficiency, then one job person-year is equivalent to two workers. Appendix B provides more detail about how this calculation was performed. Using this method, the 38,937 job person-years in the 2020 Medium Scenario (net of 2009) is translated into 78,205 workers who conduct energy efficiency activity requiring training, as part of their work—or 26,309 net new workers relative to 2015 (Table 3.13).

[49] We focus on mechanical and electrical trades, building envelope construction and performance, and architecture and engineering for the workforce education and training inventory because the others are general occupations that require minimal changes in training because they are in energy and construction industries.

Table 3.11 Occupational Groups Affected by Energy Efficiency Related Investment

Occupational Group	SOC	Occupation Title
Mechanical Systems (Construction Trades)	47-2073	Operating Engineers and Other Construction Equipment Operators
	47-2111	Electricians
	47-2152	Plumbers, Pipefitters, and Steamfitters
	47-2211	Sheet Metal Workers
	47-3013	Helpers—Electricians
	47-3015	Helpers—Pipelayers, Plumbers, Pipefitters, and Steamfitters
	47-4021	Elevator Installers and Repairers
	49-1011	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers
	49-2098	Security and Fire Alarm Systems Installers
	49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers
	49-9042	Maintenance and Repair Workers, General
	49-9052	Telecommunications Line Installers and Repairers
	49-9098	Helpers—Installation, Maintenance, and Repair Workers
		Solar Photovoltaic Panel Installers and Technicians
Building Envelope (Construction Trades)	47-1011	First-Line Sup/Mgrs of Construction Trades and Extraction Workers
	47-2031	Carpenters
	47-2051	Cement Masons and Concrete Finishers
	47-2061	Construction Laborers
	47-2081	Drywall and Ceiling Tile Installers
	47-3012	Helpers—Carpenters
Building Envelope (Performance Trades)	47-4011	Construction and Building Inspectors
		Energy Auditors
		Building Performance or Retrofitting Specialists
Architecture and Engineering	17-1011	Architects, Except Landscape and Naval
	17-1022	Surveyors
	17-2051	Civil Engineers
	17-2061	Computer Hardware Engineers
	17-2071	Electrical Engineers
	17-2072	Electronics Engineers, Except Computer
	17-2112	Industrial Engineers
	17-2141	Mechanical Engineers
	17-2199	Engineers, All Other
	17-3011	Architectural and Civil Drafters
	17-3013	Mechanical Drafters
	17-3022	Civil Engineering Technicians
	17-3023	Electrical and Electronic Engineering Technicians
Manufacturing	51-1011	First-Line Supervisors/Managers of Production and Operating Workers
	51-8031	Water and Liquid Waste Treatment Plant and System Operators
	51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers
	51-9141	Semiconductor Processors

Table 3.11 (continued) Occupational Groups Affected by Energy Efficiency Related Investment

Occupational Group	SOC	Occupation Title
Administration (General)	13-1022	Wholesale and Retail Buyers, Except Farm Products
	13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products
	13-1041	Compliance Officers, Except Ag, Constr, Health-Safety, and Transportation
	13-1111	Management Analysts
	13-1199	Business Operations Specialists, All Other
	15-1021	Computer Programmers
	15-1031	Computer Software Engineers, Applications
	15-1032	Computer Software Engineers, Systems Software
	15-1041	Computer Support Specialists
	15-1051	Computer Systems Analysts
	15-1071	Network and Computer Systems Administrators
	23-1011	Lawyers
	37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners
	43-1011	First-Line Sup/Mgrs of Office and Administrative Support Workers
Administration (Sales-Related)	13-1051	Cost Estimators
	19-3021	Market Research Analysts
	27-3031	Public Relations Specialists
	41-1012	First-Line Supervisors/Managers of Non-Retail Sales Workers
	41-3099	Sales Representatives, Services, All Other
	41-4011	Sales Reps, Wholesale & Manf., Technical & Scientific Products
	41-4012	Sales Reps, Wholesale & Manf., Exc. Technical & Scientific Products
	41-9011	Demonstrators and Product Promoters
	41-9031	Sales Engineers
	43-4051	Customer Service Representatives
Management (Blue-Collar)	11-3051	Industrial Production Managers
	11-9021	Construction Managers
	11-9041	Engineering Managers
	11-9141	Property, Real Estate, and Community Association Managers
	11-1021	General and Operations Managers
Management (White-Collar)	11-2021	Marketing Managers
	11-2022	Sales Managers
	11-3021	Computer and Information Systems Managers
	11-3031	Financial Managers
	11-3061	Purchasing Managers
	11-9199	Managers, All Other
	11-1011	Chief Executives
		Sustainability Program Coordinators/Managers
	11-3061	Purchasing Managers
	11-9199	Managers, All Other
	11-1011	Chief Executives
		Sustainability Program Coordinators/Managers

Table 3.12 Energy Efficiency Total Direct Job Person-Year Projections Per Year, Medium Scenario, by Occupational Group

Occupational Group	Direct Residential Jobs		Direct Commercial and Public Sector Jobs		Direct Industrial and Agricultural Sector Jobs	
	2015	2020	2015	2020	2015	2020
Mechanical and Electrical Trades	211	470	124	276	48	106
Building Envelope (Construction Trades)	232	312	136	184	53	71
Building Envelope (Performance Trades)	9	19	5	11	2	4
Architecture and Engineering	—	67	—	40	—	15
Administration (General)	50	112	29	66	11	25
Administration (Sales-Related)	74	121	43	71	17	27
Management (Blue-Collar)	43	98	25	57	10	22
Management (White-Collar)	29	55	17	32	7	12
Manufacturing	—	4	—	2	—	1
Occupations Not Requiring Training	277	550	163	323	63	125
Total	909	1,809	534	1,063	206	410

Table 3.13 Energy Efficiency Incremental Worker Training Projections, Medium Scenario, by Occupational Group, Total and Per Year

Occupational Group	Total Direct New Workers (Net of 2009)		Direct New Workers Per Year (Net)	
	2015	2020	2015	2020
Administration	2,205	3,798	104	319
Administration (Sales-Related)	3,110	4,961	195	370
Architecture and Engineering	2,812	4,748	—	387
Building Envelope (Construction Trades)	27,452	37,282	1,145	1,966
Building Envelope (Performance Trades)	1,004	1,487	39	96
Management (Blue-Collar)	5,883	8,395	173	502
Management (White-Collar)	1,096	1,855	62	152
Manufacturing	48	97	—	10
Mechanical and Electrical Trades	8,286	15,582	628	1,459
Total	51,896	78,205	2,301	5,262

3.5 OCCUPATIONAL PROJECTIONS BY METROPOLITAN REGION

Once we developed projections of the number of workers needing training by energy efficiency occupation statewide, we then allocated these jobs to lower geographic levels of analysis. Specifically, we estimate the number of jobs by each IOU service territory and for each of California's 36 metropolitan areas.[50] (Appendix F contains the analysis for all metropolitan areas.) The IOU service territories include PG&E, SDG&E, SCE, and SCG. The job estimates for PG&E and SDG&E are based on their respective electric utility service territories. The SCG service territory overlaps with the PG&E electric utility service territory, the SCE service territory and various other POU service territories. Thus, a portion of the job estimates reported for SCG are also reported for PG&E, SCE and other POU service areas.

There were two steps used to conduct this analysis:

STEP 1. First, we used data from the U.S. Census Bureau's American Community Survey (ACS) to calculate the number of employed workers in each energy efficiency occupation in each county or rural region in California. From this occupational data figure we calculated each county's share of statewide employment in each occupation and then allocated the statewide jobs figures from IMPLAN to each county or region based on this share.

STEP 2. Next, we built a geographic bridge between each county and each IOU service area (note: we grouped all POU service areas together to form a single non-IOU area). With each centroid associated with a particular IOU, we then calculated the share of each county's population that lay in each IOU service territory. This county allocation factor was then used to bridge the county jobs figures to IOU territories. For example, if 40 percent of county X's population fell in PG&E's territory, then 40 percent of that county's jobs were assigned to PG&E.

Table 3.14 provides the projections of workers needing training for the direct energy efficiency related occupations created under the Medium Scenario for the IOU service territories (organized by occupation group). Southern California Gas leads the IOUs in training needs, with a net of 13,502 new workers needing training in 2020. This is explained by the size of its territory. PG&E is second, with 6,113, followed by the combined POUs (4,334), Southern California Edison (4,034), and San Diego Gas & Electric (2,257).

The major metropolitan areas, including Los Angeles, Riverside–San Bernardino, Sacramento, San Diego, San Francisco–Oakland, and San Jose, gain the majority of the workers to be trained in these occupations, with 54 percent anticipated to go to the Los Angeles and San Francisco regions alone. Of these jobs, 45 percent are in construction industries related to the building envelope. Table 3.15 provides the projections for the nine occupation groups for these regions.

[50] Specifically, the analysis allocated the projections to 36 California counties within metropolitan areas, and 6 aggregations of counties outside metropolitan areas (henceforth "rural regions").

Table 3.14 Energy Efficiency Related Total Worker Training Projections Per Year, Medium Scenario, by Occupational Group and IOU/POU Region

Occupations by IOU/POU	Direct New Workers, 2020				
	PGE	SDGE	SCE	SoCalGas	POUs
Administration	57	19	27	96	36
Administration (Sales-Related)	43	19	28	84	25
Architecture and Engineering	113	41	75	197	58
Building Envelope (Construction)	199	72	140	482	147
Building Envelope (Performance)	15	4	10	30	9
Management (Blue-Collar)	85	26	57	161	50
Management (White-Collar)	22	8	14	43	13
Manufacturing	4	1	3	11	4
Mechanical Systems	180	66	109	392	129
	717	257	463	1,498	470
	Total = 3,405				

Note: The IOU totals sum to greater than 100 percent because of the overlap between Southern California Gas and other IOU territories.

3.6 LABOR SUPPLY

Is the California workforce prepared to work in the jobs created by energy efficiency and related policy-driven investment? In order to determine the extent of California's workforce education and training needs, it is necessary to examine the existing and projected workforce in energy efficiency related occupations. Relying on secondary source data from the American Community Survey and the Current Population Survey, this analysis first establishes the characteristics of California workers in energy efficiency related occupations in 2009, and then projects the labor supply (both employed and unemployed workers in these occupations) to 2010, 2015, and 2020. Data on sex and race/ethnicity reveals existing concentrations of different demographic groups in certain occupations, which may create barriers to entry. Educational attainment data suggests the level of preparation expected currently of energy efficiency workers. Data on age distribution suggests occupations where significant numbers of retirements and/or shortages of new workers might be expected. Finally, firm size, wages, and health insurance data demonstrate the quality of jobs in energy efficiency.

Table 3.15 Energy Efficiency Related Total Worker Training Projections, Medium Scenario, by Occupational Group, for the Los Angeles-Long Beach-Santa Ana Metropolitan Region and the Nine-County Bay Area Metropolitan Region

Occupations by Metro Region	Total Direct New Workers in 2020 (Net of 2009)	Direct New Workers in 2020 (Net of All Previous Years)
LA-Long Beach-Santa Ana		1,727
Administration	1,434	118
Administration (Sales-Related)	1,729	131
Architecture and Engineering	1,442	117
Building Envelope (Construction)	12,497	681
Building Envelope (Performance)	505	33
Management (Blue-Collar)	2,795	168
Management (White-Collar)	678	56
Manufacturing	38	4
Mechanical and Electrical Trades	4,464	420
San Francisco Bay Area	16,057	1,109
Administration	962	86
Administration (Sales-Related)	1,084	83
Architecture and Engineering	1,185	99
Building Envelope (Construction)	7,123	386
Building Envelope (Performance)	351	22
Management (Blue-Collar)	1,982	123
Management (white-collar)	522	43
Manufacturing	19	2
Mechanical and Electrical Trades	2,828	265

3.6.1 METHODOLOGY

The analysis of current labor supply encompasses both demographic (sex, age, race and ethnicity, and educational attainment) and employment characteristics (firm size, hourly wages, and access to health insurance) for California's current workforce. The analysis is organized into the nine energy efficiency-related occupational groups, which include the 77 occupations that require some level of job training related to energy efficiency, distributed generation, and demand response. Demographic data come from the US Census 2009 American

Community Survey (ACS).[51] Wage data come from the May 2009 California Employment Development Department (EDD) Wage Estimates, and the 2008 US Census Current Population Survey provides data on benefits and firm size.

To project future labor supply, we first obtained 2009 baseline data on employed and unemployed workers by occupation and by county from the ACS. Projections of employed workers in 2010, 2015, and 2020 were based upon the projected statewide annual growth rates by occupation from the EDD's 2008–2018 Projections of Employment by Occupation. To estimate unemployment by occupation, we first applied a growth factor based upon the overall labor force growth in 2010, 2015, and 2020 (based on the EDD projections). This allowed us to calculate the unemployed as the unemployment rate times the projected number of workers in each year. To calculate 2010 unemployment by occupation and county, we used the ratio of the California 2010 unemployment rate (12.4 percent) to the 2009 unemployment rate (12.1 percent). To project 2015 and 2020 unemployment, we built two scenarios based upon two different views of the rate that the California economy will recover. The first (the Low Unemployment Scenario) assumes, based upon the California Department of Finance 2009 Economic Forecasts, that unemployment will decline to 7.9 percent in 2015 and 4.2 percent in 2020. The second (the High Unemployment Scenario) assumes that unemployment rates will remain at 2010 levels in 2015 and decline to 7.9 percent by 2020.

3.6.2 CURRENT ENERGY EFFICIENCY, DEMAND RESPONSE, AND DISTRIBUTED GENERATION LABOR SUPPLY IN CALIFORNIA

This section describes the demographic, labor and wage characteristics of the nine occupational groups that require some energy efficiency related training, while providing additional data on the top 18 energy efficiency related occupations with significant job creation (over 400 jobs) by 2020. It is important to note that the workforce and demographic figures presented here are for the total California workforce in a given occupation or occupational group. For instance, the analysis shows the demographic characteristics of all plumbers, not just those performing energy efficiency related work, and the projections of the future supply of plumbers includes all plumbers in the state, some of whom work in energy efficiency and some who do not.

Overall, this analysis suggests that energy efficiency jobs differ in several important aspects from California employment overall. First, they disproportionately hire men, while Blacks are underrepresented, particularly in occupations in architecture/engineering, building envelope construction, and management. Second, younger workers are relatively underrepresented in energy efficiency jobs, and older workers dominate certain occupational groups, in particular (e.g., architecture/engineering, building envelope performance, mechanical and electrical trades). Not surprisingly, given the diversity of occupations funded by energy efficiency investment, educational qualifications vary significantly, with concentrations of workers with both very little education (e.g., construction laborers) and university degrees (e.g., engineers). In general, job quality is relatively high, with higher wages and health insurance benefit levels than in the California workforce as a whole, although these conditions may vary considerably both between and within occupational groups.

In 2009, over 4.3 million Californians worked in one of the nine occupation groups, representing about 23 percent of California's 18.5 million workers (Table 3.16). For comparison, we include the total number of workers that are at least in part funded by energy efficiency investment in California in 2009 (14,834). Almost one-half million workers in energy efficiency related occupations were unemployed in 2009. Over 60 percent of these jobs are in administration or management occupations. The largest affected group, general administration occupations,

[51] The ACS uses a different occupational coding system (the Census Occupation Codes (COC) instead of the Standard Occupational Codes (SOC), the 77 SOC occupations correspond to just 63 COC occupations.

includes business operations specialists and first line supervisors of office and administrative support workers. Among the largest occupations in sales-related administration are sales and customer service representatives and cost estimators.

Table 3.16 2009 Employed and Unemployed Workers by Energy Efficiency Related Occupational Group

Energy Efficiency Related Occupational Group	Employed Workers	Workers Partially Funded by Energy Efficiency Related Investment	Unemployed Workers	Unemployment Rate
Administration (General)	1,141,291	1,109	83,458	6.8%
Administration (Sales-Related)	718,383	955	75,406	9.5%
Architecture and Engineering	277,298	1,256	19,513	6.6%
Building Envelope (Construction)	482,872	1,679	119,985	19.9%
Building Envelope (Performance)	13,040	192	1,160	8.2%
Management (Blue-Collar)	346,631	896	30,725	8.1%
Management (White-Collar)	869,246	474	57,027	6.2%
Manufacturing	185,739	405	17,122	8.4%
Mechanical and Electrical Trades	289,067	7,868	55,369	16.1%
Total Energy Efficiency Related Occupational Groups	4,323,567	14,834	459,765	9.6%
Total California Workforce	18,541,318	—	2,086,740	11.3%

Source: American Community Survey, 2009; authors' calculations.

The construction trades are a large component of California's energy efficiency related occupations. In particular, workers in mechanical and electrical trades, as well as building envelope (or building performance) workers, such as energy auditors, are the most likely to be funded by energy efficiency investment: 2.7 percent of mechanical and electrical trades workers and 1.5 percent of building performance workers are funded by energy efficiency. Among the largest energy efficiency occupations in this group are several related to the building envelope: construction laborers, carpenters, drywallers, and first-line supervisors of construction trades workers. Other occupations that employ sizeable numbers of Californian workers are in the mechanical and electrical trades, including sheet metal workers; electricians; pipelayers, plumbers, pipefitters, and steamfitters; construction helpers; and HVAC workers (heating, air conditioning, and refrigeration mechanics and installers). In management, construction managers and general and operations managers employ high numbers of workers. In architecture and engineering, civil engineers stand out as one of the larger occupations.

Overall there is a large gender imbalance in energy efficiency-related occupations (see Table 3.17). Women are much better represented in administration, management, and manufacturing than they are in the building envelope and mechanical and electrical trades. Within building envelope occupations, women are more highly represented in construction supervision. In the mechanical and electrical trades, women stand out most in the fields of elevator installers and repairers, and also compose a disproportionate share of mechanical installation, maintenance, and repair helpers. Within architecture and engineering, women have highest representation among industrial engineers and engineering technicians.

Table 3.17 2009 Employment by Gender for Energy Efficiency Related Occupational Groups

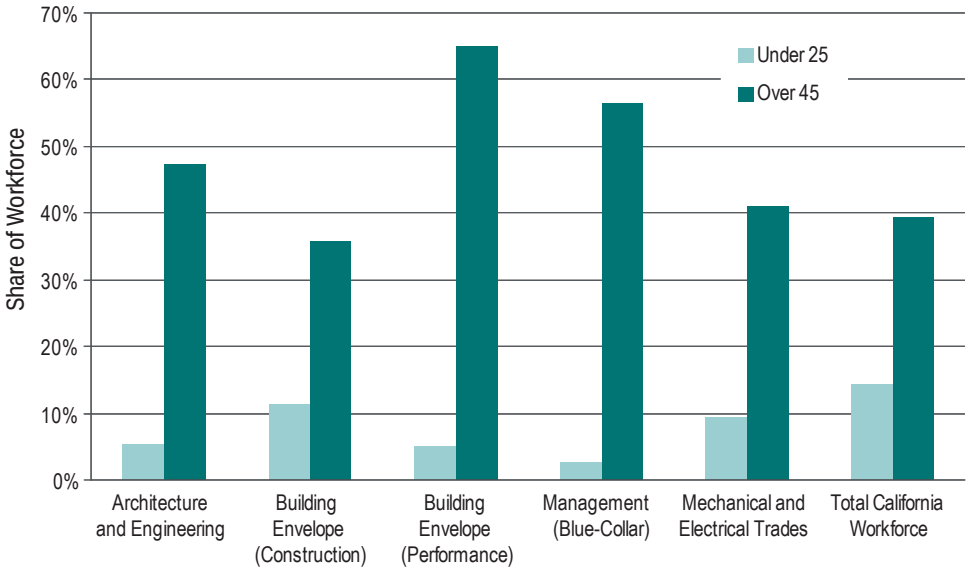
Energy Efficiency Related Occupational Group	Male	Female
Administration (General)	64%	36%
Administration (Sales-Related)	55%	45%
Architecture and Engineering	85%	15%
Building Envelope (Construction)	98%	2%
Building Envelope (Performance)	89%	11%
Management (Blue-Collar)	70%	30%
Management (White-Collar)	62%	38%
Manufacturing	68%	32%
Mechanical and Electrical Trades	97%	3%
Total Energy Efficiency Related Occupational Groups	71%	29%
Total California Workforce	55%	45%

Source: American Community Survey, 2009.

Understanding the age distribution within an occupation helps to identify opportunities for succession; as workers retire, more junior colleagues move up the career ladder and openings occur at the entry-level. Figure 3.10 shows the concentration of workers under 25 and over 45 years of age for the five occupational groups that include most of the significant energy efficiency occupations, as well as for California as a whole. Among the occupations with a higher percentage of people under 25 are low-level administrative positions (receptionists, customer service representatives, and office clerks), construction trades helpers, and construction laborers. HVAC mechanics and installers are also generally younger than workers in other construction occupations like electricians or carpenters. Among the occupations with the highest percentage of workers in the 25 to 44 year age group, are electricians, sheet metal workers, construction laborers, plumbers, carpenters, and drywall and ceiling tile installers. Engineering managers and construction managers are among the occupations with the most disproportionate concentration of workers in the 45 to 64 year age group. For the construction trades, first line supervisors and plumbers had the highest percentages of workers between 45 and 64 years old.

In the energy efficiency occupational groups, Whites and Asians are generally overrepresented, while Blacks and Latinos (Hispanics) are underrepresented (Table 3.18). However, the reader should use caution when interpreting this data, since the ACS may undercount the immigrant, particularly Latino, workforce. Management, administrative, and sales jobs have a high proportion of Whites, relative to their 44 percent of the total state workforce. Whites make up a disproportionate share of cost estimators, management analysts, construction managers, engineering managers, and general and operations managers. The proportion of Hispanics is considerably higher than other racial and ethnic groups in construction occupations. Hispanics are concentrated in the following occupations: drywall and ceiling tile installers, construction laborers, construction helpers, carpenters, plumbers, and HVAC mechanics and installers. In the construction trades, only Whites come close to these numbers, making up a disproportionate share of electricians, first-line construction supervisors, and HVAC workers. Asians are best represented as engineering managers, civil engineers, and business operation specialists. The occupation with the highest percentage of Blacks is customer service representatives; Blacks are generally underrepresented in the construction trades.

Figure 3.10 2009 Share of Workers Under 25 and Over 45 Years Old, Selected Energy Efficiency Occupational Groups



Source: American Community Survey, 2009.

Table 3.18 2009 Employment by Race/Ethnicity for Energy Efficiency Related Occupational Groups

Energy Efficiency Related Occupational Group	Non-Hispanic White	Non-Hispanic Black	Non-Hispanic Asian & Pacific Islander	Non-Hispanic Other	Hispanic
Administration (General)	48%	5%	19%	2%	26%
Administration (Sales-Related)	54%	6%	13%	2%	26%
Architecture and Engineering	50%	3%	31%	3%	13%
Building Envelope (Construction)	38%	3%	4%	2%	54%
Building Envelope (Performance)	77%	4%	7%	1%	11%
Management (Blue-Collar)	66%	3%	10%	2%	19%
Management (White-Collar)	64%	4%	15%	3%	14%
Manufacturing	36%	4%	15%	2%	43%
Mechanical and Electrical Trades	47%	5%	6%	3%	40%
Total Energy Efficiency Related Occupational Groups	52%	4%	14%	2%	28%
California Workforce	44%	6%	13%	2%	35%

Source: American Community Survey, 2009.

Because of the concentration of administrative and management occupations in energy efficiency related occupations, the workers in these occupational groups are generally better educated than the California workforce as a whole (Table 3.19). In terms of specific energy efficiency related occupations, the highest numbers of university degree holders are among civil engineers, general and operations managers, and other business operations specialists. The highest proportions of workers in the top 18 occupations who had not completed high school were among carpenters; construction laborers; construction trades helpers; and drywall and ceiling tile installers.

Table 3.19 2009 Employment by Educational Attainment for Energy Efficiency Related Occupational Groups

Energy Efficiency Related Occupational Group	No High School	High School Diploma	Some College	University Degree
Administration (General)	12%	14%	19%	55%
Administration (Sales-Related)	7%	20%	32%	41%
Architecture and Engineering	2%	6%	17%	76%
Building Envelope (Construction)	36%	33%	22%	9%
Building Envelope (Performance)	3%	18%	34%	46%
Management (Blue-Collar)	6%	17%	28%	49%
Management (White-Collar)	3%	10%	21%	66%
Manufacturing	20%	29%	27%	23%
Mechanical and Electrical Trades	19%	35%	32%	14%
Total Energy Efficiency Related Occupational Groups	12%	19%	24%	45%
Total California Workforce	16%	21%	25%	38%

Source: American Community Survey, 2009.

Energy efficiency related workers are distributed across different firm sizes in similar proportions to California's workforce as a whole (Table 3.20). Among the top energy efficiency occupations, construction laborers and helpers; pipelayers, plumbers, pipefitters, and steamfitters; and heating, air conditioning, and refrigeration mechanics and installers are most likely to be concentrated in small firms (fewer than ten employees). Business operations specialists are the most likely of all energy efficiency occupations to work in a large company with more than 1,000 employees, followed by customer service representatives and office clerks.

Table 3.21 shows the mean hourly wages for the nine occupational groups. Readers should treat these data with caution. Studies have shown that wage data collected as part of the Current Population Survey under report wages for independent contractors and "informal" workers. In addition, mean wages may be distorted by a few highly paid individuals (or outliers). In general, managerial and professional workers in California earn the highest wages among the energy efficiency-related occupations, while the construction occupations have the lowest. Despite enjoying, in general, higher pay rates, some professional occupations such as cost estimators, drafters and other business operations specialists have hourly wages below $30. Among administrative and sales positions, sales representatives are the best paid, followed by first-line supervisors of office and administrative support workers. The least well paid are receptionists and information clerks, office clerks and secretaries. In construction, workers in the residential sector earn just 80 to 90 percent of what their counterparts in the commercial sector earn.

Table 3.20 Employment by Firm Size for Energy Efficiency Related Occupational Groups, 2008

Energy Efficiency Related Occupational Group	Under 10 Employees	10 to 24 Employees	25 to 99 Employees	100 to 499 Employees	500+ Employees
Administration (General)	22%	6%	12%	13%	47%
Administration (Sales-Related)	25%	8%	11%	11%	44%
Architecture and Engineering	10%	5%	15%	13%	58%
Building Envelope (Construction)	36%	19%	16%	12%	17%
Building Envelope (Performance)	16%	12%	13%	0%	59%
Management (Blue-Collar)	30%	11%	17%	13%	28%
Management (White-Collar)	26%	8%	14%	13%	40%
Manufacturing	12%	8%	22%	21%	36%
Mechanical and Electrical Trades	26%	11%	22%	15%	27%
Total Energy Efficiency Related Occupational Groups	25%	9%	15%	13%	38%
Total California Workforce	26%	10%	14%	12%	39%

Source: Current Population Survey, 2008.

Table 3.21 Mean Wages for Energy Efficiency Related Occupational Groups, 2008

Energy Efficiency Related Occupational Group	Mean Hourly Wage
Administration (General)	$31.84
Administration (Sales-Related)	$37.06
Architecture and Engineering	$40.03
Building Envelope (Construction)	$36.54
Building Envelope (Performance)	$21.24
Management (Blue-Collar)	$52.01
Management (White-Collar)	$47.82
Manufacturing	$27.64
Mechanical and Electrical Trades	$21.95
Total Energy Efficiency Related Occupational Groups	$37.46

Source: California Employment Development Department, 2009.

Table 3.22 shows the extent and type of health insurance coverage for energy efficiency-related occupations. Overall, 82 percent of workers have some insurance and 18 percent are uninsured, compared to the 65 percent of California's workforce who have some insurance and 35 percent who are uninsured. However, for all construction occupations, the percentage of people covered by any insurance is considerably less than the California average. The lowest levels of insurance coverage for construction are for construction laborers and drywall and ceiling tile installers. Most likely to be covered in construction positions are HVAC mechanics and installers and electricians. The energy efficiency workers who are most likely to be covered by any kind of insurance are those in management and professional occupations.

Table 3.22 Health Coverage for Energy Efficiency Related Occupational Groups, 2008

Energy Efficiency Related Occupational Group	Not Insured by Employer	Insured by Employer
Administration (General)	24%	76%
Administration (Sales-Related)	27%	73%
Architecture and Engineering	10%	90%
Building Envelope (Construction)	65%	35%
Building Envelope (Performance)	0%	100%
Management (Blue-Collar)	27%	73%
Management (White-Collar)	17%	83%
Manufacturing	22%	78%
Mechanical and Electrical Trades	28%	72%
Total Energy Efficiency Related Occupational Groups	28%	72%
Total California Workforce	35%	65%

Source: Current Population Survey, 2008.

3.6.3 PROJECTING FUTURE ENERGY EFFICIENCY LABOR SUPPLY IN CALIFORNIA

In order to determine the future need for workforce education and training, it is important to understand California's future labor force. Over the next decade, the California labor force is expected to grow about one percent per year. This natural growth includes both new job openings and replacement job openings (due to retirements and turnover), and it will mean about one-half million new workers in energy efficiency related occupations by 2020 (or about one-fourth of the California workforce; see Table 3.23). The labor force in energy efficiency occupations will continue to include a significant number of unemployed workers, although the number is anticipated to decline from current levels under both scenarios. Under the Low Unemployment Scenario (4 percent unemployment in 2020), the number of unemployed drops from 460,000 in 2010 to 177,000. Even under the High Unemployment Scenario (7.9 percent in 2020), the number of unemployed will decrease by over half, to 213,000. However, the unemployment rate in the largest construction trades (building envelope and mechanical and electrical trades) is still anticipated to be significantly higher than that in the state overall. The next section evaluates these labor supply projections in light of the numbers of workers needing training in energy efficiency, demand response, and distributed generation occupations.

Table 3.23 Projections for Employed and Unemployed Workers by Energy Efficiency Related Occupational Group in 2020

Energy Efficiency Related Occupational Group	Employed Workers	Low (4%) Unemployment Scenario, # Unemployed Workers	High (8%) Unemployment Scenario, # Unemployed Workers
Administration (General)	1,304,565	32,232	38,882
Administration (Sales-Related)	812,083	29,866	36,027
Architecture and Engineering	301,736	6,794	8,196
Building Envelope (Construction)	563,331	47,916	57,802
Building Envelope (Performance)	15,232	330	398
Management (Blue-Collar)	370,634	11,633	14,033
Management (White-Collar)	932,371	21,454	25,880
Manufacturing	179,628	5,718	6,897
Mechanical and Electrical Trades	327,734	20,693	24,962
Total Energy Efficiency Related Occupational Groups	4,807,315	176,636	213,079

Source: Calculations by the authors based upon American Community Survey, 2009 and California EDD Occupational Projections, 2008-2018.

3.7 MATCH BETWEEN LABOR DEMAND AND SUPPLY

In the year 2020, the number of job openings partially funded by energy efficiency investment will be significantly lower than the number of unemployed workers. For instance, with 47,816 unemployed workers in the building envelope construction trades, there will be just 1,966 net new energy efficiency positions in that occupational group in 2020. The total from 2010 to 2020 is significantly higher, at 37,282, but unemployed workers in the early years of the decade will quickly absorb those openings. For the purposes of the Needs Assessment, it is assumed that employers will hire these unemployed workers, because they are more experienced, before tapping into the pipeline of newly trained workers. Thus, until the queue of unemployed workers is absorbed, there will be limited opportunities for newly trained workers.

Although the state overall is experiencing a surplus of workers in energy efficiency related occupations—a surplus expected to continue through the next decade—it is possible that individual metropolitan areas with significant energy efficiency and related investment will see shortages in certain occupations. To determine whether any localized shortages will occur, a gap analysis compared future projected labor demand to labor supply by metro and occupation. Specifically, we looked at projected workers needing training in the 77 energy efficiency related occupations in 2020 and compared this number to the projections of new and unemployed workers in these occupations in 2020 (using the Low Unemployment Scenario). In each metropolitan area, for each occupation, there was either a surplus, meaning more new and unemployed workers than workers needing training, or deficit, with more workers needing training than are available from the pool of new and unemployed workers. In the 42 regions (including 36 metropolitan areas or counties and 6 rural regions) and 77 occupations evaluated, there were surpluses in 1,659 occupations and deficits in 411. However, no deficit reached more than 14 workers, not enough

to warrant a single training program. Table 3.24 shows the top five occupations in surplus, as well as the top five in deficit, in particular counties in 2020. The top five in surplus, indicating an excess labor supply, are all projected to be in Los Angeles, numbering in the thousands of workers. The top five in deficit in 2020 are from smaller counties, but the deficits are projected to be very low.

Table 3.24 Top Five Occupations in Surplus or Deficit in 2020 by County

County	Occupation	2020 Gap (Surplus/Deficit)
Los Angeles	Construction Laborers	6,418
Los Angeles	Customer Service Representatives	5,379
Los Angeles	Carpenters	3,870
Los Angeles	Janitors and Building Cleaners	2,922
Los Angeles	Managers, All Other	2,726
Orange	Wholesale and Retail Buyers, Except Farm Products	-9
Contra Costa	Sheet Metal Workers	-11
Fresno	First-line Supervisors / Managers of Production and Operating Workers	-12
San Bernardino	Helpers, Construction Trades	-12
Orange	Helpers, Construction Trades	-14

It is likely that the universe of workers needing training related to energy efficiency and related activities will include not only those hired to fill the new jobs generated by energy efficiency and related investment, but also workers in existing positions. For instance, energy efficiency policies and investments will create some new jobs for electricians who need training, mostly those working in some form of construction. But technologies related to energy efficiency will also impact tens of thousands more electricians whose work is not solely in those areas. For instance, some electricians will be funded by energy efficiency investment to install energy-saving devices in supermarkets. Other electricians work in supermarkets that are not participating in energy efficiency incentive programs. Still, these electricians will need re-skilling as well, as energy-saving devices become standard. The aggregate numbers are significant: for instance, the EDD projects that there will be 64,000 electricians in California in 2018, while this study estimates just 4,800 total direct job person-years for electricians by 2020. Future research might estimate workers in these occupations that will undergo some evolution of skills, even if they are not directly related to the specific investments generated by the policies and programs analyzed here.

3.8 CONCLUSION

This chapter provided projections of the need for job training in California's energy efficiency occupations in 2010, 2015, and 2020. These projections rely on a careful seven-step methodology. To review, the analysis first estimates the public and private investment from energy efficiency-related policies and programs (step 1), develops investment scenarios (step 2) and then assigns demand to specific industries (step 3). Next, the E-DRAM model estimates indirect and induced job creation (step 4), while IMPLAN input-output model is used to translate the investment into direct jobs created in California (step 5). These jobs are then converted into numbers of workers that need training (step 6) for different California geographies (step 7).

Readers will want to keep several factors in mind when interpreting the numbers. First, the analysis is limited to energy efficiency and related industries, not only because of the limited scope of the EE Strategic Plan, but also

because the WE&T Needs Assessment focuses on job training needs relevant to energy efficiency and related activities. Since these industries comprise just one subsector of the green economy, these numbers are not comparable to those produced by many other studies that look either at the entire green economy or the impacts of clean energy investment on the economy as a whole. Second, these numbers do not simply represent job opportunities; rather, investment will help fund the part of a particular job in a particular occupation that is engaged in energy efficiency activity. Finally, this new labor demand must be assessed in the context of the California labor supply, since existing workers, many of whom have been idled by the recession, will absorb some of the new demand.

To review the highlights of this analysis, we estimate that by 2020 California will spend $11.2 billion on energy efficiency activities, according to the Medium Scenario. This demand will stem from a combination of public expenditures (including ratepayer-funded utility programs), and leveraged investments from private market actors (e.g., residential consumers and businesses). This is the level of demand that we characterize as investment-induced spending, and does not include all forms of private investments in energy efficiency. We project that this level of demand will result in a total impact in 2020 (including 2009) of over 211,000 total job person-years including all indirect and induced jobs (result of multiplier effects). However, this figure includes many jobs in the local service sector that do not relate to energy efficiency and are gained mainly from consumers and businesses devoting fewer dollars to energy use.

For the purposes of this WE&T Needs Assessment, the more important figure is the number of direct jobs in energy efficiency related industries that will require training. Using our unique "hybrid" methodology we estimate that by 2020, policy-driven investments will generate 52,371 total new job-years (38,937 over the 2009 baseline) and will require some level of training for 78,204 workers over the ten-year period, although for the general administrative and management occupation this may be minimal. The training need will fluctuate by year as investment fluctuates, and a large portion of these workers will need training during the ARRA years due to the spike in investment at that time. In any given year, the number of unemployed workers in energy efficiency related occupations will greatly exceed the number of new jobs created. Thus, the need for energy efficiency training is largely for incumbent workers.

This study did not specifically analyze the job creation potential of different investment strategies; further research is necessary to determine the most effective way to leverage energy efficiency and related investment in order to create jobs. However, these findings do suggest several general approaches the state might take. In order to create more energy efficiency and related jobs in California, the state should target programs with a higher yield of jobs per investment dollar (as ARRA did)—while still ensuring job quality, as suggested in Chapter 4. Most of the manufacturing jobs generated by this policy-driven energy efficiency investment will be created outside California unless public policy strategies are implemented to capture them in the state, for instance by requiring that the public sector purchase energy-efficient goods and services made locally. Finally, given the amount of labor market expertise in the energy efficiency and related industries, the state might also work to promote exports in energy efficiency and related industries to create more jobs. However, developing estimates as to how many jobs are likely to result from investment generated outside of California was outside the scope of this study.

CHAPTER FOUR:

4. CASE STUDIES OF THE HVAC, RESIDENTIAL RETROFIT, AND COMMERCIAL LIGHTING CONTROLS SECTORS

"Do it right the first time. Quality comes not from inspection, but from improvement of the process."

~ Dr. W. Edwards Deming

4.1 INTRODUCTION

In the first chapters of this report we examined the changes in labor demand that will result from energy efficiency and related policies and programs. In Part Two, we assess the capacity of our current workforce infrastructure to meet the changing labor demand. The purpose of this chapter—the sector case studies—is to better understand how policy interventions and market dynamics impact the state's ability to achieve both its energy and workforce related policy objectives. Specifically, we bring to light the issues that need to be addressed to ensure that energy efficiency and related work is performed at the standard necessary to achieve energy savings goals. We also examine the workforce impacts of energy efficiency policies and programs and ways to ensure that policy is creating jobs with livable wages, advancement opportunity, and pathways out of poverty for California workers. Building the high road entails developing strategies to meet both energy and workforce goals, and we shed light on the feasibility, trade-offs, and costs associated with strategies to do so.

In order to look closely at business and labor market dynamics, this chapter drills down into three submarkets: (1) the heating, ventilation, and air conditioning (HVAC) market; (2) the residential energy efficiency retrofit market; and (3) the commercial lighting market. These sectors have been selected because of their substantial contribution to total energy consumption and peak energy demand and their potential to lower energy use, and because they are illustrative of many of the workforce issues encountered in other sectors.

4.1.1 WORKFORCE ISSUES AFFECTING ENERGY SAVINGS OUTCOMES

Although workforce issues are not the sole factor affecting energy savings outcomes, there is clearly a connection between the number of trained workers, the quality of work performed, and the level of energy savings that will be achieved. When the California Long Term Energy Efficiency Strategic Plan (EE Strategic Plan) was created, there were serious concerns about an inadequate supply of experienced workers in the key occupations needed for expansion of the energy efficiency sectors. The landscape has since changed dramatically and earlier concerns have been reversed by the recession, since many skilled trades and construction workers are now unemployed. Confirming the quantitative analysis of Chapters 3, our interviews revealed a widespread view that worker shortages do not currently exist and that, at present, there is a surplus, rather than a gap, in training programs.

How long this surplus will continue depends in part on the length of the recession.[1] Although the policymakers, utility program managers, and industry experts that we interviewed are not concerned, at present, about the quantity of available workers, they consistently emphasize the issue of work quality. The term "high quality work" is used here to mean workmanship that results in proper the installation, maintenance, and operation of energy efficient equipment, (e.g., HVAC) and materials (e.g., insulation). The following are some of the most critical and commonly cited issues arising from poor work quality:

- → UNREALIZED ENERGY SAVINGS: In HVAC change-outs and maintenance, insulation work, advanced lighting controls and other energy efficiency work, incorrect installation is commonly reported and has been found to result in significant levels of unrealized energy savings.
- → SAFETY: Poor quality work also leads to safety concerns for occupants and workers.
- → CONSUMER SATISFACTION: Since market expansion is significantly dependent on word-of-mouth advertising and other social marketing, dissatisfaction resulting from inadequate work quality can significantly undermine sector growth.
- → LENDING CONSTRAINTS: Since market expansion is dependent on financing, quality verification and standardization is necessary to assure lending institutions that income from energy savings paybacks will be available to service loans. Investment grade audits are still limited to very large commercial buildings where the payback is sufficient to warrant the high cost of such audits.

4.1.2 WORKFORCE GOALS AND OUTCOMES

Throughout the sectors profiled here, concerns about the workforce outcomes of investments from energy efficiency programs and policies also surfaced. These concerns were voiced particularly by educators and trainers, low-income advocates, union representatives and elected officials. The workforce goals can be characterized by three interrelated components: (1) the quantity of jobs that these public policies generate and leverage; (2) the quality of jobs in terms of wages, benefits, career pathways; and (3) the accessibility of jobs for Californians from low-income, minority and disadvantaged communities.

The availability of jobs for training graduates is clearly on the minds of these stakeholders. Yet the quantity of jobs is not the only concern; job quality, and the existence or lack of career pathways that reward workers as they move up the skill and experience ladder are also critical. Attention to what types of jobs are being supported in these industries will also become more prevalent as the use of taxpayer and ratepayer funds is expanded to subsidize retrofits for middle- and upper-income households. Finally, who gets the available jobs and the extent to which disadvantaged workers have opportunities to obtain them is a key question to be addressed.

Workforce development providers may be reluctant to train for the historically low-wage jobs in the residential construction industry. For example, the Los Angeles Workforce Investment Board (WIB) Executive Director, stated it bluntly:, "We don't fund training for low-wage jobs." Some funders and training organizations will only support training for career tracks that provide workers with a strong wage floor and a wage progression tied to skill acquisition. In addition to these groups' concerns about placing their students/trainees in living-wage jobs, the high turnover rates common in low-wage occupations mean that training investments in those occupations are often squandered as training program graduates leave the field after a short time. Under these circumstances, the workforce development community faces the challenge of how to build career ladders from low-wage, entry-level jobs, and/or to improve conditions in the low-wage jobs themselves.

[1] Part Two addresses questions about the longer-term capacity of the state's workforce infrastructure.

As in many industries, there is a perceived trade-off between ensuring high quality energy efficiency work and providing that work at a price that consumers are willing to pay. Although there certainly are limits to what the market can bear, this trade-off between cost and quality has not been well-documented or studied. The emphasis on the trade-off does not take into account the value that high quality work provides in achieving the energy efficiency goals of the state.[2] In some cases, investing in a better compensated, more highly skilled workforce leads to productivity improvements that offset the higher wage bill. Research in the construction industry that compares public works projects carried out with and without prevailing wages shows similar overall cost, as employers are able to compensate for higher wages through the use of more highly skilled workers.[3] In other cases, investing in a more highly-skilled workforce enables firms to compete in a higher-quality, higher-price market.

The three case studies that follow illustrate these connections and trade-offs, as well as the potential dangers of allowing the development of a low road market in which workers are not compensated for their skills, so investment in training is low, turnover is high, work quality suffers, and we achieve neither our energy savings nor our workforce goals as a result.

4.1.3 METHODOLOGY AND CHAPTER ORGANIZATION

The sector case studies presented in this chapter are based on both quantitative and qualitative data gathered through in-depth interviews with 20 to 30 experts in each sector, a review of the existing research literature and utility and CPUC program documents, and a limited analysis of data from the Quarterly Census of Employment and Wages, the California Employer Survey, and the Current Population Survey.[4] Interviewees included utility program staff, contractors, training providers, technical experts, and policymakers. A partial list of interviewees is included in Appendix M.[5]

This chapter is organized by sector, with HVAC presented first, then residential retrofit and, finally, commercial lighting. Figure 4.1 provides the framework for our analysis of each sector. Program design and policy combine with market dynamics to influence the conditions of the labor market. As discussed above, labor market conditions have an impact on work quality and thus, ultimately, on energy savings. These labor conditions also have an impact on the quantity, quality and accessibility of jobs—that is, on worker outcomes. In order to contextualize the analysis of each sector, each section begins with an overview of the market and policies pertaining to that sector, followed by a description of existing labor conditions. We then assess the impact of these factors on the workforce and energy savings outcomes for each sector, and discuss new policy directions and lessons learned.

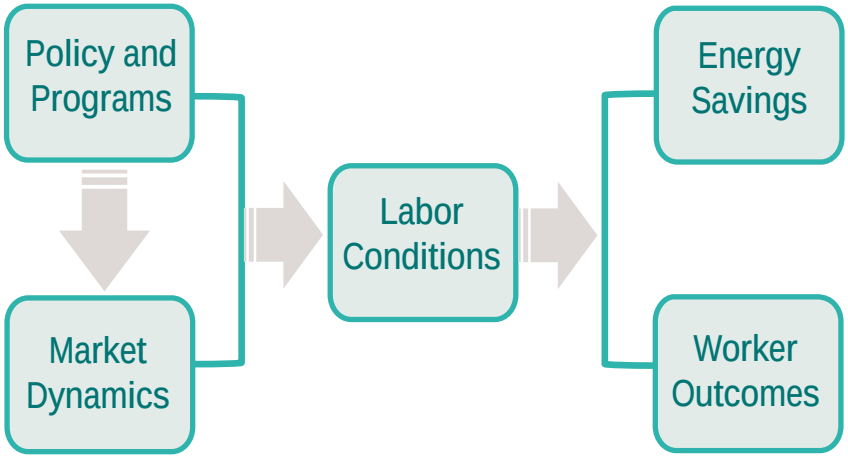
[2] There is substantial theoretical and empirical research in the Economics literature asserting the correlation between work quality and job quality. See for example the seminal work: Akerlof, G., & J. Yellen (1986). "Efficiency Wage Models of the Labor Market," *Handbook of Labor Economics*. Cambridge: Cambridge University Press.

[3] Mahalie, N. (2008), "Prevailing wages and government Contracting costs A review of the research," EPI Briefing Paper #215. Retrieved from: http://www.epi.org/publications/entry/bp215.

[4] Unfortunately, the sample size and/or level of disaggregation of these data sources limited their usefulness for this analysis.

[5] The names of the contractors and workers we interviewed are withheld.

Figure 4.1 Framework for Sector Case Studies



Clearly this model is somewhat simplified and there are myriad other factors affecting energy savings and workforce outcomes. However, this framework illustrates the role of energy efficiency policy and programs in determining workforce outcomes, as well as the connection between labor conditions, work quality, and energy savings outcomes. Each case study examines how these dynamics play out in a specific sector, to illustrate some of the ways that policy interventions can and have been used to try to improve both energy and workforce outcomes, and what the trade-offs are of doing so. There are lessons to be learned from each sector, but also lessons to be learned from comparing all three. Thus, the case studies are followed by a set of conclusions and lessons that apply more broadly to other sectors relevant to the WE&T Needs Assessment.

4.2 HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

California's EE Strategic Plan identifies the HVAC industry as a key target for major restructuring, for a variety of reasons. First and foremost, heating and cooling buildings is one of the largest electricity end uses in the state and is also the single largest contributor to peak power demand, composing up to 30 percent of total demand in the hot summer months.[6] In addition, HVAC energy use has continued to grow over time, as air conditioning in homes and offices has become more prevalent and housing stock growth shifts to the hotter regions of the state. Second, certain segments of the HVAC industry are beset by issues of poor quality installation and maintenance. In a 2008 report by the California Energy Commission (CEC) estimates that as many as 50 percent of all new HVAC systems and 85 percent of all replacement systems are not installed to a quality specification, resulting in a huge loss of potential energy savings.[7] Finally, as the state seeks to achieve deeper energy savings, the adoption of more sophisticated control technologies, products that cater to California's climate and more integrated whole-building approaches will be key components to achieving energy savings. These changes will require that HVAC system

[6] California Public Utilities Commission (2008b). *Long Term Energy Efficiency Strategic Plan: Achieving Maximum Energy Savings in California for 2009 and Beyond,* page 58. Retrieved from: http://www.cpuc.ca.gov/NR/rdonlyres/D4321448-208C-48F9-9F62-1BBB14A8D717/0/EEStrategicPlan.pdf.

[7] Messenger, M. (2008). *Strategic Plan to Reduce the Energy Impact of Air Conditioners.* California Energy Commission Staff Report (CEC-400-2008-010). p. 30. Retrieved from: http://www.energy.ca.gov/2008publications/CEC-400-2008-010/CEC-400-2008-010.PDF.

designers and technicians develop skills to properly use new technologies and cultivate a more integrated understanding of building systems.

In light of these issues, the EE Strategic Plan has set the goal of improving HVAC performance 50 percent by 2020 and 75 percent by 2030 and identifies the following strategies for transforming the sector:[8]

- → Compliance, enforcement, and verification of existing standards;
- → Mainstreaming of quality installation and maintenance practices;
- → Integration of HVAC systems into whole-building systems design; and
- → Development of climate appropriate HVAC technologies.

4.2.1 MARKET DYNAMICS

As in many areas of the construction industry, there are a number of subsectors or market segments within the larger HVAC sector. Most IOU programs in the HVAC sector target residential and commercial HVAC separately and some programs further distinguish between large commercial and small commercial market segments. These market segments are based partially on the differing technical requirements of the equipment in these different building types and partially on the resources and behavior of the customers in each segment.

For the purposes of this analysis, we have grouped the residential and small commercial market segments together, because, technical considerations aside, these markets share many characteristics. The small commercial and single-family residential market segments are highly competitive and price-driven. Consumers in these segments have difficulty distinguishing contractors on the basis of quality, because many of the attributes that contribute to energy efficiency—such as unit sizing, duct sealing, air flow, and refrigerant charge—cannot be easily appraised by most consumers. Barriers to entry for firms in these market segments are fairly low, but an estimated 25 percent of all HVAC firms go out of business in a given year.[9] This undermines professionalism and regulatory compliance. Since most homeowners and small commercial building owners do not recognize the benefits of quality installations, contractors who are committed to quality installation practices, which can raise costs by as much as 40 percent, are disfavored in the market. The CEC estimates that less than 10 percent of HVAC work is performed under legally required building permits, which trigger compliance with the minimum performance standards required by building codes.[10] Because of these issues of quality and non-compliance, we refer to these as "low-road" market segments, in which competitive advantage is gained primarily through cutting costs rather than through quality services.[11]

In contrast, the larger firms serving the large commercial and institutional markets tend to be more stable, adhere to existing standards, and compete on the basis of quality. The more complex technical requirements and sheer size of larger buildings require that firms have high levels of technical expertise, numerous highly skilled installers and service technicians, and greater capital investment in equipment. These factors make it difficult for firms to start up without a great deal of experience, training investment and initial capital. In many cases, large commercial building owners are also very knowledgeable about the energy consumption in their buildings and they may have dedicated energy management staff. Thus, large commercial and institutional building owners tend to understand the payback benefits of properly installed and maintained equipment, making them more inclined to invest in high

[8] CPUC 2008b, p. 58.

[9] San Diego Gas & Electric (2006-2008). HVAC Training, Maintenance, and Installation Program Implementation Plan (SDGE3043). Available at http://eega2006.cpuc.ca.gov/DisplayPlans.aspx?ID=9.

[10] California Energy Commission, 2008, p. 17.

[11] See Chapter 1 for a definition of high-road and low-road development.

quality work up front. Table 4.1 shows some characteristics of these segmented markets in the HVAC industry. *This does not imply that all individual firms operating within the low-road markets are low quality, but rather that the market conditions they all face favor low quality*.

Table 4.1 Segmented Markets in HVAC*

	High Road	Low Road
Market Segments	• Large owner-occupied commercial • Public buildings	• Residential • Small commercial
Average Firm Size	Large	Small
Permit Compliance	High	<10%
Firm Turnover	Low	25% annually
Barriers to Entry	High	Low
Reported Quality Problems	Very low	Very high

* This segmentation is our own analysis based on interviews with HVAC experts, U.S. Census County Business Patterns data, and other sources listed in this document.

4.2.2 POLICY INSTRUMENTS AND PROGRAMS

The majority of energy efficiency programs directed at the HVAC sector come from ratepayer-funded programs, administered by utilities. There are also some federal programs of note, as well as statewide policies, regulations and codes, which are discussed below, but we focus primarily on the investor-owned utility programs that make up the bulk of HVAC-related energy efficiency investments in California.

4.2.2.1 REBATES AND INCENTIVES

Until very recently, energy efficiency incentive programs directed at the HVAC sector have focused on equipment replacement rebates. These rebates usually take the form of one of the following:

- DOWNSTREAM CONSUMER REBATES: Consumers apply for a rebate based on their proof of purchase of the eligible piece of equipment, and then hire a contractor to do the installation work.[12] Eligible equipment must meet certain ENERGY STAR-rating requirements. From 2006 to 2009, IOU rebates for HVAC equipment ranged from $50 to $300 per unit, depending on the equipment. These rebates are often referred to as "widget" rebates, as they prescribe particular equipment, which has been rated for energy efficiency.

- UPSTREAM INCENTIVES to manufacturers or distributors of HVAC equipment – Manufacturers or distributors receive incentives to buy down the cost of high efficiency equipment. This ensures that HVAC units sold in the state comply with or exceed Title 20 and Title 24 requirements and that these more efficient units are cost competitive with less efficient models.

[12] In some cases, consumers do the installation themselves, without a contractor.

Recently, there has been a dramatic shift in the strategy behind consumer rebates programs as part of a concerted effort by the CPUC and utilities to address the massive quality shortfalls in this sector. All IOU consumer rebates for HVAC equipment are now part of quality installation and quality maintenance (QI/QM) programs, which impose requirements on contractors up front, to ensure that equipment is installed to a quality specification. Sacramento Municipal Utility District (SMUD) has also recently implemented quality HVAC programs, which require that permits be pulled and HVAC installations be done by participating contractors in order to be eligible for rebates. This shift is not yet statewide; for example the Los Angeles Department of Water and Power (LADWP) still provides "widget" rebates on equipment without upfront requirements on installation quality. Table 4.2 provides an overview of current IOU programs targeting the HVAC sector.

The first residential QI/QM program is now underway at Southern California Edison (SCE) and the other IOUs have submitted program implementation plans for programs that will converge with SCE's in the next year. For the first time, these QI/QM programs provide significant rebates based on installation quality that, when added to state and federal incentives, are large enough to close the gap between a low bid, poor installation job and a high quality job. The programs set rigorous standards for contractor participation, including the requirement that 50 percent of technicians be certified by North American Technician Excellence (NATE).[13] Technicians or other employees are also required to attend mandatory training modules on load calculations and field commissioning. These training modules were added after commencement of the program, because although training in load calculations (Air Conditioning Contractors' Association Manuals J and N) are part of the course offerings at the Energy Training Centers, SCE program managers found that most contractors were unable to properly perform them.

Table 4.2 Statewide IOU Program Budgets for HVAC, 2010 to 2012*

Program	Budget	Description
Quality Installation & Quality Maintenance (QI/QM)	$65,129,148	A set of new programs tying consumer rebates to quality specifications in residential and commercial installation and maintenance. The only program underway is SCE's Residential Installation Program. For that program, new units must be installed to a quality specification by a contractor with at least 50 percent NATE-certified technicians. Also includes training requirements.
Upstream Incentives	$31,943,132	This program provides rebates to manufacturers and distributors (see above).
Workforce Education & Training (WE&T)	$10,185,146	This is a non-resource program dedicated to training at all levels of the HVAC value chain, particularly in the area of QI/QM.
Technology & Diagnostics	$19,510,819	This is a non-resource focusing on advocacy and coordination to promote more efficient HVAC technologies.
Core Umbrella-PIP (SDGE & SoCalGas only)	$101,057	Coordination and administration.
Total HVAC Budget	$126,869,302	

*In addition to the programs described in Table 4.2, Pacific Gas and Electric (PG&E) has added a $1.5 million third-party HVAC program known as Cool Cash, which provides audits and single measure incentives for commercial and industrial facilities. San Diego Gas and Electric (SDG&E) also has third party contracts covering residential HVAC at $5,573,279 and Commercial HVAC at $5,135,116.

The existing SCE program removes contractors that do not meet standards and has thus far only retained 25 percent of the contractors who were initially recruited into the program. According to SCE HVAC staff, the other 75 percent of contractors have been removed from the program because of their inability to meet quality standards or because they were taking advantage of the marketing benefits of the program without participating in

[13] NATE is the nation's largest non-profit offering independent third party certification for technicians in the HVAC industry. The organization tests technicians in basic and specialty areas, but does not offer any training. NATE's certifications are endorsed by most major HVAC industry organizations.

the quality installation work. This is an expensive program that is limited in scale and has yet to be evaluated, but represents a significant commitment to supporting quality contractors and technicians in this industry.

The IOUs are also devoting substantial resources to HVAC training. The budget for IOU training activities in the 2010–2012 for the HVAC sector is about $10 million dollars, and a needs assessment specific to HVAC is being planned. This represents a deepening focus on HVAC, which has already been one of the most prominent topic areas in the IOU Energy Training Centers' class offerings. According to the Opinion Dynamics evaluation of the IOU WE&T Energy Training Center programs for 2006–2008, the number of individuals participating in HVAC classes was about 44 percent of the total number of Californians working in the HVAC industry.[14] Though admittedly imprecise, this is an extremely high penetration rate. However, the effectiveness of this training is not well understood, particularly given the high worker turnover in the residential and small commercial sector. In this program cycle, the IOUs are developing programs to collaborate with other HVAC training organizations, in addition to continuing their class offerings. For a further discussion of training in the low road segments, see Section 4.2.3 and Chapter 13.

4.2.2.2 CODES AND STANDARDS

Contractors doing HVAC work must have a C-20 license issued by the Contractor State Licensing Board (CSLB). In order to get a C-20 license, contractors must pass an exam, covering the topics of planning, engineering and design; fabrication, installation and startup; troubleshooting; repair and maintenance; and safety. Although energy efficiency is integral to these topics, the exam does not explicitly emphasize the importance of efficiency considerations and experts have noted that the exam covers only very basic knowledge in each of the areas.[15] There is widespread agreement that the state's licensing requirements do not adequately test for competence. Moreover, they only cover business owners (contractors), not technicians, unlike in the electrical specialty trade where both electrical contractors and electricians must obtain a license in order to practice in California.

Most HVAC work, whether it is installation of a new system, or retrofitting of an existing one, also requires a local building permit and Title 24 compliance documentation, which must be completed by a licensed contractor. As mentioned above, compliance with building permit requirements is extremely low, particularly in the residential and small commercial HVAC markets. In some cases this is because the contractors doing the work are unlicensed. However, even licensed contractors report that in many cases customers request that permits not be pulled, in order to save costs, or to avoid the inspection of previously unpermitted work.[16] In most cases, city governments have very few resources for enforcing building codes and building inspectors, who are often unfamiliar with HVAC work, are not in a position to verify the quality of installations.[17]

As of 2008, Title 24, California's statewide Energy Efficiency Building Code has been revised to include a number of additional or updated measures intended to improve efficiency. These measures also require that particular testing and verification procedures be performed by a CEC certified Home Energy Rating System (HERS) rater.[18] Some in the industry fear that without strong accompanying enforcement measures, these efforts to tighten regulations could inadvertently bolster the unregulated underground segment of the market. Particularly in the current economy, in which cash is in short supply, property owners are reluctant to spend what they see as unnecessary

[14] Opinion Dynamics Corp. (2010). *PY2006-2008 Indirect Impact Evaluation of the Statewide Education & Information Programs*. Prepared for the California Public Utilities Commission Energy Division.

[15] Interviews with SCE HVAC Staff, 3/9/2010; 10/27/2010.

[16] Interview with CPUC Staff, 9/24/2010; Interviews with HVAC Contractors.

[17] Interview with SCE HVAC Staff, 3/9/2010.

[18] California Energy Commission (2011). 2008 HVAC Change-Out Information. Retrieved from: http://www.energy.ca.gov/title24/2008standards/changeout/.

money on code compliance when their concern is ensuring that their air conditioning works. Even when rebates are tied to permitting requirements, the rebates may be too low to compensate for the much greater cost of complying with codes.[19]

4.2.2.3 FEDERAL INCENTIVES

The federal government provides tax credits for energy efficiency investments, including upgrading to ENERGY STAR-rated HVAC equipment. Homeowners can qualify for a tax credit up to 30 percent of the cost of eligible equipment, up to $1,500. Commercial property owners who invest in HVAC systems that are rated 50 percent higher than American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standards can receive a tax credit of $0.60 per square foot. These are straight equipment incentives that are not tied to quality installation or maintenance requirements. In order to receive the credit, consumers must show a proof of purchase and a manufacturer's certificate documenting the energy rating of the equipment, but there is no verification of the installation. While the commercial tax credits were recently extended until 2013, tax credits for homeowners are set to expire at the end of 2010.

Another incentive program for homeowners, funded by the 2008 American Recovery and Reinvestment Act (ARRA), but administered through the CEC, is the Cash for Appliances program. This program is based on a one-time fund of $15.6 million to provide cash incentives for consumers who replace their appliances with models that exceed minimum Title 24 requirements.[20] Rebates up to $1,000 are available for qualifying HVAC equipment. Unlike the tax credits, this program requires that the equipment be installed by a licensed contractor, that ducts are tested and sealed, and that the contractor finalize all permitting and Title 24 documentation before the customer can receive a rebate. With over 5,000 applications for HVAC rebates since its inception, this program has been successful in pushing quality for some installations. However, this number still represents only a tiny fraction of all HVAC change-outs done in the state in an average year.[21]

4.2.2.4 JOINT INDUSTRY–GOVERNMENT MARKET TRANSFORMATION INITIATIVE: WESTERN HVAC PERFORMANCE ALLIANCE

Based on recommendations in the EE Strategic Plan, the Western HVAC Performance Alliance (WHPA), an industry stakeholder group, was formed to provide the California IOUs with input from the HVAC industry as implementation of the Plan proceeds. This task force represents an unprecedented collaboration between stakeholders and government agencies, and includes representatives of the major manufacturer, distributor, union and non-union contractor trade associations; all four investor-owned and some public utilities; a number of large individual contractors; the CPUC, CEC and other government agencies; the dominant third-party personnel certification bodies, such as NATE, HVAC Excellence, and United Association (UA) STAR; and multiple other industry stakeholders. It includes individual contractors in the residential and small and large commercial markets who are interested in growing the quality segments of the industry. These stakeholders are working together in committees devoted to implementing the market transformation strategies outlined in the EE Strategic Plan, including a newly convened workforce committee.

The goal of the task force is to upgrade the HVAC industry, transforming it into an industry where quality is recognized and rewarded. In its initial stages, the WHPA is focused on addressing compliance with existing

[19] Interviews with Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), 2/5/2010; Institute of Heating and Air-Conditioning Industries (IHACI), 9/1/2010.

[20] Current standards require that equipment have a minimum Seasonal Energy Efficiency Rating (SEER) of 13.

[21] The CEC reports that 346,322 residential central air-conditioning system replacements with energy savings potential occurred in California in 2006: Messenger, M., 2008, p. 31.

standards and mainstreaming quality installation and quality maintenance practices. These strategies involve working with the Contractor State Licensing Board (CSLB) to enforce licensing and permitting requirements, and with the CEC, the IOUs, and the California Building Officials (CALBO) to train Building Inspectors in new Title 24 requirements related to HVAC systems. Other committees and subcommittees are devoted to addressing each of the transformation strategies outlined in the EE Strategic Plan. The HVAC Performance Alliance is a significant emerging venue for addressing industry issues, including workforce planning, and a workforce committee has recently been formed to address training issues.

4.2.3 LABOR MARKET CONDITIONS

As shown in Table 4.3, the market segmentation described above also exists in the labor market. In the "high road" large commercial and institutional market segments, workers are better trained, wages are much higher, and workers are much more likely to make a career commitment to the industry. A greater number of employers in this segment have collective bargaining agreements with labor unions and thus, participate in state-certified apprenticeship programs. The apprenticeship system creates a structure that allows employers who compete using highly skilled labor to jointly fund and direct training so that each business does not have to individually invest in training program design and delivery. Training consists of five-year apprenticeship programs which, according to interviews with industry and workforce experts, are much more comprehensive than community college and private trade school programs. Graduates of apprenticeship programs are better prepared to solve problems in the field and have a stronger background to understand changing work specifications and new technologies. Apprentices also have the opportunity to earn a number of certifications throughout their training, which certify their skill level and provide a baseline knowledge that can be built upon through journey upgrade training. This broad occupational background, continuing education opportunities, and career commitment all make possible the incorporation of new skills and knowledge in a way that sticks.

Contractors in the large commercial and institutional sector articulated the critical importance of training a highly skilled workforce. One commercial HVAC contractor put it like this:

> *"For example, today we're looking at a small three-story building. It's a medical office building. It not only has energy problems, but this July, which is one of the coldest Julys on record, the building consumed more energy than it has ever consumed in its history. So we can send somebody in there to put some meters on it and take some readings, but to assess that building and understand why this building is suddenly using more energy than ever before requires somebody that has a deeper understanding of the systems and how they work. And how the operation of the building demands assistance with the building-timers, settings, economizers, and how that impacts how they use energy. That's not something we can teach someone in two weeks. That's something that takes a couple of years of training, as well as a couple of years of on the job experience.*
>
> *We are union contractors, so we have the benefit of journeyman upgrade training that's provided through our labor partner. Whether we're dealing with the pipe fitters or the sheet metal workers, the specific programs and classes that we need are available to us through our apprenticeship and journeyman upgrade programs. The classes that are very specific to what we need are on air balance, measurement and verification, and specific certifications. When we want to get our technicians certified to work with certain tools or do certain types of measurements—to get somebody NATE certified, TABB (Testing, Adjusting, and*

> *Balancing Bureau) certified or to get somebody with a Home Energy Rating System (HERS) rating, we're able to get that through our training program."*

This contractor and others we spoke with in the commercial sector recognize that quality depends on a well-trained workforce with access to continuing education to keep up with new practices and technologies. They also recognize the link between better wages and benefits, and their capacity to retain a stable and professionalized work force.

Table 4.3 Dual Labor Markets in the HVAC Industry

	High Road	Low Road
Market Segments	• Large owner-occupied commercial • Public buildings	• Residential • Small commercial
Wages	$14 to $22/hr+ entry wage for apprentices Prevailing wage average $37/hr (plus benefits)*	$10 - $15/hr Maximum around $25/hr
Turnover	Low	High
Training	5-year apprenticeship, comprehensive, funded by employer/employee contributions averaging $1.15 per journey hour worked	On the job, skills specific, paid for by worker or public subsidy
Certifications**	*Common* Journey Card NATE UA STAR TABB	*Rare* NATE HVAC Excellence ICE

* Prevailing wages vary by location, ranging from $25 to $55/hr in California. Union wages are higher, on average, as prevailing wage takes into account both union and non-union sectors. Workers in the high road sector are also much more likely to receive health insurance, pension, and other benefits which can greatly increase their total compensation.

**See Appendix H for a more complete list of certifications.

In contrast, in the residential and small commercial markets, where pressures to reduce costs are greater, there is little incentive for contractors to hire and retain workers with a deep knowledge of the craft, or to invest much time or money in training their staff about more advanced installation techniques or new technology for energy efficiency. Our interviews with HVAC experts in California strongly suggest that this "low-road" segment of the HVAC industry is characterized by low wages, and as a consequence, a lack of career commitment among technicians. Although no quantitative data are available to confirm turnover estimates, anecdotal evidence suggests that turnover is close to 30 percent per year in this sector.[22]

Although a minority of residential contractors offer good quality internal training and encourage workers to pursue industry recognized credentials, a large percentage of employers limit educational opportunities to short term, skills-specific training, often at the workers' own expense. Because most of the training that residential HVAC technicians receive is not formalized, or is specific to a given firm, it is not easily transferable to a higher-level position at a different company, or to acquiring further educational credentials in the sector. Several employers stated that though they preferred to hire technicians with certificates, they did not offer them higher wages. Although third-party certification could provide these workers with a more portable credential, most workers are reluctant to pursue certification if it is unlikely to bring them significantly higher wages.[23] High turnover discourages employers from investing in training for workers and low-paid workers have neither time

[22] San Diego Gas & Electric (2006-2008); interviews with HVAC contractors and experts.

[23] See Appendix H for a more complete description of skills certifications in HVAC.

nor money to invest in improving their skills. Despite this piecemeal training, most small firms expect technicians to perform all aspects of the trade, which require substantial skills if work is to be performed correctly. Some medium-sized firms classify workers into lower paid installation jobs, which require only a few weeks to a few months of on-the-job training, and slightly higher paid service technician jobs, which may require up to a year of community college or trade school, but in general, career ladders in the low-road sector are limited.

4.2.4 IMPACT ON ENERGY SAVINGS AND WORKFORCE OUTCOMES

There is very widespread recognition among HVAC industry stakeholders and experts of the installation and maintenance quality issues in the residential and small commercial market segments described above. The impact of these poorly-installed systems has been a significant loss of energy savings.[24] In the 2008 *Strategic Plan to Reduce the Energy Impact of Air Conditioners,* the CEC estimates that potential cumulative savings from higher quality HVAC installation in the residential and small commercial markets could reach 1,216 GWh and 1,096 MW by 2020.[25] This represents roughly two combined-cycle gas-fired power plants of 500 MW each. The report also notes that estimated cumulative savings would be 1,272 MW from "accelerated introduction of more efficient and *properly installed* [emphasis added] cooling technologies," by 2020.[26] The CPUC's Evaluation of the 2006–2008 IOU Energy Efficiency programs reports that for residential HVAC incentive programs, not only were evaluated energy savings consistently lower than predicted, but the data from measured duct leakage in the sample houses indicates that "some of these units never had any work performed."[27] It is possible that service contractors on the site "made some efforts to seal the duct work," but even if this is the case, it was done so poorly as to be equivalent to having no improvements made at all.[28]

The major obstacle to increasing energy savings in the HVAC sector is the poor quality of installation and maintenance in the small commercial and residential markets. Because good quality installations are difficult for the layman to see or measure, residential and small commercial customers overwhelmingly choose the low-priced option. There is consensus that poor quality is the result of this low-bid market, favored when standards are not enforced and the low road is not closed off.

Before the 2010–2012 program cycle IOU rebates had been limited to equipment standards, and had placed no upfront requirements on contractors to hire skilled workers, perform work to quality specifications, or obtain required building permits. The CPUC and some industry leaders are now embarking on an earnest effort to address some of these issues, which are fundamentally workforce issues. And, although training is necessary, it is not sufficient to address the problem of low-quality work. Unless there is a demand to recruit and retain trained workers and support them to use their skills, there will not be an improvement in quality. Thus, the sector itself needs to be transformed so that a thriving market develops for skilled, high-wage work that delivers real energy savings.

Currently, the low-road conditions and lack of quality requirements in residential and small commercial markets provide little reward for investments in training by either workers or employers. Though skills are required for optimal performance, they are not rewarded. In this situation, although public investment in skills training for technicians in the residential and small commercial segments appears, at first glance, to be a good solution for

[24] California Public Utilities Commission, 2008b, page 58.

[25] Messenger, 2008, p. 36.

[26] Ibid.

[27] California Public Utilities Commission (2010). *2006-2008 Energy Division Scenario Analysis Report*, p. 18. Retrieved from: ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Final%20Energy%20Division%20Scenario%20Analysis%20Report_070910.pdf

[28] Ibid.

improving installation and maintenance quality, training is unlikely to have a transformative impact. If estimates of turnover in the HVAC sector are accurate, as much as $3 million or more out of the $10 million invested in HVAC workforce education and training over this three-year funding cycle may be wasted as workers leave the industry. Training will have a much more valuable impact once market conditions have created a more stable and committed workforce. One small commercial HVAC contractor in Southern California summed up the situation:

> *"If we're to get where the state wants us to be with the strategic plan…it's so fundamental at so many levels for us to be able to pay kids what we're going to need to be able to attract them to the industry. We have to be able to charge higher rates—charge our customers more, rather than what the low ball guys are charging."*

This situation obviously affects worker outcomes as well. In the large commercial, more highly unionized HVAC sector, workers who start out with no postsecondary education support themselves through five year apprenticeship programs and end up with journey level wages of $35 to $45 per hour, with health and pension benefits and access to further training. In contrast, residential and small commercial HVAC workers enter at about $14 per hour and top out at $25 per hour after years of work experience, much more meager benefits and fewer opportunities for free skills upgrading. These low-road conditions mean that although being an HVAC technician in the residential and small commercial sector could be a good middle skill career, based on substantial investment in skill development, it currently neither provides the wage floors nor career ladders that could make it so.

4.2.5 FUTURE DIRECTIONS AND LESSONS FROM HVAC

The problems of quality and standards in the residential and small commercial HVAC sector are broadly acknowledged, and have reached such dramatic levels that concerted efforts are now being made to close off the low road and build the high road. In designing future policies to promote energy efficiency in HVAC and other areas, it is critical to keep in mind the lessons that the story of the HVAC industry teaches. Most importantly, although training is necessary, it is insufficient to address the problem of low-quality work. Unless the existing competitive conditions support high quality work, there will not be an improvement in quality. In some sectors, like residential and small commercial HVAC, this requires closing off the low road by setting and enforcing minimum quality standards. Thus, the sector itself needs to be transformed so that a thriving market develops for higher-skilled, high-wage work that delivers real energy savings.

It is also important to recognize that market transformation goes beyond what utility energy efficiency incentives can address. Steering low-road market segments onto the high road will require more than limited incentive programs and training programs. Utilities do not have the authority or the capacity to enforce licensing and code regulations, and incentive programs drive only a portion of the market.

Concerted and coordinated efforts by the many state agencies and regulatory bodies that influence the HVAC sector are necessary. Such efforts include enforcement of existing standards and stronger licensure provisions that cover both contractors and workers and require testing of expertise and ongoing professional development. In addition, the use of prevailing wages and project labor agreements in public and many commercial projects help support a business model built on the demand for highly skilled workers. In this business model contractors balance higher wages with more highly skilled and productive workers and maintain high training standards through bargained contributions to the apprenticeship programs.

Recent work on improving compliance and developing new codes and standards within the CEC, CPUC, Contractor State Licensing Board (CSLB), California Building Officials (CALBO), utilities, and the stakeholders in

the WHPA show significant effort toward setting the bar for contractor qualifications and performance higher. These efforts are a start, but key informants at the WHPA admit that there is still a long way to go toward transforming the market.

If these statewide efforts to build the high road and close off the low road in the HVAC sector are successful, they will support the development of a more stable and professionalized workforce. They will also likely drive up the upfront costs of HVAC installation. While further evaluations are warranted, the expectation is that over the long run, higher energy savings, particularly the more valuable peak energy savings from properly installed HVAC systems, along with savings from higher worker retention rates will compensate for the higher costs.

4.3 RESIDENTIAL ENERGY EFFICIENCY RETROFITS

Retrofitting residential buildings represents one of the greatest opportunities and one of the greatest challenges for achieving California's energy efficiency goals. The residential sector represents about one-third of California's current electricity and natural gas consumption.[29] Without major efforts to reduce household consumption, residential electricity demand is expected to increase nearly 25 percent by 2018. Although California is a leader in reducing energy use in homes, there are significant opportunities to achieve deeper energy savings on a greater number of dwellings. Policymakers have responded to this challenge with specific goals in the EE Strategic Plan. These goals are also supported by AB 758, California's Comprehensive Energy Efficiency Program for Existing Residential and Non-residential Buildings law, passed in 2010, as well as by significant channeling of funding from the 2009 ARRA to the residential sector.

The EE Strategic Plan goals for the residential sector are that by the year 2020:[30]

- → All eligible low-income customers will be given the opportunity to participate in low-income energy efficiency programs; and
- → Twenty-five percent of existing homes will achieve a 70 percent decrease in purchased energy from 2008 levels and 75 percent of existing homes will achieve a 30 percent decrease in purchased energy from 2008 levels.

Like the HVAC sector, the emerging residential retrofit sector faces issues of poor quality work which can lead to unrealized energy savings and undermine market expansion.

4.3.1 MARKET DYNAMICS

The home performance market (i.e., the market that specializes in energy efficiency retrofits) is still very underdeveloped. Homeowners are as likely to invest in energy efficiency upgrades during comprehensive remodeling projects and when they replace worn out appliances and other equipment, as they are to invest specifically in energy retrofits. Many barriers to the expansion of the home performance market persist. Frequently identified barriers include payback periods from energy savings that may outpace ownership or tenancy, homeowners' lack of access to capital to cover the upfront costs, split incentives between the building's owner and

[29] Thirty-two percent of electricity consumption and 36 percent of natural gas consumption is in the residential sector. (California Public Utilities Commission, 2008b, p. 9.)

[30] California Public Utilities Commission, 2008b, pp. 19, 26.

tenants (who pay the energy bills), a lack of reliable information for consumers to make decisions, and the overall atomization of the work that leads to dispersed returns and increased costs.[31]

The pool of contractors carrying out energy efficiency services includes home performance specialists as well as more general remodeling and specialty trade contractors. Contractors that do not usually specialize in home performance may make particular choices regarding practices or materials in order to take advantage of rebates on projects that would likely occur even without incentives. In addition, some HVAC and other specialty trade contractors are broadening their work into the home performance market, using the opportunity of HVAC change-outs to sell customers on related energy efficiency measures.[32] Because of these blurry boundaries, the retrofit market is embedded within the residential construction industry as a whole and is largely shaped by the competitive dynamics and regulatory framework of this wider market.

The residential construction industry, in which home performance is embedded, is characterized by intense competition between numerous small firms, with upfront costs being the primary consideration for many homeowners. The structure of the residential construction industry is similar to what we have described above as the "low-road" side of the HVAC sector. Much of the market is unregulated, and some contractors operate without proper licenses and/or without the required building permits. Firm size is small and employment relationships are often casual. In 2008, 89 percent of residential remodeling contractors employed fewer than ten workers each.[33] This tally does not include the considerable number of contractors with no permanent employees, those who subcontract for all their labor needs, or those who hire undocumented day laborers to supplement their workforce.[34] It is also relatively easy for contractors to enter the residential retrofit market, as licensing requirements are not stringent, and many homeowners are not aware whether or not their contractor holds a license.

4.3.2 POLICY INSTRUMENTS AND PROGRAMS

The main policy instruments aimed at achieving residential energy efficiency goals in the state are direct-install weatherization programs for low-income households, and incentive programs for homeowners. In addition, Titles 20 and 24 of the California Code of Regulations set minimum standards for appliances and work specifications for home remodels.[35] As mentioned above, these codes were recently updated to require more stringent energy efficiency measures and third-party inspections. However, in many cases remodeling and retrofit work in the residential sector is done without the required permits, so the work is never inspected to ensure it is compliant with these codes.

[31] See for example, Fuller, M., C. Kunkel, M. Zimring, I. Hoffman, K. L. Soroye, and C. Goldman (September 2010). *Driving Demand for Home Energy Improvements*, LBNL-3960E. http://drivingdemand.lbl.gov/.

[32] Interviews with Contractors, 8/2010–11/2010.

[33] Quarterly Census of Employment and Wages and U.S. Census, 2008 County Business Patterns. Retrieved from: http://www.labormarketinfo.edd.ca.gov/.

[34] According to a landmark 2006 survey of day laborers, residential construction contractors and home-owners are the top two employers of casual workers picked up on the street or at day labor sites. See Valenzuela A. et al. (2006). *On the Corner: Day Labor in the United States.* Center for the Study of Urban Poverty, University of California, Los Angeles. Retrieved from: http://www.sscnet.ucla.edu/issr/csup/index.php.

[35] Title 20 pertains to the Public Utilities and Energy Code and Title 24 pertains to Energy Efficiency Building Standards. Title 24, Part 6 applies to residential and nonresidential building envelopes, space-conditioning systems, water-heating systems, and indoor lighting systems of buildings, and outdoor lighting systems and signs located either indoors or outdoors.

4.3.2.1 LOW-INCOME PROGRAMS

Low-income programs provide free energy efficiency retrofits for low-income households. This market is entirely policy driven and is publicly funded from federal, state, and ratepayer sources. These programs have the dual objectives of creating energy savings through improvements to residences that would not otherwise be retrofitted, and of supporting low-income families by reducing their energy bills.

There are two federally funded low-income programs: the Weatherization Assistance Program (WAP), funded by the U.S. Department of Energy (DOE) and the Low Income Home Energy Assistance Program (LIHEAP,) funded by the U.S. Department of Health and Human Services (HHS). In California, these federally funded programs are administered by the California Department of Community Services and Development (CSD). All the investor-owned utilities and some public utilities also run energy efficiency programs for low-income households. In the case of the IOUs, these Low-Income Energy Efficiency (LIEE) programs are overseen by the CPUC and the Low-Income Oversight Board (LIOB).

Low-income programs typically use a "direct install" approach that gives the utilities and state agencies substantial oversight and control over the work that is carried out, including the choice of contractors and training requirements. Retrofit businesses have contracts with the utilities or their subcontractors for the LIEE and public utility programs and with the CSD for the federally funded WAP and LIHEAP. Since these programs aim to provide benefit to low-income households, some of the contractors chosen are "social enterprises," such as community action agencies that provide a variety of services in the community, while others are for profit firms.

Table 4.4 shows how WAP and LIHEAP, which had been fairly stable since 1979, have been given a large but short-term boost through ARRA funding.[36] Funding for the low-income IOU programs has also increased substantially in the latest funding cycle, providing a larger and more stable source of funding. These large increases in funding for low-income weatherization have greatly amplified the workload for contractors participating in these programs. Contractors report higher levels of subcontracting, as well as increased work hours and hiring to meet this demand.[37] Because the ARRA funding for WAP and LIHEAP is only temporary, most contractors have chosen to subcontract this work.

The low income programs focus on a package of prescriptive measures that are installed in every household. This means that emphasis is placed on installing particular equipment or materials, rather than on a whole house building systems approach that uses diagnostic testing to determine the best package of measures. However, the federally funded programs have recently begun requiring some diagnostic testing and have also substantially increased the maximum budget available for each household to cover these increased costs.

Table 4.4 Low-Income Program Summary

Program	Agency	2010 Budget	Assistance Per Unit	Quality Assurance
WAP + LIHEAP	U.S. Department of Energy and U.S. Department of Health & Human Services	Formula, $71 million ARRA, $186 million	Raised from $2,500 to $6,500 under ARRA statute	Diagnostic testing, in-house inspection
Low Income Energy Efficiency (LIEE)	Investor-Owned Utilities & CPUC	$310 million		Field verifications on some installations

[36] Low Income Home Energy Assistance Program Clearinghouse, National Center for Appropriate Technology. Retrieved from: http://liheap.NCAT.org.

[37] Interviews with contractors 8/2010–10/2010.

In the LIEE programs, implementation contractors for some of the IOUs were reported to subcontract out specific components of the work, such as signing up new customers or carrying out a specific measure, to other firms or independent contractors. Interviews with former employees and experts familiar with the LIEE program suggest that this piecemeal approach reduces potential energy savings by providing incentives that undercut the ability of the program to address whole house linkages among measures and to leverage all available funding streams.

4.3.2.2 CUSTOMER INCENTIVE PROGRAMS

Customer incentive programs are market driven programs that primarily take the form of rebates that buy down the cost of energy efficiency retrofits, thereby encouraging additional consumer investment. In contrast to the fully subsidized direct-install low-income programs, in rebate programs the consumer chooses and hires the contractor. Historically, these programs have focused rebates on single measures or equipment change-outs. As in the case of HVAC, these "widget" rebates focus on energy efficient equipment and materials, rather than installation quality and rely on back-end inspection rather than upfront contractor or worker standards.

As a result of the EE Strategic Plan goals, AB 758, and significant funding from the ARRA, California's customer incentive programs have recently been rolled into the statewide "Energy Upgrade California" initiative.[38] In contrast to previous approaches, Energy Upgrade California emphasizes: (1) a whole house approach to energy retrofits; (2) an alignment of numerous funding streams along with efforts to expand financing; and (3) greater emphasis on contractor and worker certifications to meet strict test-in and test-out quality standards. Table 4.5 shows the various funding streams that have been aligned under the Energy Upgrade program and gives a basic description of the program incentives and requirements.

Energy Upgrade California acts as a statewide branding mechanism as well as a clearinghouse for financing options and incentives in each locale. The coordination of this statewide program began under the auspices of an ad hoc coordinating body convened by the California Environmental Protection Agency (EPA), known as the California Home Energy Retrofit Coordinating Committee (CA HERCC). This group was originally convened to provide recommendations to local governments that were planning to implement a Property Assessed Clean Energy (PACE) financing program. The committee has included government agencies, the IOUs, and the California Building Performance Contractors Association (CBPCA) in an effort to align agencies and programs relevant to the residential retrofit industry. Although most local PACE programs have now been cancelled or postponed, recommendations drafted by CA HERCC have been instrumental in focusing ARRA funds and utility incentive programs on the whole house retrofit strategy and determining the contractor requirements and quality assurance mechanisms adopted by the Energy Upgrade program.

[38] Energy Upgrade California is also the policy umbrella for ARRA-funded commercial retrofit incentive programs, which have not yet been fully developed.

Table 4.5 Energy Upgrade California Summary*

Program	Agency	2010 Budget
Residential Whole House Programs	IOUs & CPUC	$116 million
Comprehensive Residential Retrofit Program	State Energy Program (ARRA)	$50 million
Statewide Community Development Association	State Energy Program	$33 million
Energy Efficiency and Conservation Block Grants	ARRA funds, administered by local governments	$12.9 million
Clean Energy Workforce Development Program	ARRA funds	$20 million
Better Buildings Program	DOE	$30 million
Workforce Investment Act	California Employment Development Department	$13 million+
Total	Energy Upgrade California	$275 million+

Program Description
• A Basic Package offers $1,000 rebate to customers who implement a prescribed set of energy efficiency measures. • An Advanced Package offers a maximum rebate of $4,000 for customers who are willing to invest in a more thorough performance-based retrofit. • All participating contractors must be licensed, complete an orientation course, and sign a participation agreement, and have a BPI-certified Building Analyst conduct safety tests. • Contractors must be BPI-certified to participate in the Advanced Program or complete a 3-day Basic Path Training for the Basic Program. • Post-installation inspections must be conducted by CEC certified HERS II raters.

*"Energy Upgrade California Introduction," Slides from All-Party Meeting on October 7, 2010. Retrieved from: http://www.energyupgradecalifornia.com/documents/2010-10-07_presentations/Energy_Upgrade_California_All_Party_Introduction_Final.pdf.

4.3.3 LABOR CONDITIONS

Because rebate programs have, until recently, focused on equipment ratings and not on the quality of work being performed, and because energy retrofits are not yet a market separate from remodeling and equipment change-outs, the residential retrofit market is subject to the labor conditions in the wider residential construction market. As described above, the residential construction industry in California is highly competitive and largely unregulated. Workers in this industry are often subject to poor wages, high injury rates, poor working conditions, and a lack of career pathways.[39] A large percentage of workers are immigrants, many of whom are undocumented.[40] Many workers are hired as independent contractors or as casual day laborers, rather than as employees. Although it is technically illegal, it is common practice for residential contractors to misclassify employees as independent contractors, enabling employers to save money on insurance, payroll taxes, and other costs. While workers in this industry may be skilled, they frequently face low wages and employment law violations due to their legal status, language barriers, and lack of other options. These conditions are not captured in government wage data, but the only available large scale survey of residential construction and other low-wage workers in Los Angeles, 17 percent of surveyed workers in the residential construction industry reported experiencing minimum wage violations,

[39] Wilson, C. (2009). *Construction Apprenticeship Programs*. Center on Policy Initiatives; Baxamuza (2009). *Construction: Working without a Healthcare Net*. Center on Policy Initiatives.

[40] Valenzuela A. et al. (2006). *On the Corner: Day Labor in the United States.* Center for the Study of Urban Poverty, University of California - Los Angeles. Retrieved from: http://www.sscnet.ucla.edu/issr/csup/index.php.

64 percent reported being forced to work off the clock with no pay, and 79 percent reported being denied a standard meal break.[41]

A number of home performance contractors, focusing on whole-home performance that requires extensive diagnostics and testing, are attempting to carve out a quality niche in this market. These contractors are committed to high quality services and in interviews stated their desire to employ long-term well-trained employees. However, they are forced to compete in the wider residential remodeling market where competitive conditions favor the low road. LIEE and WAP contractors are more shielded from the wider residential construction market because they enter into long-term contracts with the IOUs or state agencies, so competitive pressures are determined by program budgets and bidding mechanisms.

Wages for workers in the residential retrofit market are inevitably influenced by these labor market conditions. The largest job category in residential energy efficiency retrofit work is the installer/technician category, comprising an estimated 68 percent of all non-administrative work, according to the Los Angeles County Energy Plan. These workers perform basic insulation, caulking, weather stripping, sealing, and related tasks. In some cases crews are also responsible for mechanical and glazing work, and even installation of solar panels. Although no reliable quantitative wage data is available, our interviews revealed entry-level technician installer wages as low as $8.00 per hour and as high as $15 per hour in home performance. Notably, higher wage contractors described how hard it is to maintain a viable business when their competitors commonly pay lower wages, and cut corners in other ways, such as subcontracting out asbestos work to unlicensed contractors.

Though LIEE contractors are shielded from the competitive dynamics of the customer driven retrofit market, there seems to be great variation in the wages paid in this segment as well. Some LIEE subcontractors pay piece rates for each item installed or customer enrolled, and anecdotal evidence suggests pay can be as low as $50 to $70 per day in these cases. Some LIEE and WAP contractors that are community-based organizations with economic development missions pay higher starting wages, in the range of $13 to $14 per hour. For WAP work funded through the ARRA, Davis–Bacon Act prevailing wages apply, which for weatherization installers range from $11 to $15 per hour, depending on location.

Higher-wage and higher-skills jobs in the residential retrofit industry include crew chiefs, home performance analysts or auditors and raters and quality inspectors, but these jobs are much less numerous that the basic installer job. Though no certifications have been adopted on an industry-wide basis, a number of them now exist for home energy auditors and home energy raters, including those offered by the Building Performance Institute (BPI). In the 1990s the CEC developed the HERS for new homes and is now rolling out the HERS II certifications for raters and inspectors for home retrofits. The DOE has also developed voluntary skill standards for four main field jobs in residential retrofit, discussed below. At this time, there are no training or certification requirements for the bulk of workers employed by contractors participating in the newly launched Energy Upgrade California, though there are contractor requirements for all incentive packages. For the advanced upgrade package (based on test-in and test-out performance), contractors or one of their staff must have a BPI Building Analyst (BA) certification, and raters must have a whole house HERS II certification.[42]

In contrast, WAP and most LIEE workers, including installation workers, are required to attend short-term trainings at approved training facilities (such as PG&E's Energy Training Center in Stockton) before starting work. These training programs provide certificates of completion to workers, which are the only certificates that were

[41] See Milkman et al. (2010). *Wage Theft and Workplace Violations in Los Angeles: The failure of employment and labor law for low-wage workers.* Institute for Research on Labor and Employment, University of California−Los Angeles. Retrieved from: http://www.irle.ucla.edu/publications/pdf/LAwagetheft.pdf.

[42] California Energy Commission (2010). Energy Upgrade California: Becoming a Participating Contractor. Retrieved from: https://energyupgradeca.org/statewide_for_contractors.

identified for the weatherization installer job category in California. PG&E and SCE have established specific training standards and courses; these courses follow a specific set of training standards established by the utilities. However, the other two IOUs do not require their contractors to follow specific standards.

Though the WAP and LIEE programs are very similar, the training requirements differ, so that a worker trained for a WAP contractor is required to undergo new training to be eligible to work for a LIEE contractor. The DOE is now funding efforts to align all the major trainings and link them as much as possible to their new voluntary guidelines for skill standards and training, discussed below.

4.3.4 IMPACT ON ENERGY SAVINGS AND WORKFORCE OUTCOMES

Concerns about quality work in residential retrofit were commonly expressed in interviews conducted for this study. In addition, quality concerns have been a central focus of program design in all the new policy efforts to expand funding for residential retrofits in California and nationally.

In residential retrofit, the quality issues that surfaced in our interviews included concerns about safety, loss of immediate potential energy savings, and slowing down the expansion of the market for retrofits. Safety concerns were focused mostly sharply on the necessity of testing for appliance combustion safety in order to avoid dangerous buildup of toxic gases inside the building as a consequence of envelope sealing. In terms of immediate energy savings, interviewees identified both single measure quality issues, such as improper installation of insulation, and the more sophisticated diagnostics and workmanship needed for whole house retrofits. Finally, interviewees also emphasized the importance of consumer satisfaction for market expansion. Since growing the market for homeowner investments in energy efficiency retrofits depends in large measure on word-of-mouth advertising and other social marketing, consumer dissatisfaction resulting from inadequate work quality can significantly undermine sector growth.

Traditionally IOU incentive programs and low-income weatherization programs have relied primarily on post-installation inspections of a sample of dwellings. This method only captures a fraction of the work that is done, and when poor quality is found, often requires expensive reworking. Though certainly part of any quality assurance package, back-end inspections have not rid programs of quality concerns.

Energy Upgrade California has continued to use back-end verification, but is also addressing quality concerns through upfront contractor requirements, including licensure, permitting, a standard agreement, and a mandated orientation course. The program currently has determined that HERS II and BPI certifications will be required for building raters and auditors; certification requirements and quality work specifications for specialty trade technicians (such as HVAC) are now under consideration for inclusion. However, at this time there are no specific training or certification requirements for weatherization installers who perform the majority of energy efficiency installations. The LIEE programs carry out both upfront training of workers and back end inspections, but their single measure approach (and possibly program design incentive structures) limits overall potential energy savings. The LIEE programs are being evaluated at this time and may undergo changes in the next funding cycle.

In terms of worker outcomes, the residential retrofit sector seems to provide low wages and few benefits, though the lack of basic jobs and workforce data frustrated our attempts to quantify this. As in many low-wage industries, career ladders are currently very limited in the residential retrofit industry. Research on career ladders has shown that large firms with internal labor markets are much more likely to provide promotion opportunities internally.[43] In sectors, such as residential construction, characterized by small firms and multiple subcontracting levels, career

[43] Fitzgerald, J. (2006). *Moving Up in the New Economy: Career Ladders for U.S. Workers*. Ithaca: Cornell University Press.

advancement opportunities are much more difficult to find. As discussed above, the residential and commercial construction markets are highly segmented in terms of wages, skill levels, and contractor type, making movement up from the low-wage residential to the much higher-wage, higher-skills commercial market segment difficult.[44]

4.3.5 NEW POLICY DIRECTIONS

California, a number of other states, and the federal government are all engaged in enormous efforts to ramp up residential retrofits. The current period is one of great experimentation in program design for many residential retrofit programs. A number of approaches are being tried—and debated—to achieve the objective of improved work quality. In some cases, policymakers and program designers have also attempted to build in job quality and job access requirements. Below, we discuss some of the promising approaches to the workforce issue that are being undertaken and promoted nationally and in some other states.

The "Recovery through Retrofit Workforce Working Group," convened by the Obama administration to scale up the residential retrofit market, identified the lack of a skilled and credentialed workforce as a key obstacle to the industry's growth. As a result, the U.S. Department of Energy (DOE) has developed a set of industry guidelines for worker certifications and training program accreditation for the four main field job categories: Installer/ Technician, Crew Chief, Energy Auditor, and Quality Assurance Inspector.[45] These guidelines were created through rigorous technical analyses of job tasks and minimum technical requirements, standard work specifications, and essential knowledge and skills for workers in each job category. The development of these guidelines followed well-known protocols that included substantive feedback from industry and educators. They provide the first standard for the entry level job category of weatherization installer/technician, which can be used to ensure workers are prepared to do quality work. Now, BPI, WAP, and training programs around the country are working with DOE to align their standards with these basic guidelines. Los Angeles Trade–Technical College (LATTC) is one of the training centers funded by DOE and is working to align the WAP, LIEE, and other curricula. The DOE is encouraging these voluntary standards, and it remains to be seen whether these guidelines will be adopted as mandatory certification requirements by any major state or local retrofit program.

Certifications can contribute to improvements in quality, and they can also help improve workforce outcomes.[46] LATTC's involvement in the alignment of curricula for certifications is motivated by wanting to provide students with portable and stackable certifications that can facilitate career mobility. The college has also been working to establish a number of career pathways in the industry. The challenge LATTC articulates is that in order for certification to actually lead to strong career pathways with higher skills and higher wages, there must be adequate floors on wages and wide acceptance of the value of certification within the industry, so that employers are willing to pay certified workers more. It is not clear yet whether the residential market can offer these conditions.

One model to incorporate certification has been proposed by Efficiency First, a national trade association for the home performance industry.[47] They propose a "training within industry" (TWI) model that would use public funding for on-the-job training, tied to worker certification. Training within industry has the advantage of targeting

[44] Wilson, C. (2009). *Construction Apprenticeship Programs*. Center on Policy Initiatives, Center on Policy Initiatives; Baxamuza (2009). *Construction: Working without a Healthcare Net*. Center on Policy Initiatives.

[45] U.S. Department of Energy (2011). *Energy Efficiency & Renewable Energy: Weatherization & Intergovernmental Program*. Retrieved from: http://www1.eere.energy.gov/wip/retrofit_guidelines.html.

[46] See Chapter 5 for an in-depth discussion of certifications.

[47] Redman, E. (2010). Green Jobs in the Residential Energy Efficiency Industry: The Home Performance Industry Perspective on Training and Workforce Development. Home Performance Resource Center. Retrieved from: www.hprcenter.org/.../green_jobs_in_the_residential_energy_efficiency_ industry.pdf.

training to workers who are already hired and have been screened by employers to make sure that they can physically perform the work (for example move through small crawl spaces). In addition, it provides trainees with hands-on work experience, not just classroom or online learning, which is insufficient in this hands-on profession. This approach is very similar to apprenticeship but proposes using public rather than industry funding. Workforce development funding from state and federal sources for on-the-job training has been quite limited because of the concern that employers might pay for this type of training without a public subsidy. However, if there were systems in place to track participants, clear agreements on wage progressions tied to certifications and other accountability measures, this could be a viable way to achieve both higher work quality and better workforce outcomes.

Attempts to integrate apprenticeship and unionized contractors into residential retrofit projects are also occurring, though not without challenges. In the residential sector, particularly, the rigid craft lines of the unionized sector do not make sense for small jobs, and unions have only begun to address the possibility of new job classifications that entail doing work that combines the traditional jurisdiction of more than one craft and have wage scales that correspond to the lower skills needed for residential work. For example, the Los Angeles Department of Water and Power (LADWP) is considering a model for energy efficiency retrofit of low-income residences and non-profit buildings where utility employees carry out retrofit work under a new "pre-craft trainee" job classification in the International Brotherhood of Electrical Workers (IBEW) Local 18–LADWP collective bargaining agreement. These trainees would have a starting wage of $16 per hour plus benefits and participate in an 18 month training program that will prepare them for jobs at the LADWP and to take the civil service exam, assuring a solid career ladder. While this model has not been launched or even approved, we bring it up here as an example of the ways to make energy efficiency work a good job with a career ladder.

An alternative approach to creating career paths for residential retrofit workers and trainees is to help them use their training and experience to move out of residential into commercial construction where wages are higher. LATTC and other colleges, community organizations like MAAC (Metropolitan Area Advisory Committee on Anti-Poverty, the WAP agency in San Diego), and city programs such as Richmond BUILD in the Bay Area, is to develop working relationships with local apprenticeship programs, and provide pathways for their graduates into apprenticeship in the commercial construction industry.[48]

Another approach to achieving workforce goals is to directly institute labor standards, in addition to contractor requirements and worker certification. This method directly addresses the quality of the jobs that are created through publicly funded or subsidized programs. The White House Recovery through Retrofit Working Group is encouraging this approach and the DOE Better Buildings grant program has funded a number of initiatives that use it—all outside California. Green for All, a national nonprofit, has worked with retrofit program managers to refine and implement this strategy, including in Portland, discussed below. In addition, a national coalition of low-income and minority advocacy groups and organized labor has formed to advocate for this strategy under the Emerald Cities Collaborative project, which recently held a briefing at the White House.[49] It has funded project start-ups in ten cities, including Oakland and San Francisco, which are just now being organized.

Key components of these initiatives are:

- → Job quality standards that include living wages or other wage standards, health and other benefits;
- → Local hire and targeted hire policies to enable job seekers from historically disadvantaged minority and low-income communities to access new job opportunities;

[48] See Chapter 7 and Chapter 13.

[49] Emerald Cities Collaborative (2011). http://emeraldcities.org/.

- → Stringent contractor qualifications, to eliminate labor violations, ensure high-quality work, and "close off the low road;"
- → Provision of high-quality training with industry recognized certification that enables workers to advance in the field, and in some cases use of apprenticeship; and
- → Efforts to increase demand and lower costs for contractors through neighborhood and other bundling approaches that enable contractors to bid on multiple jobs and achieve scale.

A notable example of this approach is the "Clean Energy Works" residential retrofit program in Portland, Oregon. This comprehensive retrofit program is a DOE Better Buildings grantee and includes many innovative components such as on-bill repayment of third party financing.[50] In partnership with Green for All, this program requires contractors to comply with the provisions established in a high-road agreement. This agreement, developed through a multi-stakeholder process, establishes workforce goals and minimum labor standards for participants, including a wage floor and targeted and local hiring quotas.

In addition, the program establishes a rating system for contractors, based on a number of factors set forth in the high-road agreement, including labor standards, contractor standards, local and targeted hire, and inclusion of minority and women subcontractors. These and other factors are used to rank contractors and work is awarded preferentially based on these rankings. Although some of these factors do not tie directly in to improving work quality, the overall goal of the program is to "level the playing field" for high-road contractors and to disfavor those whose business model is based exclusively on cutting costs and hiring low-wage labor.

The Portland experience provides a successful example that illustrates the ability of contractors to comply with the requirements embedded in high-road agreements, albeit at a small scale and in a much less complex environment than a California-wide program. When the Portland program began there were six partner contractors participating in the high-road program; over the last year that number has grown to 17 participating contractors. The program has met or exceeded all of its workforce goals, including paying family supporting wages; employment of underrepresented or disadvantaged workers, who have worked 30 percent of total project work hours; and inclusion of women- and minority-owned businesses, who have received 20 percent of contract dollars. The pilot phase of the program has also been very successful in achieving its energy goals and has been awarded a $20 million ARRA grant to expand the program statewide.

The Portland program is too new to evaluate the potential cost increases associated with the high-road labor standards. While there is a general acknowledgment of the importance of work quality in energy efficiency projects, some stakeholders worry that imposing too many requirements on an emerging industry could raise costs prohibitively, hinder the industry's growth, and slow down job creation as well as energy savings. Increasing demand is certainly a concern in the currently depressed residential market. To date, there is insufficient information to evaluate whether or not imposing higher skill standards and/or labor standards significantly affects the costs of saving energy. In large-scale construction projects, research suggests that higher wage and benefit costs are offset by higher skills, quality, and productivity.[51] In small-scale residential retrofit projects that require lower skill levels, raising skill levels of installers may not compensate for higher training and wage costs. If this is the case, policymakers will have to weigh the competing priorities of cost-effective energy efficiency and good jobs for Californians.

[50] Clean Energy Works Portland (2011). http://www.cleanenergyworksportland.org/index.php; Green for All (2010). *Clean Energy Works Portland: A National Model for Energy-Efficiency Retrofits*. Retrieved from: http://www.greenforall.org/resources/clean-energy-works-portland-report.

[51] Mahalie, N. (2008), "Prevailing Wages and Government Contracting Costs: A Review of the Research," EPI Briefing Paper #215. http://www.epi.org/publications/entry/b p. 215.

In California, Energy Upgrade California has largely proceeded without incorporating these high-road agreement strategies, due to fears about layering too many workforce goals on top of a new program that is trying to stand up an underdeveloped residential retrofit industry. The County of Santa Clara passed high road language for its PACE program (now held up), which was met by strong objections from the CBPCA, due to their perception that the burdens on their contractors—who are overwhelmingly very small—would be too great.

One of the key challenges in the approaches built on high road agreements is the issue of scale. Very small residential or building performance contractors usually cannot meet either the wage or the reporting requirements of high-road agreements. At the same time, it is difficult for program implementers to attract larger contractors, such as unionized commercial sector contractors, whose business models are based on more highly skilled, highly paid workers and who have the administrative structures and efficiencies to meet accountability requirements of these publicly subsidized programs. Attracting such contractors would also mean negotiating new agreements with unions that include residential wage levels commensurate with residential skill levels, and that allow workers to cross craft boundaries to perform multi-craft work.

Bundling work at a larger scale is an essential strategy for building a program that attracts higher road contractors and that can overcome the barriers just described. There are a number of initiatives around the country that are attempting to create scale, for example, by instituting a competitive bidding process for a group of homes, rather than requiring each consumer to find its own contractor. Because of the strong voice of the CBPCA and the absence of the voice of stakeholder coalitions such as Green for All and the Emerald Cities Collaborative in the design of Energy Upgrade California thus far, there is little experimentation in this kind of scaling strategy in California.

4.3.6 LESSONS FROM RESIDENTIAL RETROFIT

Major new efforts to expand the residential retrofit sector in California have been launched, most importantly Energy Upgrade California and large funding increases for the IOU LIEE programs (as well as the temporary increase in funding for the WAP program from ARRA). These efforts are attempting to carve out and grow a quality residential retrofit sector in California. The initiatives face an important workforce challenge because market conditions in the broader residential construction industry, in which residential retrofit is embedded, are unlikely to support the work quality that is needed to create real energy savings, or the job quality that is needed to provide opportunities for California's workers.

In order to carve out a quality residential energy efficiency market, a number of complementary solutions are needed. These include standardized training and certification requirements for workers and contractors, enforcement of contractor licensing requirements, and other incentives and standards that encourage contractors to engage in high road practices. In addition, if policy priorities include workforce goals in addition to energy efficiency goals, then labor standards and job access provisions, like those embedded in high-road agreements, need support. At a minimum, there is a critical need for more information on wages, turnover and other basic labor market conditions to inform the design of future policies and programs. This information is important to verify if poor labor conditions are, in fact, widespread, and if so, to assess their impact on achieving energy savings and growing the retrofit market. This is needed to be able to analyze the cost effectiveness of alternative program designs and their impact on both energy efficiency and worker outcomes.

4.4 COMMERCIAL LIGHTING CONTROLS

Lighting has long been one of the most cost effective ways to achieve energy savings. Many of the least expensive lighting upgrades, such as bulb change-outs, have already been implemented. However, the EE Strategic Plan estimates that lighting still accounts for approximately 25 percent of California's total energy use and more than 35 percent in the commercial sector.[52] Table 4.6 gives an overview of approved IOU Lighting Program budgets for the 2010–2012 funding cycle.

Table 4.6 IOU Lighting Program Budget, 2010–2012

Utility	CFL Program	Advanced Lighting	Lighting Market Transformation
PG&E	$30 million	$33 million	Statewide non-resource program focused on research, coordination, and outreach
SCE	$32 million	$45 million	
SDG&E	$16 million	$11 million	
Total	$78 million	$89 million	$1.5 million

California has been a leader in policies to reduce energy use from lighting. In 2007, AB 1109, the California Lighting Efficiency and Toxics Reduction Act was signed into law. Known as the Huffman bill, this law prohibits the manufacturing for sale or the sale of certain general purpose lights that contain hazardous substances. In addition, the bill requires the CEC to adopt energy efficiency standards for all general-purpose lights. The CPUC has also taken strong action on lighting and in September 2010 voted to adopt a chapter on lighting as an addition to the EE Strategic Plan. The goal for the lighting sector in the EE Strategic Plan is the reduction of lighting energy use by 60 to 80 percent statewide by 2020.[53] While this seems ambitious, newly emerging technologies and practices, including task lighting, advanced lighting controls, and light-emitting diode (LED) lamps can already save about 60 percent over standard practices. Lighting controls, in particular, offer great potential, not only for reducing energy use in lighting, but for moving towards integration of energy efficiency retrofits across lighting and mechanical building systems.

4.4.1 MARKET DYNAMICS

Like the residential construction and HVAC industries, the electrical contracting industry, which installs lighting, is a highly fragmented industry with many small firms and self-employed contractors. In 2007, 79 percent of electrical contracting establishments in the state had fewer than ten employees.[54] However, many electrical contractors in the commercial sector in California belong to the National Electrical Contractors Association (NECA), are unionized, and fund and participate in apprenticeship programs. Thus, though small, these contractors are organized into a broader infrastructure that facilitates proactive response to adopting emerging technologies and upgrading workforce skills.

[52] California Public Utilities Commission, 2008b, Section 13.

[53] Ibid.

[54] Quarterly Census of Employment and Wages and U.S. Census, 2008 County Business Patterns. Retrieved from: http://www.labormarketinfo.edd.ca.gov/.

4.4.2 POLICY INSTRUMENTS AND PROGRAMS

Until recently, the utilities have relied almost exclusively on "widget" incentives for lighting, particularly upstream incentives to reduce the price of efficient light bulbs. Much of this "low-hanging fruit" has now been exploited, the market has largely been transformed, and the incentives are no longer needed. In order to obtain more savings out of the lighting sector, the CPUC has directed utilities to shift the focus of incentives to advanced lighting technologies and lighting systems, particularly in the commercial sector. The CPUC's decision approving the latest Portfolio of IOU Energy Efficiency Programs shifted funding from the Basic Compact Fluorescent Lamp (CFL) Program to the Advanced Lighting Program, which is consistent with the EE Strategic Plan's vision that utilities will phase out "traditional mass market CFL bulb promotions and giveaways" in favor of new technologies and programs.[55]

Both the CFL and Advanced Lighting systems provide upstream incentives for lighting products, but the Advanced Lighting Controls Program targets newer technologies with greater savings potential and less existing market penetration. The Advanced Lighting Controls Program also provides midstream rebates to contractors for certain products.

The IOUs are, thus, now shifting away from widget based programs towards systems approaches and approaches that focus on quality installation. Advanced lighting systems and controls involve new technologies and new ways of planning, procuring, installing and commissioning lighting. These technologies are considered emerging, and many established contractors and highly trained electricians are still unfamiliar with them. The IOUs have an important role in testing and carrying out demonstration projects with these emerging technologies, developing the performance standards that are needed to yield expected energy savings, and finally pushing them to market by developing incentive programs. In initiating this process for advanced lighting controls, installation issues surfaced as a major market barrier. An experienced lighting program staff person at SCE described the installation issues as follows:

> *"We've done a number of demonstration projects where we've been putting in advanced lighting systems to see how the technology interface works—does it work? In the process of doing this…one of the things that I knew, but didn't really pay attention to is that, typically, controls are never installed properly. They're too complicated; there aren't good instructions. We did one of our own facilities. It was a half million dollar test where we tested three pretty advanced systems with all new fixtures, ballasts, controls, interfaces, etc. Lo and behold, every single one of those was installed improperly by the manufacturers' own installers. That's when we realized that this is a huge problem."* [56]

Improper installation often leads to customer dissatisfaction and override of control systems, resulting in a loss of estimated energy savings. It also leads consumers to have a negative perception of the technology, which slows market expansion and implementation.

4.4.2.1 CALCTP PROGRAM

In order to develop solutions to address the installation quality issues in the Advanced Lighting Controls sector, SCE embarked on a cutting edge effort that is now known as the California Advanced Lighting Controls Training

[55] Gruenich, D. and A. Gamson (2009). CPUC Decision Approving 2010 to 2012 Energy Efficiency Portfolios and Budgets(D0909047). Retrieved from: http://docs.cpuc.ca.gov/PUBLISHED/Graphics/107829.PDF.

[56] Interview with program staff, Southern California Edison, 10/2010.

Program (CALCTP). CALCTP is a high-level training program for licensed electricians that will be tied to a new incentive program providing an additional rebate to customers who hire an electrician with CALCTP training and certification. Though still in development, the incentive program will reward certified contractors whose workforce has been trained and certified by the CALCTP.

CALCTP has become a nationally recognized model for improving work quality in a key energy efficiency sector and provides a guide for workforce planning for other emerging technologies and measures such as retro-commissioning, new energy storage technologies, and other integrated demand-side management initiatives. This program also illustrates the benefits of collaboration between the IOUs, the University of California, and networks of licensed contractors who have a proven commitment to investing in comprehensive skills training. It has drawn on the existing strengths of each of the partners, taking advantage of the technical expertise of California Lighting Technology Center at UC Davis (CLTC) and the existing training infrastructure at the International Brotherhood of Electrical Workers and National Electrical Contractors Association (IBEW–NECA), as well as the Design and Engineering Services Group at SCE which promotes emerging technologies.

In the language of the workforce development world, CALCTP represents a quintessential example of a successful "sector strategy."[57] It started with an industry partnership that identified workforce issues and skill shortages as a major barrier to market competitiveness and growth. Industry partners then formed a collaborative to plan and implemented training, including convening training partners, creating a curriculum, developing a training delivery system, and seeking public and private funding.

SCE took the lead on developing the curriculum and continues to own its intellectual property rights, which it licenses to others. Although the majority of training is currently offered through the IBEW–NECA's 23 joint apprenticeship and training centers (JATCs), the program is also being rolled out at community college Advanced Transportation Technology and Energy campuses and IOU Energy Training Centers, making it widely available to all state certified General Electricians. Due to the advanced level of the skills taught, CALCTP is technical upgrade training that requires significant technical expertise and mandated online prerequisites provided by lighting controls manufacturers.

In conjunction with the roll-out of CALCTP, new incentives are focusing on installation as well as equipment performance standards. Now that several hundred electricians have gone through the training program, the utilities are planning to offer an extra incentive for installation meeting CALCTP-certified project requirements, that is projects installed by CALCTP-certified electricians working for a CALCTP-certified contractor on a utility approved project. As in HVAC and other construction trades, there is a low bid process for commercial lighting contractors, but shifting incentives towards certified technical workers creates a value proposition for investing in quality installations with verified energy savings.

4.4.3 LABOR CONDITIONS

Commercial electrical contracting is primarily a high-road industry. Unlike other trades, where only contractors must be licensed, California requires that all practicing electricians be licensed. In addition to the substantial initial training, on-the-job experience, and testing requirements that is needed for licensure, electricians must complete 32 hours of continuing education and training every three years in order to maintain their license. These requirements mean that nearly all electricians in the state have completed an apprenticeship or extensive training program. For this reason, prevailing wages for commercial sector electricians are higher than for most other trades.

[57] See Chapter 5 for an in-depth explanation of sector strategies and their role in the workforce development world.

Nationally, about 32 percent of licensed electricians belong to a labor union, mostly IBEW.[58] In the commercial sector, union representation is even higher. These conditions also provide a lifelong career for workers, starting with paid on the job training through apprenticeship, high journey level wages, and health and retirement benefits. Life-long learning through journey upgrade training is also available and since license renewal requires continuing education, skills upgrading is embedded in the career.

In addition to providing benefits to workers choosing a career as an electrician, high union density creates a stable and professional workforce. Apprenticeship coordinators reported very high retention rates as workers who finish five year apprenticeship programs have made an enormous investment in their career. The forty-hour CALCTP program, though rigorous, is a small addition to this broad occupational training. The apprenticeship infrastructure facilitates ongoing learning through free journey upgrade training. The simultaneous training of both contractors and workers means that as contractors are able to gain business in advanced lighting controls in new construction and retrofits, their workforce will be ready and able to carry out the work.

4.4.4 LESSONS FROM LIGHTING

The commercial lighting sector is more successful in achieving work quality goals with new technologies and programs than either the HVAC or residential sectors. This success is due to: (1) the existing high-road conditions of the market, which provided an already well-trained, stable, and professional work force that could quickly gain the advanced skills; (2) the foresight and flexibility which enabled the utilities to collaborate successfully with NECA–IBEW and the UC Davis CLTC to create the CALCTP training program; and (3) the development of strong skill certification standards that will be tied to incentive programs to help drive quality in the market. This collaboration leveraged the existing training infrastructure of NECA–IBEW with the technical expertise and funding capacity of the utilities, enabling the rapid development and implementation of a rigorous training program and associated incentive program.

4.5 CONCLUSIONS AND RECOMMENDATIONS

The case studies presented in this chapter illustrate the workforce related possibilities and pitfalls of energy efficiency programming. The issues of work quality highlighted here pertain particularly to the sectors studied, but can arise in any unchecked low-road industry. Across all sectors, it is clear that energy efficiency program designers and administrators have an active role to play in ensuring quality energy savings outcomes *and* that work quality and job quality outcomes are closely linked. The examples in this chapter also present a range of solutions for addressing quality, some of which have been tested and proven, and others that are relatively new.

The CALCTP project provides an example of a sector strategy leading to the successful development of advanced level training to address specific industry needs—in a context in which training investments are likely to stick because the workforce is already stable and professionalized and employers are already committed to investing in training for their current and future employees through their contributions to the apprenticeship trust funds. The CALCTP utility–industry–labor partnership enabled planning for workforce training and new utility programming to be done simultaneously and in a complementary fashion, rather than addressing workforce issues after the fact. This enables policymakers and energy program designers to build in upfront quality assurance mechanisms that get to the root of market related issues and training gaps.

[58] Bureau of Labor Statistics (2010-2011). Occupational Outlook Handbook: Electricians. http://www.bls.gov/oco/ocos206.htm.

We suggest that this type of sector strategy is a model that should be expanded and replicated throughout energy efficiency programming. Such training oriented strategies are likely to have the most immediate success in programs and technologies targeted at the large commercial sector, such as retro-commissioning and a variety of integrated demand-side measures. As discussed above, the large commercial construction sector is largely a high-road industry with an existing trained workforce and workforce infrastructure in place to support skills upgrade training as new technologies and systems are developed and deployed.

In low-road sectors, such as residential construction and residential and small commercial HVAC, the solutions are less straightforward, although a number of approaches are being tried. Sector strategies are needed in these industries, not only to address training gaps, but to initiate transformations in the market that will support quality work and improve workforce outcomes. The beginnings of these industry partnerships are already in place in emerging organizations, such as the WHPA and the networks formed around Energy Upgrade California. However these initiatives can be informed by the best practices that have been developed for sector strategies, which include the development of stackable and portable industry-recognized certifications, along with robust multi-employer agreements to train the existing workforce and/or hire newly trained job seekers. Ultimately, skills upgrading and certification must be linked to wage progressions to stabilize and professionalize the workforce, so that training investments are not wasted, but instead lead to changes in practice in the field.[59]

The ongoing and growing investment of public and ratepayer funds in residential retrofits provides an important opportunity to build high-road energy efficiency and related industries that are based on high-quality work as well as living wage jobs with career ladders. A number of initiatives attempting to scale up this sector have taken different approaches to addressing quality:

4.5.1 SKILL STANDARDS AND CERTIFICATIONS

Skill certifications have the potential for improving quality, making workforce investments more efficient, and creating greater certainty for contractors. The DOE has developed skills standards for the major job categories in residential retrofit, which could be adopted in California to guide training and certification. Incentive programs that are tied to a particular training or certification standard, like the residential HVAC Quality Installation program, have the most potential for influencing the market, although they are not guaranteed to transform it without further measures. Third party accredited certifications, at the very least, guarantee a minimum training investment that ensures workers are prepared to do work to a quality specification. More in-depth discussion of certifications can be found in Chapter 5 and Chapter13 of this report.

4.5.2 HIGH-ROAD AGREEMENTS AND LABOR STANDARDS

When—as we have seen in HVAC and the residential sector—training is not sufficient to ensure quality work, other strategies have been employed to attempt to transform labor market conditions. Some approaches include building permit and code enforcement, best-value contracting, and labor standards, all of which favor high-road contractors. High-road agreements that govern some retrofit programs directly address workforce considerations such as wages and benefits, and they often include local and targeted hiring agreements that improve access to jobs for disadvantaged workers. Policies that mandate or incentivize quality may increase the cost of residential energy retrofit or HVAC work, but higher-quality work and lower turnover may offset some costs.

[59] See Chapter 5 of this report for a more thorough discussion of sector strategies.

In sum, our research and others' indicate that policies such as skill standards, contractor requirements, worker certifications, labor standards, local hire policies, and other quality assurance mechanisms enhance workforce outcomes *and* may increase energy savings enough to improve or at least not reduce overall cost-effectiveness. Because the application of these strategies to energy efficiency sectors is relatively new, however, it is difficult to accurately anticipate the magnitude of long-term cost-effectiveness and energy savings. The impact of workforce conditions such as wages, benefits, turnover and retention rates on the quality and cost of energy retrofit programs has been an overlooked area of analysis. As a result, policymakers who share both workforce and energy goals are not yet able to evaluate potential trade-offs in policy design. All programs should be rigorously reviewed along these lines, focusing on energy savings, workforce outcomes and cost effectiveness. Thus, Dr. W. Edwards Deming's refrain to "do it right the first time" doesn't just apply to the energy efficiency installation work itself; it also refers to the need to improve our processes of policy development in order to produce higher-quality outcomes.