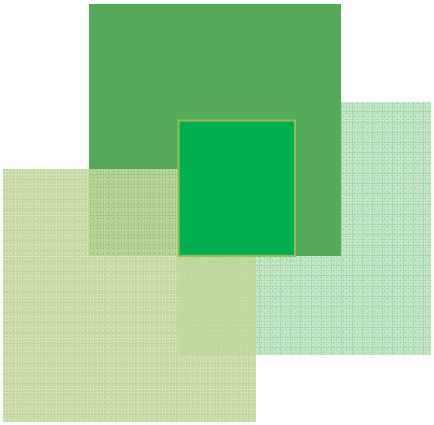

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Geneva

Skills for green jobs in the United States

Unedited background country study

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ILO Skills and
Employability
Department

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Preface

The world finds itself in a slow recovery after the deepest recession since the Great Depression. The world is also coping with a host of environmental problems and the urgent need to reduce carbon emissions. A greener future also promises an enormous potential in a much needed employment growth. However, without suitable skills, this potential cannot be realized. Today, skills gaps are already recognized as a major bottleneck in a number of sectors, such as renewable energy, energy and resource efficiency, green building and retrofitting, environmental services, and green manufacturing. Training response measures are successful where they are coherent across policy domains, systemic and systematic, and targeted at disadvantaged groups. These training measures can only be effective if based on timely identification of skills needs. Effectiveness of training measures is decisive not only for the economic recovery but also for a longer-term sustainability agenda.

This report was produced in the framework of the project, 'Skills for green jobs'. The project was implemented in cooperation between the International Labour Organization (ILO) and the European Centre for the Development of Vocational Training (Cedefop). The project identifies skills needed for greener economies with respect to structural shifts, and new, emerging and changing occupational profiles. The 'Skills for green jobs' study is embedded in the Green Jobs Initiative, a joint initiative of the United Nations Environment Programme (UNEP), the ILO, the International Employers Organization (IOE) and the International Trade Union Confederation (ITUC), to assess, analyze and promote the creation of decent jobs as a consequence of the needed environmental policies. The global study was jointly funded by the Skills and Employability Department of the ILO and the Green Jobs Initiative.

The following countries have been included in the study: the ILO covered Australia, Bangladesh, Brazil, China, Costa Rica, Egypt, India, Indonesia, the Republic of Korea, Mali, the Philippines, South Africa, Thailand, Uganda and the United States. In addition, Cedefop covered six European Union (EU) member States: Denmark, Estonia, France, Germany, Spain and the United Kingdom. The ILO global synthesis report,[1] which analyzes the situation in all 21 countries involved in the study, and the European synthesis report,[2] which covers the six EU countries, as well as all individual country reports, are available at: http://www.ilo.org/skills/what/projects/lang--en/WCMS_115959/index.htm (the ILO web site) and http://www.cedefop.europa.eu (Cedefop web site; look under Skills Needs theme). The unedited background country studies have been published in the electronic form in order to make them available quickly. The summaries are published as part of the synthesis reports.

The global project in the ILO was coordinated by the Skills and Employability Department and, in particular, benefited from comments and technical guidance by the team under the leadership of Olga Strietska-Ilina, Christine Hofmann, Mercedes Duran and Shinyoung Jeon. The ILO coordinating team would like to express great thanks to the authors of the report, William Mass, Philip Moss, Matthew Hopkins, Matthew Ross, of the University of Massachusetts Lowell Center for Industrial Competitiveness, for their background country research which contributed to the global study. Special thanks also go to the ILO regional and country field offices for the project support and the ILO colleagues who assisted research at national level.

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[1] Strietska-Ilina, O.; Hofmann, C.; Duran Haro, M.; Jeon, S. (forthcoming 2010). *Skills for green jobs: A global view. Synthesis report based on 21 countries* (Geneva, ILO Skills and Employability Department).

[2] Cedefop. (forthcoming 2010). *Skills for green jobs: European synthesis report* (Luxembourg, Publications Office of the European Union).

Foreword

In this report, we describe the major policy efforts in the United States to promote the development of green jobs, the occupational classification systems being created to track the growth of green jobs, and the education and training efforts that have been implemented to prepare US workers for employment in green industries.

We discuss the two major federal environmental policy initiatives in the most recent years; the Energy Improvement and Extension Act (EIEA), enacted in 2008, and the 2009 American Recovery and Reinvestment Act (ARRA). The first provided a host of financial incentives to invest in and use alternative energies. The second was the primary fiscal stimulus effort meant to combat the economic downturn, and supplied the funds which have been used to support state and local green investments and the education and training programs to provide skills and support for green jobs. Spurred in part by these federal efforts, as well as from their own policy priorities, state governments have implemented a very large variety of financial incentive programs to advance green technology and alternative fuel use, green building and retrofitting, and green skills development programs. We provide detail on the array of these state efforts.

United States green jobs policy has proceeded with neither a single accepted definition for a green job nor an agreed-upon best manner to analyze the green economy. We discuss the difficulties in classifying jobs as green. Further, we report on the federal government's effort to develop a data classification system which tracks the development of green jobs. In the case studies we present, we consider two new occupations: Wind Technicians and Photovoltaic (PV) Installers. We divide the existing green economy occupations into two categories; occupations for which there will be an increased demand without an increase in skills, and occupations for which there will be a demand for enhanced skills. The first category contains jobs in the area of green building, which will primarily involve occupations in the green construction industry such as weatherization and retrofitting. The second category includes the occupation of Energy Auditors. Although PV Installation is considered a new green occupation, PV technology has been around for a quite a long time, even longer than wind-generated electricity.

We close our report with a set of recommendation and conclusions. In this section, we provide suggestions on the development of information systems to bring together research and evaluations relating to green investments, job development, and training initiatives. These information systems will help to identify and track green economic activities as well as count the associated green jobs. In addition, we make recommendations on improving and sustaining quality high road development of green jobs and associated skill training.

The authors acknowledge and appreciate the questions, comments, suggestions and corrections provided by reviewers from the International Labour Organization (ILO) and the United States Department of Labor (DOL). They improved this case study, however, the views expressed are those of the authors and do not necessarily represent those of either organization. All errors of commission and omission are solely the responsibility of the authors.

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Abbreviations and acronyms

AC	Alternating Current
ARRA	American Recovery and Reinvestment Act
ASES	American Solar Energy Society
ATEEC	Advanced Technology Environmental and Energy Center
AWEA	American Wind Energy Association
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
BPI	Building Performance Institute
CAL WORKS	California Work Opportunities and Responsibility to Kids
CSI	California Solar Initiative
CSLB	California Contractors State License Board
DC	Direct Current
DOE	Department of Energy
DOL	Department of Labor
DOT	Department of Transportation
EDF	Environmental Defense Fund
EE	Energy Efficiency Industry
EIA	Energy Information Administration
EIEA	Energy Improvement and Extension Act
EOS	Economic Opportunities Studies
EPA	Environmental Protection Agency
EPIA	European Photovoltaic Installation Association
ESCO	Energy Service Company
ESOL	English Speakers of Other Languages
ETA	Employment and Training Administration
EWEA	European Wind Energy Association
FSEC	Florida Solar Energy Center
FTE	Full Time Equivalent Jobs
GBCI	Green Building Certification Institute
GCJA	Green Collar Job Academies
GED	General Educational Development High School Equivalency Test
GGS	Green Goods and Services
GHG	Greenhouse gas
HERS	Home Energy Rating System
HUD	Department of Housing and Urban Development
HVAC	Heating Ventilation and Air Conditioning
IBEW	International Brotherhood of Electrical Workers

IREC	Interstate Renewable Energy Council
ISPQ	Institute for Sustainable Power's Quality
LEED	Leadership in Energy & Environmental Design
MISI	Management Information Services, Inc.
NABCEP	North American Board of Certified Energy Practitioners
NAHB	National Association of Home Builders
NAICS	North American Industry Classification System
NHTSA	National Highway Traffic Safety Administration
NJATC	National Joint Apprenticeship and Training Committee
NSF	National Science Foundation
O*NET	Occupational Information Network
OGJC	Oakland Green Jobs Corps
OSHA	Occupational Safety and Health Administration
PERI	Political Economy Research Institute
PPCP	Photovoltaic Practitioner Certificate Program
PUMAS	Public Micro Data Areas
PV	Photovoltaic
R&D	Research and Development
RCS	Residential Conservation Service
RE	Renewable Energy Industry
REC	Renewable Energy Credit
REPP	Renewable Energy Policy Project
RESNET	Residential Energy Services Network
RPS	Renewable Portfolio Standard
SEIA	Solar Energy Industry Association
SEP	State Energy Programs
SITN	Solar Instructor Training Network
SOC	Standard Occupational Classification System
STEM	Science, Technology, Engineering, and Mathematics
TANF	Transitional Assistance for Needy Families
UNEP	United Nations Environmental Policy
USGBC	United States Green Building Council
WAP	Weatherization Assistance Programs
WIC GJSG	Workforce Information Council Green Jobs Study Group
WIRED	Workforce Innovation in Regional Economic Development

1. Introduction

United States green jobs policy has proceeded with neither a single accepted definition for a green job nor an agreed-upon manner to analyze the green economy. Different federal agencies provide overlapping but conflicting standards for defining green jobs, the scope of green economic activities, and the boundaries of green industries. There is a wide variety in green jobs policies and programs at the state and municipal level. This variation is important to the analysis of the green economy given the significant degree of autonomy held by state and municipal policy-makers. The extensive role of state-based programs, as well as efforts to align and integrate state and federal programs, is a fundamental feature of the design and implementation of recent US policy.

Energy policy, primarily renewable energy (RE) and energy efficiency (EE), dominates the key policy initiatives related to "greening" the economy, both at the state and federal levels. Green or clean energy jobs are the common thread linking the various sections of this report. We detail the working definitions of green jobs as related to key policy initiatives and provide a brief overview of the federal efforts to define jobs and occupational standards for identifying careers in the green economy. We attempt to create a common platform that includes both the foundational definitions and operational measurement instruments to assess both the extent of emerging green jobs and the greening of existing occupations. The specific definitions and analytical framework we develop will support future comparisons of state policies and with federal initiatives.

The most widely agreed-upon definition of a green job is that it contributes to environmental quality. This definition is extremely broad and includes existing semi-skilled construction-related jobs, such as weatherizing and retrofitting buildings, along with the New and Emerging more technical occupations, such as developing and implementing clean energy technologies. These New and Emerging occupations are generally what constitute the public's image of a green job. A broad definition such as this has appeal to policy-makers because it results in larger counts of green jobs relative to a more narrow definition. This definition of a green job encompasses a large variety of sectors and therefore allows more categories of jobs to qualify for federal and state policy funding streams. This definition is problematic, however, precisely because it includes so many job categories within which there are many jobs that would not be considered green by most observers. Therefore, it will be imprecise in assessing the level of environmental impact various job categories have and it lacks the complexity necessary to measure progress accurately. Understanding the workforce dimensions of this definition is crucial to attaining progressive environmental policy goals. The measurement challenge is related to policy challenges because the sets of institutions engaged in workforce development must emphasize the job or occupation as the relevant unit of analysis. The definition of an occupation as "green" or "greening" must link to the economic activity and its environmental impact addition to an analysis conducted at the level of work.

The second dimension of the US policy discussions relating to the definition of a green job focuses on establishing a minimum level of job quality. Primarily the issue is discussed in terms of wage levels and working conditions. The latter includes worker health and safety. The movement to promote green jobs is generally considered a progressive one in the United States. As a result, it is often asserted that green jobs should be high quality jobs and not be low wage or dangerous jobs. This is less a definition of a job in the green economy than a characteristic deemed appropriate for all jobs that government policy is attempting to promote. Organized labor in the United States has historically opposed the environmental movement and has strongly opposed tightening environmental regulations. Environmental regulations have been often seen as job-threatening regulations within specific industries by organized labor in the United States whose broader carriage regarding these canons was considered generally unfavorable. Recently,

however, there has been a dramatic shift toward general as well as industry-specific collaboration for green job creation by organized labor and policy-makers through what have become known as Blue-Green alliances.[3] The adoption of the requirement that a green job must be a job of decent quality into the overall description of a green job is a subtle nuance of the policy debate occurring in the United States. This is an excellent example of how green jobs policy has evolved to have a number of goals and how these different goals lead to different working definitions of a green job.

The primary goal for promoting green jobs and enhancing green-specific training is to improve environmental quality while reducing the forces contributing to climate change. Additional policy goals have been attached to this primary mission and are critical to the extent that environmental policy goals come to fruition. The ability of green policy in the United States to gain sufficient political will for passage and effective implementation is highly contingent on this more comprehensive set of agendas. These additional policy priorities include:

1. providing a means to generate rapid job growth as part of the fiscal stimulus plan in the current period of high unemployment;
2. diminishing dependence on foreign energy sources for national security reasons as separate if not wholly distinct from national economic goals;
3. improving the quality of jobs available to modestly-skilled and/or educated workers;
4. providing access to decent employment for groups such as high school dropouts, inner city minorities and others who have experienced low levels of employment success.

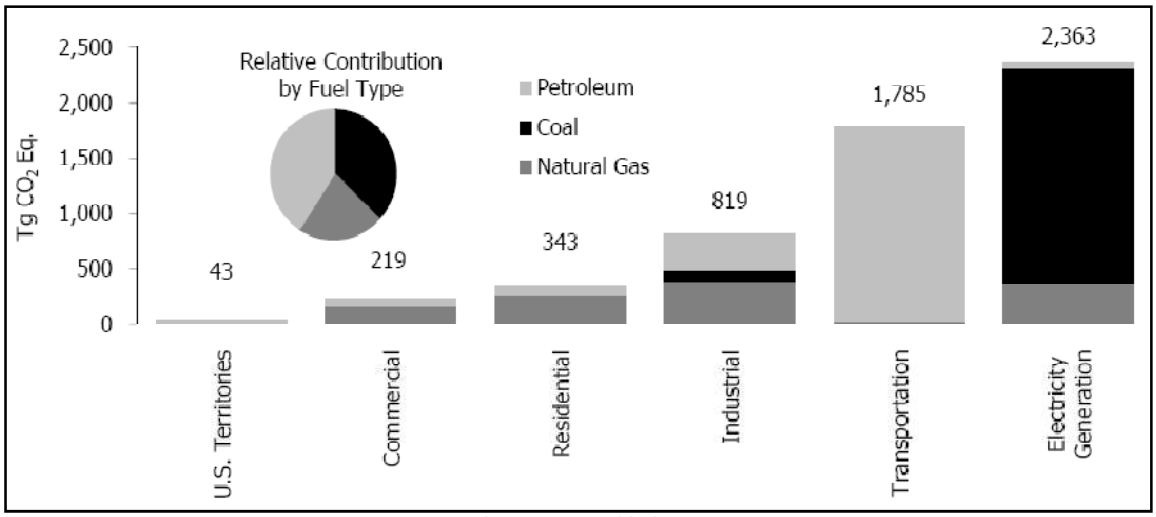
2. The policy context

2.1 Key challenges and priorities for the green economy

The United States is the second largest producer of greenhouse gases (GHGs) in the world and depends tremendously on fossil fuel. President Barack Obama, who campaigned for office as an environmentalist and has articulated a need to lessen the US demand for fossil fuel, particularly oil, announced in the spring of 2010 that the United States needed to expand the dangerous practice of offshore oil drilling along the east coast. As is now widely known, offshore oil drilling in the Gulf of Mexico lead to a catastrophic environmental disaster when British Petroleum's Deepwater Horizon Rig exploded in April, releasing millions of barrels of oil from its underground well. It is one of several examples of the risks of fossil fuels. Clearly the United States needs to reduce its consumption of oil or risk further devastating oil-related environmental calamities. Independent from the issue of individual environmental calamities such as oil spills is the issue of CO_2 emissions and their effect on global climate change. The pattern of automobile use in the United States as well as the slow pace of developing more fuel-efficient and alternative fuel-powered cars poses an enormous challenge for the reduction of CO_2 emissions. Additionally, the United States relies very heavily on coal-powered energy plants, which contribute substantially to the nation's output of CO_2 emissions.

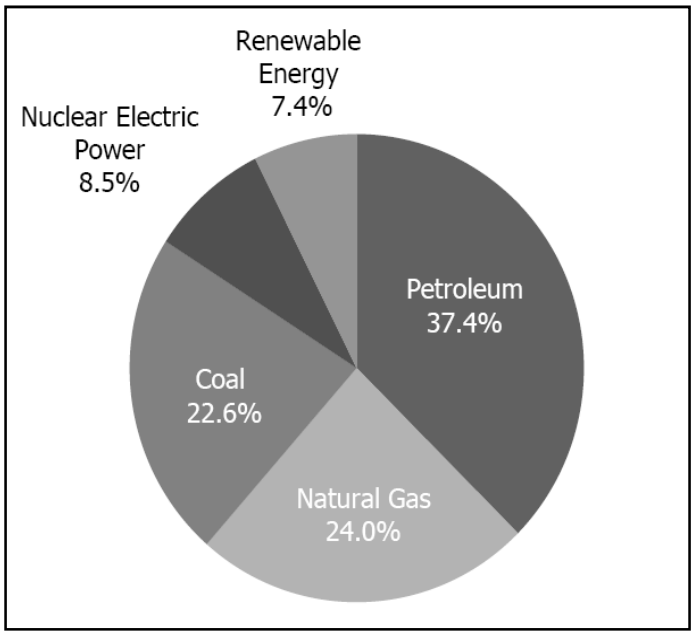
[3] Prominent examples include: Blue Green Alliance (http://www.bluegreenalliance.org), Apollo Alliance (http://www.apolloalliance.org), and the AFL-CIO's Center for Green Jobs (http://www.workingforamerica.org/documents/greenjobs.asp)

Figure 1: CO_2 emissions from fossil fuel combustion by sector and fuel type, 2008



Source: EPA, 2010a.

Figure 2: Energy consumption by source, 2008

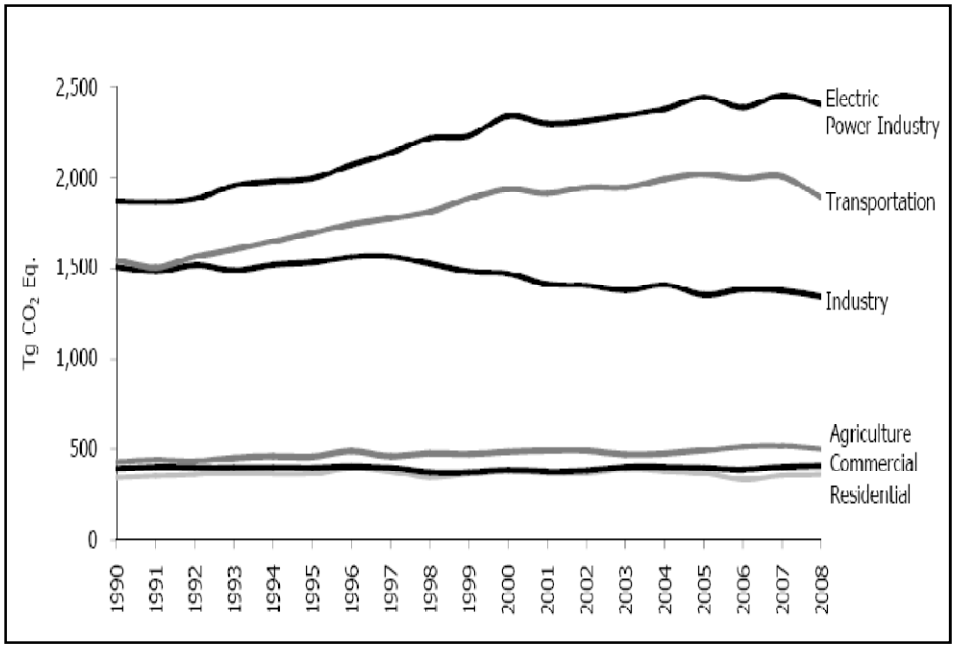


Source: EPA, 2010a.

The most current data for the US economy, 2008, in an Environmental Protection Agency (EPA, Apr. 2010) report entitled *Inventory of U.S. greenhouse gas emissions and skins: 1990-2008* is shown in Figures 1 through 4 and outlines the primary sources of carbon emissions from fossil fuel by sector, fuel type, per capita, and per dollar of GDP GHG emissions. The following graphs from the Executive Summary of the EPA's US Inventory summarize the data most pertinent to this report.

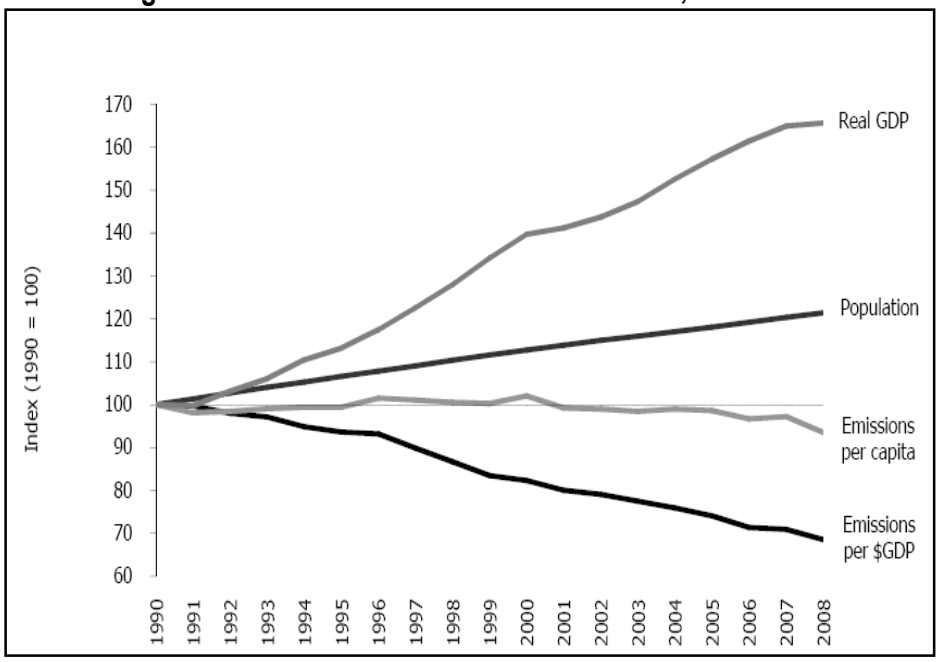
The Bush-Cheney Administration was heavily criticized for insufficient regulation and oversight of the US energy sector, as well as other sectors that contribute to environmental damage. They were also criticized for slowing down the development or the tightening of standards for vehicle emissions and emissions from coal-fired power plants. The Obama Administration has stated its intentions and begun legislative efforts to strengthen vehicle efficiency standards and promote the development of alternative energy sources. In addition, through relatively large anti-recession federal spending and financial incentive programs along with complementary state incentive programs, the government is spurring sufficient activity that should make a difference in CO_2 emissions and in the occupational composition of the US labor market. President Obama has made it clear in public speeches that he sees the duality in his environmental policy agenda of reducing carbon emissions and promoting alternative fuels and renewable energies on the one hand, and job creation on the other.

Figure 3: Emissions allocated by source, 1990-2008



Source: EPA, 2010a.

Figure 4: Economic distribution of emissions, 1990-2008



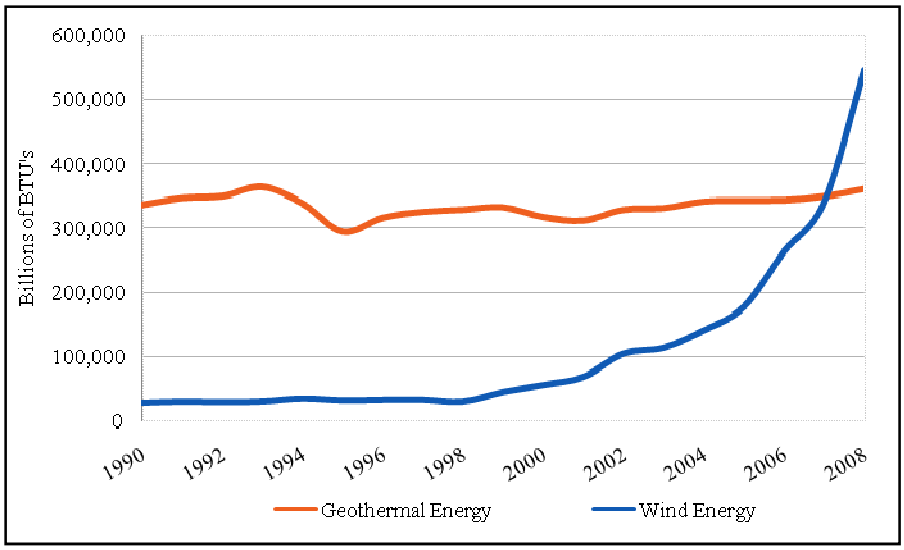
Source: EPA, 2010a.

2.2 The response strategy

The federal and state governments have been investing in the research and development (R&D) of renewable energy sources as well as technology that better conserves the use of fossil fuels. Figures 5 and 6 below show the growth in consumption of RE sources in the United States since 1990. These efforts have increased and decreased in momentum over the last two decades depending on the agenda of the Executive Branch and who occupies the White House. The election of Barack Obama placed environmental policy high on the policy agenda. The severe economic decline has prompted a large increase in federal stimulus spending and a large proportion of these funds have been invested in RE and EE industries. As a result, the scale of environmental policy activity has increased substantially.

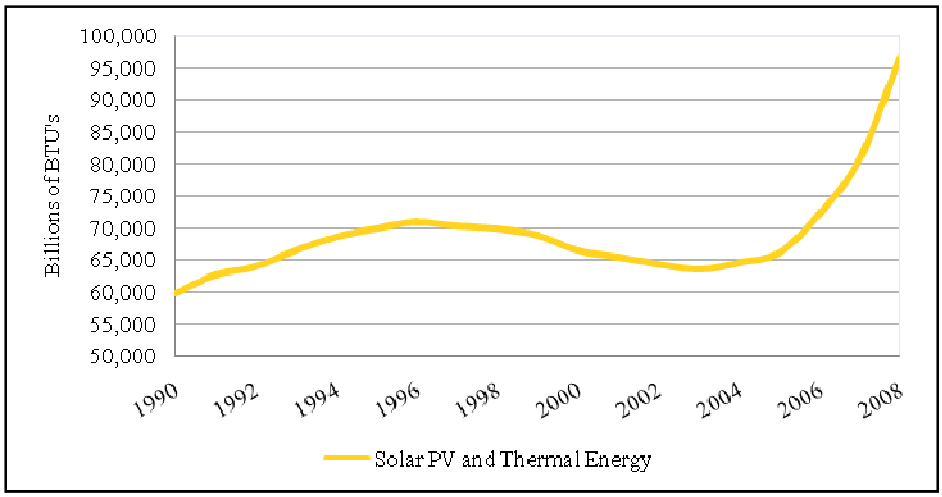
Some examples of EE industry sectors that have received significant investment include: green construction, improved public transportation, and energy retrofits. Some of the RE sectors that have recently received large-scale investments include: wind energy, solar energy, biofuels, and geothermal energy. As a result of the increased investment in these industries, the labor demand for skilled workers who are fluent in the specific skills necessary for employment in the green economy has expanded. Many of these industries require basic construction skills where the skills and occupations are not necessarily being changed but are experiencing greater demand. One example of an occupation with increased demand is Energy Auditors. Similarly, many of these industries have the same skill requirements of existing occupations but require some green-specific retraining. Some existing occupations with green-specific training requirements include: Green Construction, Weatherization, and Energy Retrofitting. Some industries, however, require labor that might be considered a new green occupation. An example of a new green occupation can be found in the example of Photovoltaic (PV) Installers and Wind Technicians. This report will detail US policy initiatives to promote the EE and RE industries and include an analysis of both federal and state spending, regulatory changes, and financial incentives such as changes in taxes and subsidies. The report presents case studies on both specific occupations and training programs in order to trace the link between these policies and the skill demands they will create.

Figure 5: Geothermal and wind energy consumption, 1990-2008



Source: DOE, 2010e.

Figure 6: Solar energy consumption, 1990-2008



Source: DOE, 2010e.

2.2.1 The general environmental strategy

The major elements of the US energy-focused environmental strategy consist of reducing vehicle emissions and fuel consumption, regulating industry emissions, regulating waste disposal, regulating the emissions of electric power plants, permitting the building of new power plants, and promoting non-fossil fuel-based energy sources. In addition to the programmatic and regulatory functions dealing with environmental degradation, an important part of US policy involves tax subsidies and other financial incentives for energy conservation, transportation, and alternative energy development.

Although many US government departments and agencies are involved in programs and regulations that concern the environment, the major responsibility for policy that addresses threats to the environment resides with the US Department of Transportation (DOT), the EPA, the DOE (Department of Energy) and to a lesser degree the Department of the Interior. The National Highway Traffic Safety Administration (NHTSA) of the DOT and the EPA share

responsibility for setting vehicle emission and miles per gallon standards for automobiles. The EPA sets emission and waste disposal standards for business and commercial enterprises. The DOE, along with the EPA, oversees and regulates the emissions of electricity generation by power plants. The Department of the Treasury administers the tax and subsidy provisions that encourage energy conservation and the development of alternative and RE sources.

Tax and subsidy incentive programs have been part of the US environmental strategy for three decades. While the Bush-Cheney Administration was viewed negatively within the environmental movement, the previous Administration did enact a number of tax incentive programs to stimulate activities that contributed to environmental improvement and decreased dependence on non-US sources of fuel. President Bush extended these various tax incentive programs in 2008 with the legislation HR 1424: The Energy Improvement and Extension Act (EIEA) (Du Bois, 2008). The Act extended many existing policies (in 2008) through 2016. The Act focused primarily on the extension of RE incentives, Clean Renewable Energy Bonds (CREBS), investments in hybrid and biofuel transportation, and various incentives for EE. A summary of some of the tax incentives available can be seen in Table 1.

As we discuss below, these tax and credit provisions are meant to induce state and local governments, companies and individuals to spend and invest in ways that promote alternative and RE use, energy conservation, and public transportation. All of these activities will generate a variety of jobs that require a gamut of skill levels. Demand will increase for scientists and engineers to design and implement new alternative fuel technologies. Similarly, intermediate skill-level jobs such as inspectors and technicians will experience growth. Construction occupations with both high and very basic skill requirements will experience growth in employment from a variety of green sectors from wind and PV to weatherization and green construction. The existing construction labor supply will be required to make skill modifications to conduct projects ranging from building new power generating systems, erecting new energy efficient buildings, and retrofitting existing buildings and homes. We discuss the specific job creation estimates in section 3.2. These tax and credit provisions do not, however, directly fund the training necessary to generate the relevant skills. The federal government is the primary funding source for training programs through the DOL. State governments are also adding green skills training programs through the use of community colleges, vocational schools, municipal legislation, transitional assistance, and a wide variety of nonprofit organizations.

Table 1: EIEA incentives, credits, and deductions, 2009

Renewable energy (RE)	Transportation and domestic fuel security	Energy conservation and efficiency
Extension of Production Tax Credit	Plug-in Electric Vehicle Credit Increase	Qualified Energy Conservation Bonds Conservation Bonds
Long-Term Extension of Energy Credit	Incentives for Idling Reduction Units and Advanced Insulation for Heavy Trucks	Extension and Modification of Credit for Energy- Efficiency Improvements Existing Homes
Long-Tern Extension and Modification of Residential Energy-Efficient Property Tax	Expansion of Allowance for Cellulosic Biofuels Property	Extension of Energy-Efficient Buildings Deduction
Sales of Electric Transmission Property	Extension of Biodiesel Prod Tax Credit	Extension of Credit for Energy-Efficiency Improvements to New Homes
New Clean Renewable Energy Bonds "CREBS"	Extension and modification of renewable diesel tax credit	Modification and extension of energy-efficient appliance credit
	Extension and Modification of Alternative Fuels Credit	Accelerated Depreciation for Smart Meters and Smart Grid Systems
	Extension and Expansion of the Alternative Refueling Stations Credit	Extension and Modification of Qualified Green Building and Sustainable Design Project Bonds
	Publicly Traded Partnership Income Treatment of Alternative Fuels	Investments in Recycling
	Percentage Depletion for Marginal Wells	
	Bicycle Commuter Tax Incentives	
	Refinery Expensing Tax Deduction	

Source: Information gathered from EnergyPriorities.com (2010) and GovTrack (2010).

The total ten-year cost estimated by the Senate Finance Committee for the provision of these incentives is expected to be US$15-17 billion between 2008 and 2016 (US 110th Congress, 2008). This is approximately a $2 billion per year commitment from the US Government to support the continued development of the RE and EE sectors. These economic efforts are almost exclusively being enacted through various tax credits and exemptions. In addition to the incentives listed, investments in R&D focused in environmental areas qualify for the federal R&D Tax Credit (IRS, 2010).

The majority of green economy programs and training come from the American Recovery and Reinvestment Act (ARRA) and the DOE. As a result, the lion's share of the funding is being distributed through federal agencies. Some states have also adopted a very large number of complementary regulatory and financial incentive policies which contribute to the demand for green jobs (DSIRE, 2010a). The sheer number of state and municipal policies that can be found *in support or as part of regulatory effort for RE and EE is astounding.* The DSIREusa.org database of state and municipal RE and EE policy contains over a thousand rules, regulations, legislation, and incentives (ibid.). The massive number of policies aimed at the expansion of these green industries makes it extremely difficult to comment on the range of activities occurring at the state level in a straightforward and comprehensive way.

One thing that is clear is that the funding provisions under the 2008 EIEA and 2009 ARRA have contributed to expansion of policies that focus on manufacturing more RE technologies, researching basic renewable technologies, and helping states to attract clean economy activities. These incentives are being allocated at the state level through tax incentives and the diversification of renewable goals into industries such as solar by modifying existing renewable

portfolio standards (RPS).[4] Thanks to the billions of dollars released to states for State Energy Programs (SEPs), states are better positioned by the stimulus to invent new incentives and revise old ones. Some states are beginning to adopt new green building standards that give priority permitting (Hawaii) or permit rebates (Connecticut) to green-certified projects. Some states allow for increased building density to projects that meet the Leadership in Energy & Environmental Design (LEED) standard (Virginia) (DOE, 2010b).

LEED is a green building certification system, developed by the United States Green Building Council (USGBC) that is widely recognized. Data from the Energy Information Administration (EIA) reveals that non-hydroelectric expansion of RE has in the last ten years responded to the increased adoption of RPS policies throughout the states. Moving forward, the implications of the "Smart Grid" and increasing support and funding for electric vehicles should force changing standards for net metering and interconnection policies across the United States. It is unclear how, for now, although it is not inconceivable that residential properties currently supplying electricity to the US grid may also find themselves positioned to sell their storage capacity to it as well. All of the state initiatives will have job creation implications, as the activities that are incentivized involve the kinds of demands for existing jobs, enhanced skills jobs and new and emerging jobs that we mention below.

Booz Allen Hamilton (2009) estimated that the green building industry will support around 8 million jobs through 2013. Their estimates are broken into two parts, estimating the job impacts from green construction, and from LEED-related growth. The period 2000-08 shows 2.4 million jobs and $554 billion for GDP (Gross Domestic Product). Direct impact on employment during this time period was 1,039,177 jobs. The green building market was only 2 per cent of non-residential construction starts in 2005; 10-12 per cent in 2008; and predicted to grow to 20-25 per cent by 2013. A lot of the buildings expected to drive this sector in the future will be on the public and industrial side (DOE; EPA, 2010); (USGBC, 2010b).

Table 2: RE rules, regulations, and policies, 2009

RE rules, regulations, and policies	States with a rule, regulation, or policy in place	Federal rule, regulation, or policy	Total rules, regulations, or policies
Public benefits funds — A tax on energy use to fund renewable energy uses	18	0	23
Renewable Portfolio Standard (RPS)	36	0	44
Net Metering	46	0	68
Inter-Connection	41	1	44
Contract License	9	0	11
Equipment Certification	4	0	5
Access Laws	36	0	55
Construction & Design	36	1	96
Green Power Purchasing	0	0	0
Required Green Power	9	0	9

Source: Authors' tabulations from DSIRE, 2010a.

[4] "A renewable portfolio standard is a state policy that requires electricity providers to obtain a minimum percentage of their power from renewable energy resources. Currently there are 24 states plus the District of Columbia that have RPS policies in place. Together these states account for more than half of the electricity sales in the United States." (DOE, 2010b).

A report by the Interstate Renewable Energy Council (IREC, 2009) tracked changes in policies for RE and EE for 2009, pointing out that along with the policies shown below, at least 13 states are implementing property-assessed clean energy policies, and many are shifting away from rebates in favor of "performance"- or "production"- based incentives. A summary of the number of green regulations and policies at a federal and state level can be seen in Tables 1 through 4. These incentives can take the form of a feed-in-tariff, which subsidizes the cost of RE and which 13 states have adopted so far. An RPS is a regulatory standard enacted in the United States at the state level setting a minimum level of RE use by a certain target date. More states are mandating a minimum balance of solar energy in their RPS figures, and over half of the states now have an RPS requirement of 10 to 30 per cent in place to be met in the next ten years (by 2020). Thus, even lacking an official federal target, the United States is positioned to potentially double or triple its RE base in the next ten years. Working in conjunction with these policies are policies mandating green power purchasing, meaning in some cases that large utility companies or publicly-regulated power companies must offer green energy options to customers. So far, only states with an RPS already in place have forced a green power policy as well. These kinds of mandates are important in that they help to expand the reach of RE to more customers.

Table 3: EE rules, regulations, and policies, 2009

EE rules, regulations, and policies	States with a rule, regulation, or policy in place	Federal rule, regulation, or policy	Total rules, regulations, or policies
Appliance / equipment standards	12	1	13
Energy standards for public buildings	45	1	51
Building energy codes	50	0	53
Public benefits funds	20	0	23

Source: Authors' tabulations from DSIRE, 2010a.

Overall, rebates, loans, and regulations surrounding construction, and net metering policies are the most widespread policy types in the United States. It is clear, however, that policies such as the RPS and access laws have been broadly adapted and put into use by more than half of all US states, and in many cases adopted by as many as two-thirds. Many of the policies represent incentives to build efficiently and according to LEED standards (Bronze, Silver, or Gold standard), and these policies so far appear to be occurring at the local, rather than state or federal levels. New categories of rules and regulations are also appearing, found under DSIRE as green power purchasing or required green rules. At this time, only required green power has appeared in only nine states. This mandate has appeared in states that already have an RPS in place and can indicate either that utilities must provide a green power purchasing option to customers, or an RE credit. In the State of Virginia, the mandate provides for the ability of customers to buy 100 per cent RE from their utility company.

Table 4: Financial incentives for RE, 2009

Financial incentives for RE	States with an incentive	Federal policies	Total policies
Personal tax	21	3	38
Corporate tax	24	4	39
Sales tax	27	0	36
Property tax	33	0	62
Rebates	43	0	326
Grants	28	3	66
Loans	37	5	159
Industry support	21	1	35
Bonds	3	0	3
Production incentives	9	1	55

Source: Authors' tabulations from DSIRE, 2010a.

Each Policy Table 1 through 4 above is meant to support continued investment in RE or EE. While most of these policies are enacted at the state or utility level, organizations like the American Wind Energy Association (AWEA) and the American Solar Energy Society (ASES) like to highlight the importance of federal leadership in some areas, such as adoption of a national RPS that can standardize and unify RE objectives for the industry. Instead, policy "leadership" seems to be occurring within those states that have adopted the most aggressive policies or who offer lucrative incentives. In 2009, Hawaii, a historically oil-dependent state, selected a 40 per cent renewable standard by 2030. This exceeded California's 2002 adoption of a 33 per cent standard, also for 2030. Hawaii will attempt to achieve a 25 per cent standard by 2020. Other states, like Maine, adopted a 40 per cent RPS by 2017 (goal enacted in 2006), declaring that 10 per cent of RE must be new by that time period. For Maine specifically, this seems like a lofty target, however, that state already has achieved a 40 per cent proportion of RE, if you include existing reliance on hydro power and biomass energy sources. Clearly, some states are playing it safe – establishing goals meant to express a commitment to green investments without leaving room to fail to make truly meaningful headway. Nevertheless, the RPS represents a commitment to green investment that usually guarantees some level of activity in the RE sector for the next decade or two.

EE, primarily "green building" activities, are driven by building code standards combined with incentives to invest in either new green materials for a new building or to retrofit existing spaces. Every state has a building code, but more state and local governments, as noted above, are specifically carving out new green building codes that take advantage of the strict LEED standard for green building.

> "Interest in smart grid has only intensified over the last year given $700 million in federal stimulus funding for smart grid demonstration projects. Further embedding intelligence into the grid offers a host of benefits including facilitating higher penetration levels of renewable energy. One such source of embedded intelligence is grid-integrated, electrical energy storage, including plug-in electric vehicles and battery electric vehicles. As electrical energy storage technologies become increasingly financially attractive across a broad range of locations and applications, policy-makers will need to address regulatory barriers that may impede the deployment of electrical energy storage onto the grid." (EIA, 2009)

A large piece of the transition to a smart grid is the simultaneous expansion of battery-equipped electric cars which provide a storage source when plugged in by day or night. As the number of electric vehicles multiplies in part through direct funding of advanced battery research

(on the order of $2 billion) and federal policies focused on increasing incentives to purchase hybrids (such as the $4,500 tax credit and "cash for clunkers" program), the additional power storage and flexibility needed to support a smart grid increases. Policy-makers are starting to think about ways to integrate this changing technology with existing net metering and interconnection policies, which have so far provided financial incentives for connecting RE sources to the grid and regulating the size of installations that can feed into the grid. These kinds of policies also vary by states, for instance, the State of California allows systems up to 5 MW (megawatts) to qualify for net metering incentives, and allows utility companies that pay customers supplying the grid to own the customers' Renewable Energy Credit (REC), which they in turn can then use to offset their own CO_2 emissions. The State of Massachusetts has a tiered system that extends from 60 kW (kilowatts) to 2 MW, allowing utility customers to own their REC, and has provisions for "neighborhood" net metering where groups of homeowners can be included together. Most net metering policies range in qualifying power loads from small scale (up to 600 kW or so) to larger scale (2 MW) and tier them based on whether the generator is a residence, a municipality, or other non-residential groups (ibid., p. 38).

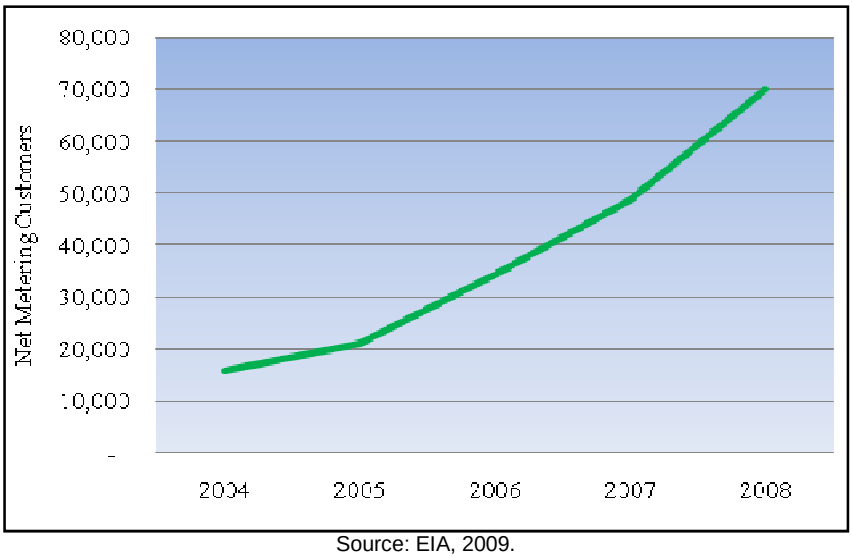
Table 5: Financial incentives for EE, 2009

Financial incentives for EE	States with an incentive	Federal policies	Total policies
Personal tax	13	2	15
Corporate tax	8	4	12
Sales tax	9	0	9
Property tax	5	0	6
Rebates	49	0	943
Grants	25	2	58
Loans	46	4	211
Bonds	3	0	3

Source: Authors' tabulations from DSIRE, 2010a.

According to the IREC, many states are now in the process of beginning to change their interconnection and net metering policies in anticipation of changes to the energy grid brought on by the ARRA. As Figure 7 shows, there is no shortage of interest in net metering, and it appears that as more states add policies, the number of net metering customers will continue to rise. The Institute for Sustainable Power's Quality (ISPQ) was founded by IREC and works directly with the North American Board of Certified Energy Practitioners (NABCEP) to develop and spread credentials as well as international standards.

Figure 7: Net metering program enrollment, 2004-08



Source: EIA, 2009.

The IREC surveyed representatives of the PV industry and found the following concerning training required for an expansion of the PV industry. PV installers are the highest priority job need. Other jobs for which training is needed are: PV system designers and engineers, contractors licensed to install PV equipment, building code inspectors, sales and site assessment personnel including estimators, architects and building designers that can incorporate PV into their designs, personnel for utility companies that are interested in solar applications, and construction cost accountants and financing personnel specializing in PV installations. The IREC has begun to hold workshops around the country to "train the trainers" to be able to provide the training for these skills and occupations.

2.2.2 The green response to the economic crisis

Aside from the actions taken by the US Government to stabilize financial markets and financial institutions, the principal response to the economic collapse of 2008 was the fiscal stimulus effort, the ARRA of February 2009. Its purpose is also to provide employment opportunities to virtually every sector of the economy, from construction and transportation, to renewable and legacy energies, to funds investing in fundamental sciences. The complexity and ambition of the Bill also acknowledges, to a degree, the impacts of the US-created global financial crisis, historic state budget squeezes, federal bailouts, and renewed fears of a world environmental catastrophe related to the recent and significant increase in the cost of fuel and global warming. Energy-related activities, however, represent a minority of the total spending under the ARRA. As we note below, the majority of spending is on items directly related to creating and maintaining jobs in state and local governments and business, and income supports to individuals and businesses suffering from the economic crisis.

The ARRA authorized a $787 billion injection into the US economy, with $288 billion (or 37 per cent) of the funds to be paid out in the form of tax benefits; $275 billion (or 35 per cent) of funds to be paid out in tens of thousands of contracts, grants, and loans to a variety of organizations and businesses; and the remaining $224 billion (or 28 per cent) of the Act to be spent on various entitlement outlays. By February 2010, only 35 per cent of the funds made available had been paid out, and while over 70 per cent was paid out by the end of November, there was a significant amount of funding either still available, or not yet utilized (US Executive Office of President Barak Obama, 2009). Some $362.5 billion, or nearly half (46.1 per cent) of the money granted under ARRA is being used for tax cuts for individuals ($116 billion), Medicaid ($87.1 billion), extending the Alternative Minimum Tax ($70 billion), granting state

support for education and education jobs ($53.6 billion), and providing additional funding for unemployment insurance ($35.8 billion) (Hossain et al., 2009).

There are several estimates of the amount of ARRA funding that is devoted to green activities that will generate jobs and promote environmental quality. The White House claims that some $80 billion of the stimulus fund are supporting activities which provide jobs as well as an American future most simply characterized as more energy independent (US Executive Office of President Barak Obama, 2010). This represents about 10.2 per cent of the ARRA outlay, and is notably smaller than most of the major funding efforts noted above. Our own calculations suggest approximately $76.6 billion from different parts of the stimulus program supports EE, transportation, and job training efforts. Other estimates of the total job-generating spending vary. Some reach $100 billion or more, including the estimate by the Political Economy Research Institute (PERI), which we discuss below.

The PERI of the University of Massachusetts Amherst, in a widely-cited report (Pollin et al., 2008), estimates that about $100 billion of the Stimulus Act and the EIEA will be directed toward green initiatives. The goal of the PERI research was to make an estimate of the job creation impact of the total spending being made on green activities. The PERI researchers took a very broad view of green-related funding and included spending beyond the specific categories that make up the White House and our own estimates. The $100 billion attributed to clean economy investments in the PERI report included all funding from the DOE ($40 billion), funding from the Treasury (some of the tax incentives) and DOT. Not all of the information that PERI relied upon for funding values could be readily disaggregated. For example, they counted all dollars going toward public transportation (like buses) on a comparable basis, whatever the energy source. This was done, however, in part because that money will support electric or biodiesel buses along with buses powered by fossil fuels.

Some of the EPA programs related to toxic waste remediation (former industrial sites with toxic wastes, or nuclear waste disposal sites) were also included in the PERI measure of ARRA environmental programs not directly related to clean energy production. Some of the EE dollars in the PERI total came from the Department of Defense for retrofitting and otherwise greening Department of Defense-related buildings; the Office of Veterans Affairs and the Department of Housing and Urban Development (HUD) for weatherization of homes; and the Department of the Interior for a variety of public land management activities. Obviously some might dispute the "greenness" of several of these spending categories such as nuclear waste management or various fossil fuel investments. Nuclear power might be considered green by those prioritizing carbon mitigation as the singularly most significant environmental concern; others concerned about the thousands of years of risk to health and environment associated with nuclear waste maintain a priority of opposition to nuclear energy relative to other sources of energy generation. While there is a general consensus that cleaning up and containing nuclear waste that already exists is an environmentally-appropriate priority, the issue of who should pay and how it may add to incentives promoting nuclear energy generation remains a contested policy among environmentalists (Pollin et al., 2009, p. 6); (Kitschelt, 2009).

Below is a list of perhaps the most significant funding activities under ARRA and EIEA (EIA, 2009); (US Executive Office of Barack Obama, 2009; 2010); (Hossain et al., 2009); (DOE, 2010a):

- $18.7 billion for EE, building RE industry, restructuring transportation, and fundamental research in the sciences related to energy;
- $13-17 billion to support incentives and tax credits related to RE, EE, housing retrofits, and other activities;
- $4.5 billion for the greening of federal buildings;

- $600 million for direct green workforce training – up to $10 billion for other economy-wide workforce investments.

To those concerned with the environment, the proportion of total funding that is going to activities that will create and train for green jobs may appear relatively small under the ARRA and EIEA. Nonetheless, the total government outlay for energy is historically striking, as spending in this area is expected to be at least 50 per cent higher than 2008 levels through 2012 (US Executive Office of President Barack Obama, OMB, 2010b). The EIEA and ARRA have provided for the extension and creation of significant federal outlays which amounted to numerous direct and indirect investments in RE, EE, production, and technology. The billions of dollars released and made available primarily through competitive grants were dispersed to extend or enhance many existing state policies which form a complex commitment to advancing the need for the creation of greater overall national energy independence.[5]

2.3 The skills development strategy in response to greening

The ARRA contains a $600 million allocation to the DOL for education and training programs related to the expansion of green skills through the labor force. These monies are being disbursed through a variety of training providers reflecting the extremely diverse set of organizations - governmental, nonprofit, and private - that make up the publicly-funded education and training system in the United States. A competitive grant process governs the allocation of the training monies. State and local government agencies involved in financing local training programs bid for grants, as do universities, colleges, and community colleges. State and local governments then evaluate proposals from community-based nonprofit agencies, from the vocational schools within their jurisdiction, as well as higher education institutions, and sometimes the state or local governments provide the training themselves through their own local training facilities. The Green Jobs Act passed in 2007 authorized the spending of monies to be administered by the DOL, "to help address job shortages that are impairing growth in green industries, such as energy efficient buildings and construction, renewable electric power, energy efficient vehicles, and biofuels development." (US 110th Congress, 2007). The Green Jobs Act was extended by the ARRA to provide funding in five categories including the State Energy Sector Partnership and Training, Pathways Out of Poverty, Energy Training Partnerships, State Labor Market Information Improvement, and Green Capacity-Building grants.

State Energy Sector Partnership and Training (34 grants)

Funds are awarded to support the formation of a comprehensive state-level clean energy and RE strategy, develop new partnerships, and integrate education and training activities to promote skill development and career pathways for low-skilled and displaced workers. Thirty-four states received awards, and the total value of these awards was about $190 million (ETA, 2009d). Energy Training Partnership Grants include 22 grants, which were awarded to 22 states, with a total award value of about $100 million. The purpose of the grants was to prepare workers for the emerging green industry, but also to invest in a diverse set of stakeholders including labor organizations, public and private employers and the workforce system. Some $28 million of the funds were reserved specifically to serve communities impacted by the auto industry down-turn, all training and placement activities are to occur at the local level, and all funds were directed toward the RE and EE industries (ETA, 2009b).

[5] The sudden spike in energy spending does not appear to be matched by any other period except the mid- to late 1970s, and early 1990s. As a proportion of total federal outlays, however, it is notable that energy spending appears to be within the average established since the 1960s.

Pathways Out of Poverty (38 grants)

Some $147 million were awarded to 22 states through Pathways Out of Poverty Grants. These grants are targeted to persons living at or below the poverty level, and the current recession has created a need for focus on poverty as more individuals slip into poverty. The purpose of these grants is to fund integrative solutions and supportive solutions to Public Micro Data Areas (PUMAS) where poverty rates are 15 per cent or higher (as defined by the census). Thus the concentration of these grants reflects high poverty urban areas. Incumbents in these integrative programs are supposed to have access to sound recruitment and referral strategies, teach basic job skills, with flexible services and locations. These awards were made to national nonprofits and local public, private, and nonprofit organizations (ETA, 2009c).

Energy Training Partnership (25 grants)

Twenty-five grants totaling nearly $28 million in funds from the Energy Training Partnership grants were provided for the creation of dislocated worker training programs with a focus on green energy. These awards range from $1.4 to 5 million and target women, minorities, dropouts, youth, underemployed, and others, and will support training in energy auditing, solar and wind installation. The grant recipients will partner with labor organizations, and workforce investment boards to create training partnerships in the green energy sector.

State Labor Market Information Improvement (30 grants)

Thirty grants worth $47 million were awarded to 30 states. These grants are intended to assist states with the assessment of green technology impact studies, occupational studies that identify occupational needs and the needs of the RE and EE industries, research that focuses on the regulatory and policy environment, capital investments in green industries, and the posting of jobs to online job banks, which includes trying to connect 'local' workers to 'local' jobs (ETA, 2009f).

Green Capacity-Building (62 grants)

Sixty-two grants were made to 29 states. The purpose of these grants is to build on the green capacity of current DOL grantees. DOL agencies that receive federal funding through the DOL are to use these funds to add green components to their existing job training or skill boosting facilities, building incumbent competencies for green industries (ETA, 2009c).

In addition, the ARRA provided additional support to DOL programs that began several years before the ARRA was passed. While not dedicated to green job training, these programs include EE and alternative fuels sectors and occupations and therefore are contributing to the US green skills development strategy.

One major such program is the Community-Based Job Training Grants program (ETA, 2008a). These grants are intended to build the capacity of community colleges to train workers in the skills required to succeed in high growth, high demand industries. These grants build on the High Growth Job Training grants, which are intended to increase the number of qualified individuals that can enter healthcare, information technology (IT), and advanced manufacturing jobs (ETA, 2010b). The industries selected by the High Growth Training Grant Initiative were selected on the basis of projected industry growth and/or industries that are in the process of transforming as the result of innovation and new technologies. Two of the 14 sectors chosen are energy and transportation, both green job sectors. The Community-Based Job Training and High Growth Job Training grants are supported by the Workforce Innovation in Regional Economic Development (WIRED), which brings together state, local and federal entities, academic institutions, investment groups, foundations, and business and industry to develop new data

research tools for the analysis of regional development and workforce trends, and generate job creation opportunities (ETA, 2010a).

3. Anticipation and provision of green skills

3.1 Green structural change and (re)training needs

As we discuss below in section 3.1.4, while the federal and state governments have been actively promoting green activities such as EE, reduction of the use of toxic materials, and the development and use of alternative fuels, these efforts still represent a small fraction of energy use and production techniques in the US economy. The industries that now are connected to extracting and using fossil fuels have not seen a decline in demand, except as a result of the current global recession.

3.1.1 Green restructuring and its impacts on the labor market

Along with this funding support is $500 million of support for green job training delivered through the DOL. The range of jobs that will be impacted by the ARRA stimulus include occupations in the construction industry and the RE industry, specifically solar energy and wind. Training more Energy Auditors will be an important component in the $12 billion that is spent supporting EE initiatives and green construction, but a significant piece of the stimulus is also related to supporting job creation and growth among America's youth and the economically disadvantaged. In the construction industry, persons of these diverse groups will learn construction skills and work with new greener and more efficient construction materials and methods.

As we discussed in section 2.2.2, PERI (Pollin et al. 2009) estimates that approximately $100 billion will be spent through the ARRA on investments in the green economy. PERI uses this $100 billion of federal outlays, and estimates the induced spending by state and local governments, as well as companies and individuals over the next ten years to come up with a total level of spending that they then turn into an estimated 2.5 million jobs created from the total green economy investment. Because they assume jobs will be lost in the fossil fuel industries with the rise in the use of non-fossil fuel energy sources, the net estimate of jobs created is 1.7 million. Because the ARRA and EIEA funding contains a great deal of financial inducements to state and local governments and private enterprises, PERI estimates that a ten-year long mixture of public and private investments can create direct, indirect, and induced spending of $150 billion annually until 2020. The matching funds from the ARRA and the EIEA are connected, for example, to policies that might provide a 30 per cent tax credit if investment in a roof top solar panel is installed. This implies a 70 per cent investment from some private source. Some of the grants may be matching grants and so PERI assigned a multiplier to those grants.

Of the 1.7 million net jobs to be created by 2010 by the PERI report, we can expect that as many as 40 per cent of jobs created will be related to weatherization, and about 10 per cent of jobs created will result from solar or wind investments. That is 680,000 jobs in weatherization, and 170,000 jobs for wind and solar. The report highlights that there are about 110 million occupied housing units in the United States at this time, and this does not include commercial and public space that can also be retrofitted. In the estimated jobs by occupation, we assumed that approximately 30 per cent of solar and wind jobs are in installation- and/or maintenance-related activities. This is consistent with the PERI article, and articles published by the Renewable Energy Policy Project (REPP).

Table 6: Job creation by sector, 2009

Energy source	Direct, indirect, and induced job creation per $1 million in output (# of jobs)	$millions committed under ARRA	Total jobs	Estimated jobs by occupation
Energy efficiency				Energy Auditors (about 10% of jobs)
Building retrofits	16.7 (direct is 7)	Approx $10.5-12 billion	73,500 – 125,950	~7,350 – 12,500 jobs
Renewable				Installers / Maintenance Workers (about 30% of jobs)
Wind	13.3 (direct is 4.6)	Approx $1.125 billion	5,175 – 15,000	1,500-5,000
Solar	13.7 (direct is 5.4)	Approx $1.125 billion	6,075-15,400	1,800-4,600

Source: Authors' own tabulations from data from Pollin et al., 2009.

These estimates accept the PERI institute's job creation estimates based on investments, but use what we believe to be more targeted understandings of ARRA spending to estimate job creation as a direct result under the ARRA. What this essentially means is that RE job creation spending is significantly smaller than the $24 billion used by PERI. Total spending on tax incentives for RE are worth approximately $10 billion at this time, but the amount spent per year for the next several years will be something closer to $1 billion. Most of the ARRA stimulus is expected to be paid out completely by 2012, so these job estimates can be considered conservative. Additional estimates have been provided in other reports. Estimating the job impact for Energy Auditors is more difficult, since this occupation has been differentiated greatly not only by pay level, and education, but also by inclusion in jobs with widely-varied responsibilities. For instance, there are broad general distinctions in energy audit activities by focus on public, commercial, or residential facilities. Occupational Information Network (O*Net) has estimated that the number of new Energy Auditor jobs is slightly less than 400,000 between 2010 and 2018.

3.1.2 Identification of (re)training needs

The Bureau of Labor Statistics (BLS) of the DOL works closely with the O*NET to develop criteria for defining green jobs as they are tasked to measure the number of green jobs and trend over time (ETA, 2009d; BLS, 2010b). O*NET is part of the Employment and Training Administration (ETA) and is also an agency within the DOL. The BLS definition may not necessarily be used by other federal or state agencies, but it does provide a national set of measures. BLS and O*NET also identify the skills required for the green jobs they track. The O*NET report (Dierdorff et al. 2009), *Greening of the world of work: Implications for O*NET-SOC and New and Emerging occupations* (referred to below as O*NET GWW), identifies occupational needs and requirements implied by US green economy developments. In this report, the authors separate occupations that will experience increased demand, without a change in the skill requirements, occupations that will experience an increase in demand plus an enhancement in the skills needed to perform them, and New and Emerging occupations. The methods used to construct these lists are discussed in the report. As the New and Emerging occupations were identified, the final list had to meet criteria of significant employment, positive employment growth, existing accredited education and training programs, certification and licensure standards, national associations and evidence of some trade or professional journal. We append these lists at the end of this report. Examples of specific occupations from these lists are discussed further below as we transition to our case studies of specific green occupations and the programs that have been instituted to train people for them. The list of occupations from the O*Net report can be seen in Appendix Tables 2 through 4.

3.1.3 Skills response

The $500 million being paid out to support green jobs training represents about 1 per cent of the DOL's total allocation of funds, and is paid out in the following ways:

State Energy Sector Partnership and Training - $190 million (34 grants)[6]

1. Education, training and supportive services for skill attainment and career path development in emerging green industries for low-income, low-skilled workers.
2. Support and development for state-wide partnerships that integrate green industry focus into state workforce development plans.
3. Awards range from $2 to 6 million, and target veterans, at-risk youth, ex-offenders, dislocated workers, low-income workers, disadvantaged, underemployed, new workforce entrants, high school dropouts, tribal members, and others.

Pathways Out of Poverty - $150 million (38 grants)[7]

1. Programs target and seek to help disadvantaged populations out of poverty.
2. Applicants are encouraged to focus on PUMAS where rates of poverty are 15 per cent or higher.
3. Awards are targeted for national and local nonprofits, community, faith-based, education and training, public workforce investment system, etc.
4. Awards range from $2 to 8 million and target the unemployed, under-employed, veterans, dropouts, urban youth, disabled, homeless, ex-offenders, and more.

Energy Training Partnership - $100 million (25 grants)[8]

1. $28 million of these funds will target dislocated auto workers.
2. Awards range from $1.4 to 5 million and target women, minorities, dropouts, youth, underemployed, and others, and will support training in energy auditing, solar and wind installation.
3. Grant recipients will partner with labor organizations, and workforce investment boards.

Green Capacity-Building - $5.8 million (62 grants)[9]

1. Awards range from $42,000 to 100,000 and support grantee education and training initiatives directed at green education and skill development.
2. Awards will support various YouthBuild activities, weatherization, solar, energy auditing, and other green activities.
3. Grants will add funds to 62 existing DOL grant recipients that offer training opportunities to women, farm workers, Native Americans, and at-risk youth in green industries.

State Labor Market Information Improvement - $48.8 million (30 grants)[10]

1. $48.8 million for state LMI improvement grants will support LMI gathering and green job banks. Awards range $763,000 to $4 million and are directed at state agencies, many forming into consortiums and producing research at the regional, multi-state, or national level.

The total outlay from all grants is nearly $495 million.

[6] ETA, 2009d; BLS, 2010b.

[7] ETA, 2009c.

[8] ETA, 2009b.

[9] ETA, 2009e.

[10] ETA, 2009f.

In addition, $50 million will support the activities of YouthBuild, an organization that targets out of school youth ages 14-25 for green building projects that provides them with occupational experience in the construction trades. It is expected the job skills for weatherization, retrofitting, etc., will be the major categories of skills developed. The awards average approximately $550,000, and reach a large number of states (ETA, 2009a). In combination with the above mentioned, and in addition to the $100 million allotted for line-worker training in green industries, $645 million has been allocated and targeted at a diverse, typically-disadvantaged population with the intention of directing them toward green activities that will include things like energy auditing, and solar and wind installations.

An additional $85 million has been set aside for the DOL's 2011 $14 billion budget for continuing DOL programs, of which $85 million will fund continued green jobs training. This is expected to support 14,000 additional green training program participants. While we lack concrete values at this time, the activities described so far should support the training of 120,000 persons or more in green jobs by summer 2012 (US Executive Office of President Barack Obama, OMB, 2010b).[11] It is notable as well that an additional $14 million, for a total of $573 million, will fund the Occupational Safety and Health Administration this year and allow for a 9 per cent increase in workplace inspections. Worker safety concerns are being linked to green jobs both because green jobs have unique risks involved, and because many green jobs may expose workers to the hazardous chemicals, materials, and additives of our industrial past and present (Michaels, 2009).

All told, the DOL (2010) estimates that between May and December of 2009, approximately 3.2 million persons participated in the different job training initiatives launched both before, and under ARRA.[12] Of these jobs, 2.9 million fell under Wagner-Peyser Reemployment services, 9,000 fell under the energy grant funding, and 360,000 participants have gone through the WIA Youth Recovery Act funding. In the last case, the majority of participants can be described in percentage terms as in-school (62 per cent), African American (44 per cent), White (38 per cent), or Latino (24 per cent) (in that order), and summer employed (88 per cent). It is unclear at this time when results tailored more specifically for ARRA will become available, though the early indication is that DOL activities supporting green-specific training could number anywhere from 100,000 to a million or more in the near future.

3.1.4 Case studies

We were not able to identify any major efforts by the US government on retraining of workers who have been displaced because of structural changes caused by a shift to a greener economy. The DOL is making efforts to direct a significant portion of its training funding overall, and of green job-related training in particular to US automobile workers. The plight of US automobile workers cannot at present be blamed on restructuring to a greener economy. The problem of US automobile workers was caused by a secular loss of market share by US automobile companies, poor management and financial decisions made by the executives of US automobile companies, and the current worldwide recession. The future demand for auto workers will be affected positively by efforts by US companies to make more fuel-efficient and alternative-fuel cars, and negatively by green policy efforts such as the ones we have noted that provide incentives and subsidies for a shift to more public transportation. To the degree that energy generation shifts to alternative and RE sources and away from fossil fuels, we may anticipate a need for retraining of workers who are employed by companies connected to fossil fuel. The United States does not seem to have recognized this as a problem of yet.

[11] If one assumes that even $85 million spent supports 14,000 green jobs, then $500 million originally allocated under ARRA would equal 82,300 green jobs.

[12] The DOL has NOT yet developed statistics that describe the direct impact of ARRA on the figures viewable at the link given, meaning that the current number of Green Jobs supported by ARRA funding is unknown.

In this section, we will present two case studies. Both of these case studies have the dual policy purpose of first, preparing employees for green jobs that will have a substantial increased demand over the coming years, and second, moving persons with employment barriers into sustainable jobs. The first of the case studies is of the Pinderhughes Model, which is a program for several target populations with employment difficulties, developed in Berkeley, California. The second case study is of YouthBuild, a national program with large funding from the DOL. The target population for the eponymous program YouthBuild is disadvantaged youth, typically high school dropouts and minority youth of color.

Case Study 1: An outline of the Pinderhughes Model

Raquel Pinderhughes, an Urban Studies Professor at San Francisco State University with extensive environmental consulting experience, was funded by the City of Berkeley Office of Energy and Sustainable Development to report on how to link community development and green workforce development (Pinderhughes, 2007). In particular, she focused on identifying existing green collar jobs that could be accessible to a target population facing barriers to employment. Those facing employment barriers included people who did not have a high school degree, had been out of the labor market for a long time, were formally incarcerated, and/or had limited labor market skills and experience. The proposed programs included short-term 3-6 month training programs that utilized both training in the classroom and on-the-job training, but most importantly, case management follow up, extending over time to support pathways to employment and educational and occupational mobility. Table 7 summarizes the structure of the Pinderhughes Model of green skills development.

Table 7: Outline of the Pinderhughes Model

Target population	18-35 year old men and women with barriers to employment. This population includes men and women who do not have a high school degree, have been out of the labor market for a long time, were formally incarcerated, and/or have limited labor market skills and experience .
Training	This is an approximately 3-6 month training program that utilizes both training in the classroom and on-the-job training to provide clients with the following direct services: (1) initial assessment; (2) basic literacy skills (math, English, writing, computer, oral presentation, basic communication skills, etc.); (3) life skills and soft skills training; (4) financial management skills; (5) OSHA Safety Training Certification; (6) an environmental educational component; (7) basic vocational skills relevant to green collar workforce opportunities.
Internship	The Internship component is designed to place job ready clients in local green collar jobs for a trial period of 2-6 months. Internship sites and placements will be identified by employers in the Green Business Council who will meet regularly to identify green collar internships as well as full-time jobs for job ready clients. The internships allow the employer and the client a trial period during which they can assess fit and capacity without committing to a full-time permanent position for the client. In the best case scenarios, clients who excel in their internships will be hired on as full-time workers.
Case management and follow up	Each client will have access to case management and follow up services during the period in which they work as interns and for up to 6-12 months after they start their first employment opportunity in a green business. Case management and follow up services are designed to help both the client and the employer.
Pathways to employment, education, and occupational mobility	Graduates of training programs that prepare people for green collar jobs will have access to multiple pathways to employment as well as to educational and occupational mobility. These pathways include: (1) ongoing on-the-job training opportunities in green businesses; (2) information about union apprenticeship programs, particularly electrical and construction; (3) access to higher education through adult schools, community colleges, and four year institutions; and (4) ongoing job placement services through employers in the Green Business Council.
Employers	To succeed, the program must have an involved, supportive, and enthusiastic group of green business employers who regularly communicate with the job training staff preparing program participants to enter the labor market. These employers will (a) identify growing green economic sectors and opportunities; (b) identify training standards for specific green-collar jobs; (c) identify placement opportunities; (d) create internship opportunities for program participants; and (e) hire job ready applicants for entry level green collar jobs when there are job openings in their firms. They may also refer job ready applicants to firms outside of Berkeley.
Green Business Council	To develop and nurture relationships with employers, the Chamber of Commerce should convene a Green Business Council composed of the owners and managers of local green businesses in the private, nonprofit, and public sectors that provide workers with green collar jobs.
Local government	Government staff working on issues related to economic development, workforce development, and improvements in environmental quality should provide ongoing support to the green businesses that provide workers with green collar jobs. This can be accomplished in many ways, including: streamlining permitting processes for green businesses that provide green collar jobs in the city; utilizing procurement dollars and city contracts to support local green businesses; creating incentives for working with "first source" hiring policies; helping green businesses access tax credits; working with regional organizations that support job training programs.
Community involvement	The program should involve members of Berkeley's low income communities in assisting with recruitment and retention of program applicants as well as supporting public and private sector initiatives to improve urban environmental quality and create green collar jobs.

Source: Information collected from Pinderhughes, 2007, p. 7.

What was distinctive in Pinderhughes' and similar approaches was the integration with economic development strategies partnered between Green Business Councils and newly-formed local sustainable development or green development city planning offices along with community organizational supports to sustain program participation. Thus the economic strategies promote a common focus for a three-sided program that integrates public, private business, and community considerations.[13]

The "Pinderhughes Model" served as the basis for the Oakland, California Green Jobs Corps Program championed by the Ella Baker Center and the Oakland Apollo Alliance. Pinderhughes provided a guide book for economic and community development linked to the objectives of each and a methodology for green labor extension programs and job placement (Roach, 2009). It has since been adapted and is in various stages of implementation in other urban areas including Cleveland, Philadelphia, San Francisco, and San Mateo, among others. Pinderhughes has provided a model for community organizations to craft green labor extension programs adapted to the local social, economic and physical environment. The program has been adopted by diverse local community development organizations nationwide. These programs share an emphasis on training targeted to groups facing barriers to employment and placement in jobs that are green increased-demand and green-enhanced skill entry-level occupations. The model includes consultation and placement on career ladders that lead to new and emerging green job opportunities and increased skill advancement. Table 8 summarizes Pinderhughes' message that green collar jobs are community-serving workforce opportunities.

[13] The full Berkeley Report recommendations are provided in http://bss.sfsu.edu/raquelrp/documents/v13FullReport.pdf.

Table 8: Green collar jobs are community-serving workforce opportunities

Green business sector	Types of services providing green collar jobs	Types of entry-level green collar jobs currently available	More advanced green collar work
Energy	Energy Retrofits. Heating, Ventilation, Air Conditioning, Solar Installation, Water Conservation, and Whole Home Performance	Customer Service, Evaluation, Installation, Construction, Maintenance, and Repair	Energy Partner, Journeyman Solar, Electrician Service Technician, and Project Manager
Water	Water Conservation and Adaptive Grey Water Reuse	Installation, Construction, Maintenance, and Repair	Journeyman and Project Manager
Green Building	Construction Demolition and Removal	Construction, Carpentry, Demolition, Hauling, and Driving	General Contractor and Project Manager
Woodworking	Custom Architecture, Cabinetry, Furniture, and Repair	Assembly, Sanding, Finishing, Carpentry, and Installation	Journeyman and Head Carpenter
Green Space	Parks & Open Space Landscaping	Planting, Maintenance, and Tree Cutting & Pruning	Project Manager and Head Gardener
Food	Urban Agriculture, Farmers' Markets, Specialty Foods Production, and Baking	Growing, Packaging, Delivery, Set-up & Tear-down, Selling, Brewing, Roasting, Packaging, Baking, Mixing, and Cleaning	Production Manager, Market Manager, Floor Manager, and Head Baker
Transportation	Bicycle Delivery, Bicycle Repair, Bio-Diesel & Veggie Fuels, and Public Transportation	Dispatch & Delivery Assembly, Repair, Fuel Production, Distribution, Driving, Maintenance, and Repair	Messenger, Owner, Shop Manager, Production Manager, and Head Mechanic
Non-Toxic Printing	Commercial Printing Services	Binding, Post-Press, and Delivery	Press Op and Pre-Press
Non-Toxic Cleaning	Residential & Commercial Cleaning	Cleaning and Customer Service	Team Leader
Waste Stream Diversion	Materials Recycling and Re-use	Collection, Sorting, Driving, Loading, Salvaging, Warehouse, Packaging, and Composting	Warehouse Manager and Floor & Department Manager

Source: Pinderhughes, 2007, p. 3.

Pinderhughes' methodology (Pinderhughes; Flores, 2010) has been successful at creating a link between an at risk population encountering barriers to employment with:

1. the local workforce training system, particularly, but not solely, focused on community college programs,
2. job opportunities identified by local business associations including current hiring needs and trends and entrepreneurial opportunities, and
3. education in environmental literacy and sustainable development, as foundational to systems thinking that builds the capacity for community empowerment to sustain an integrated program of community and workforce development.[14]

[14] "The Roots of Success Environmental Literacy curriculum is designed for youth and adults enrolled in green job training programs. It can also be used in other educational settings. The curriculum teaches environmental literacy while enhancing academic literacy and job readiness skills. It provides extensive and in-depth information about jobs and careers in the green economy." (Pinderhughes; Flores, 2010).

Pinderhughes has increasingly focused on the importance and development of the environmental literacy training component designed to teach environmental literacy while simultaneously enhancing academic literacy and job readiness skills. The curriculum integrates a multi-disciplinary perspective that includes modules based in environmental science, land use planning, public health, and social justice. The curriculum focuses on the economic and infrastructural sectors of water, waste, transportation and energy as well as locally-focused industries related to building, food and agriculture.

The Oakland Green Jobs Corps (OGJC)
The first implementation of the "Pinderhughes Model"
Oakland, California

The OGJC, a widely-acclaimed initiative, was the first implementation of the Pinderhughes Model of successful labor extension in green industries. The program was developed in Oakland, California, through a joint initiative between the Ella Baker Center and the Apollo Alliance. Since the program was successfully instituted in Oakland, it has been adopted by other community development organizations in cities across the nation. Each adopting city provides insight into aspects of the model that can be easily applied, as well as revealing variation required for flexible implementation into new localities.

The Peralta Community College Network commonly provides participant training for the OGJC. In a telephone interview on 21 May 2010, Peter Crabtree, Dean of Instruction for the Vocational Technology Division at the Peralta Community College, indicated that he expected that the growth in RE and EE will green traditional blue collar jobs and become the "greening of the blue collar workforce". He claimed that this is driven by a demand for traditionally-organized trades to be aware of and understand more complex systems. As a result, a skill gap is developing between the skills required of a traditional blue collar tradesperson and a green/blue (turquoise) worker in the construction trades. Often the traditional apprenticeship model cannot provide technicians with all the skills demanded by the current, more complex labor market. Crabtree also went on to claim that the chronically unemployed are desperate to be passionate about something and that in addition to hard skills training, "employers demand green labor that understands and [is] passionate about why we are greening the economy." Crabtree emphasized that passion about greening industry is a key component employers use to evaluate employees.

The OGJC has shifted relative priority from training for RE to EE at a residential level through two primary training tracks. The EE installer track, that includes a range of skills primarily supporting jobs that are carpentry skills, weatherization, HVAC, window repair, appliance safety/ CO_2 back draft awareness (gas), and awareness of the aging housing stock (i.e. asbestos, lead paint, mold, and toxins). The second new training program is the EE/Energy Auditors sales and customer service track. Graduates obtain the skills and competencies to demonstrate the "returns on investment" and the available financial incentives supporting an EE upgrade to residential consumers.

The program utilized a grant from various foundations for EE, RE training programs and adapted them to create low income, green jobs programs. The Green Jobs Act, passed as part of the 2007 Energy Bill, set aside $125 million for job training (Pinderhughes; Flores, 2010). One notable program that has emerged as a successful result of these funding efforts has been the OGJC - a joint effort of the Apollo Alliance and Ella Baker Center. The OGJC is a job training and employment pipeline that uses the expanding labor demand of the RE and EE qualified workers to propel individuals out of poverty (Ella Baker Center for Human Rights, 2010). The program used a strategy for labor force development based on the model created by Raquel Pinderhughes which emerged from a case study she conducted in Berkeley (ibid.). The Apollo Alliance described The Green Jobs Corps as bringing

> "…economic, environmental and social equity goals together in one program by: providing green employment pathways for people to move from poverty to economic self-sufficiency; educating young people and other community members about environmental issues and the green economy; meeting green-collar workforce demand with the local workers most in need of good jobs; and connecting qualified participants to career training and advanced education opportunities." (Apollo Alliance; Green for All, 2008).

The Green Collar Job Academies (GCJA)
A program that is ambitiously targeting the chronically unemployed
San Mateo, California

The GCJA of San Mateo, California, that began in October 2009 is directly modeled on the Pinderhughes Model. The program is entirely funded by the ARRA channeled through a State program known as the California Work Opportunities and Responsibility to Kids (CAL WORKS). Nearly 80 per cent of the wages paid to the program's participants can be traced back to ARRA funds. The GCJA only admits candidates who qualify for the State's Transitional Assistance for Needy Families (TANF) program. This singular admission requirement ensures that the recovery funds are strictly targeting the structurally- and chronically-unemployed. Targeting individuals who qualify for TANF requires the program to have a dual-pronged approach to their recipe of labor extension. As a result, the GCJA teaches both the hard skills necessary to enter the green collar workforce, as well as the soft skills many low-income individuals have never been given the opportunity to develop.

The total 16-week program consists of nearly 144 hours of hard and soft skills development. The first eight weeks are dedicated to classroom learning with a practical application and an emphasis on soft skills development, as well as basic math and verbal communication skills. During this period, the candidates earn nearly $10 per hour and participate in long-term career mapping that aids in the placement of the candidates during the second eight weeks of the program. The second part of the program includes a job internship with a green employer. The candidates are placed by a "green staffing agent" with green employers that match both their interests and anticipated regional demand. The placement process strives to increase the likelihood of successful long-term career placement by coupling the consideration for anticipated regional demands with the individual career mapping done during the first part of the program.

The 16-week, 144 hour curriculum includes the following components: 55 hours dedicated to classroom learning of math and literacy put to a practical application; 35 hours of focus on Raquel Pinderhughes' *Roots for Success* environmental literacy training; 6 hours of instructions in basic financial skills for success; 18 hours of the training in basic life skills; and a module on conflict resolution in the workplace. The remaining 30 hours is focused on workplace communication skills including oral, written, and technological communications training, as well as resume building and interview techniques. The second part of the program involves an internship program where hard skills are trained through on-the-job experience.

The initial period of the San Mateo program addressed the training needs of the habitually unemployed. The GCJA has had 99 total enrollments. Excluding the most recent cohort still engaged in the program, the first three waves consisted of 71 participants. Of the 71 participants, nearly 87 per cent (62) completed the first 8 weeks, and 75 per cent (53) completed the entire 16 weeks of the program. The majority of the graduates have so far maintained employment and launched careers in what are expected to be rapidly growing industries. Kay O'Neill, Manager of the GCJA, noted that "people are often hired on hard skills and fired on soft skills". She is a strong advocate for the Pinderhughes Model, specifically because she believes it "provides training in both areas" to ensure long-term pathways out of poverty (O'Neill, 2010).

Richmond Build (Richmond Works)
The right mix of policy, practice, and progress
Richmond, California

Richmond Build is the Green Careers Training Program of the Richmond Works Labor Extension Program that targets low-income individuals with barriers to employment. Richmond Build began in 2007 and has not had to advertise to attract applicants. From the start, the program has had a competitive application process and a long waiting list. Only one in ten applicants are admitted into the program. Richmond Build does not require candidates to pass a drug screening upon entrance to the program, but it does require a clean screening to graduate.

The pilot program began with workforce development funds but has since formed a coalition with the Richmond public works, housing development, housing authority, and private sector investors. The program uses this coalition to leverage successfully a strategy of funding that it refers to as "Co-investing."

Richmond Build offers 12 programs in various fields including EPA clean up, lead certification, hazardous materials training, EE, retrofitting, PV, solar thermal, and is currently in the process of implementing a green plumbing program. The nine-week program can be considered a pre-apprenticeship program with a focus on "green building". The PV and solar thermal installation programs are coupled to an electrical training program. The practice installations are done on the homes of qualified low-income residents. This practice is referred to as the "triple win" and benefits the homeowners, the trainees, and the environment. All specific trade training programs include the Raquel Pinderhughes book (2010), *Roots for Success,* as a curriculum module. Richmond Build has also implemented a youth outreach program known as the California Youth Energy Retrofitters that has a clean energy leadership in Science, Technology, Engineering, and Mathematics (STEM) fields' curriculum. The program also offers a tailored course for English Speakers of Other Languages (ESOL) on the subject of EE.

In its short three-year lifespan, the program has produced more than 275 graduates. Richmond Build has just finished completion of a new 3,500 sq. ft. training facility and with it has the capability of producing 250-300 graduates annually. Richmond Build has partnered with local community colleges that utilize the program's state of the art training facilities for the onsite portion of their own green training courses. During the first year, the program was able to place 90 per cent of graduates with jobs. During the second year of the program, the placement rate declined as the economy deteriorated, but it was still able to place 70-75 per cent of graduates. In addition, the first year placements likely were meeting pent-up labor demand.

Two very important supporting local policies are in place in Richmond that enhance the long-term sustainability of Richmond Build. The first, and more significant, policy is a local employment ordinance that has been in place for over ten years. The ordinance requires that local tradesman are given hiring priority for all projects done by the municipality. Additionally, through negotiations with local unions, a municipal project coordinator can request the union hall to dispatch a Richmond Build graduate. Sal Vaca, Director of Employment and Training at Richmond Works, explained that this "Policy makes use of local union chapters and training programs" in an effective way. The second city program offers an additional solar thermal rebate to homeowners that use a Richmond Build graduate during installation. Sal Vaca further explained the fundamental importance of Richmond Build's employment impacts in the broader context of community development by noting that at a conceptual level Richmond Build "truly" and "essentially" is "a sustainable violence reduction strategy that began at the municipal level." (Vaca, 2010).

Project Neighborhood Environmental Action Team (NEAT)
A passion to help those that society has forgotten
Philadelphia, Pennsylvania

The American Cities Foundation, based in Philadelphia, began in 1992 with a goal to create best management practices for American cities on sustainability as well as environmental responsibility. In 2004, the group began working on a grant-funded project aimed at the greening of storm water and other effluents management. During this project, the program encountered a group of underserved workers and was able to employ and train them temporarily. This project impact initiated a focus that linked a passion for the environment with the goal of raising the standard of living for individuals with barriers to employment. The Foundation-initiated program started a green workforce training program for disadvantaged individuals known as Project NEAT. The program was developed explicitly around the Raquel Pinderhughes Model for green labor extension.

The first cohort has become known as the original "environmental stewards" and they have been helpful in recruiting new applicants to the program. The program also uses local faith-based organizations to refer individuals to the program. The program is coordinated with a local branch of the workforce development initiative known as "Career Link" to refer the unemployed and chronically unemployed to the program. The program examined a variety of potential industries and eventually prioritized weatherization and green landscaping. The eight-week training program targets both hard and soft skills. The soft skills are crucial for the structurally-unemployed to transition to the labor force. Soft skills include resume writing, communication, and general information on how to keep a job. The first two weeks concentrate on safety skills and candidates earn an OSHA (Occupational Safety and Health Administration) certification. The remainder of the six weeks combines training in environmental literacy, basic verbal communication skills, and math skills with an industry-focused education in one of its two key training areas.

Job placement is supported through case management and is directed by a job placement coordinator. The connection with an employer begins as soon as an individual is placed into the program and continues throughout. No individual is placed in the program without first being placed with an employer. The program has also created an employment council that creates an interaction with local green employers who come and speak to classes and inspire candidates.

During the past six years, the program has trained approximately 180 adults and 300 youth, many of whom completed program activity prior to the formal establishment of the current program structure. In its first official cohort, 20 entered the program and 20 graduated, while 19 graduated out of the second cohort of 20. Follow-up reports show a 65 per cent long-term placement rate for employment. Many of the non-placed members were successful in finding employment but are not counted as a program-related placement. Although the program may have developed these members' skills and confidence by helping them find employment, they chose to work in a non-green industry. Project NEAT emphasizes the "triple bottom line" which consists of:

1. getting individuals to change their behavior in a positive direction;
2. building self esteem; and
3. getting them employed.

Dennis Lee, Director of Project NEAT, stated that the program is all about "getting people to see what they've seen all their lives in a different light and appreciate it" and claimed that the environmental literacy taught in the program accomplished that to an amazing degree (Lee, 2010).

Conclusions about the Pinderhughes Model

Proponents of the RE and EE industries claim that sustainable investment in human capital could allow these industries to "lift all boats" and become a "pathway out of poverty" for many Americans (Hassan, 2009; Woehrle, 2008). The Apollo Alliance (2008) claims that,

> "the green economy is growing rapidly, and a number of forward-thinking cities, states, and organizations are responding by launching training programs to build green career ladders to good, family-supporting jobs. But some of the people most in need of these programs are in danger of being left behind. These programs focus specifically on providing… a rung within reach of these job seekers".

Paula DiPerna (2004) summarized the movement's philosophy, claiming in her article, *The mean green job machine*, that,

> "establishing a large-scale job-creation effort in the United States, a "Green WPA", so to speak, has been recommended as one answer to the post-industrial woes of the rust belt. Job creation can be reconciled with environmental protection. It would make sense to put infrastructure investment programs into environmental jobs. Importantly, changes in the environment demand new skills, and training workers with those skills prepares them to live in a 21st-century world."

Pinderhughes (2007) stated in her Berkeley case study report that "green collar jobs are blue collar jobs in green businesses. That is, manual labor jobs in businesses whose products and services directly improve environmental quality." She goes on to describe their importance emphasizing that,

> "Green collar jobs represent an important new category of workforce opportunities because they are relatively high quality jobs, with relatively low barriers to entry, in sectors that are poised for dramatic growth. The combination of these three features means that cultivating green collar jobs for people with barriers to employment can be an effective strategy to provide low-income men and women with access to good jobs - jobs that provide workers with meaningful, community serving work, living wages, benefits, and advancement opportunities."

It is widely acknowledged that the RE and EE sectors are already experiencing a labor shortage of qualified and knowledgeable workers that Pinderhughes claims can be supplied through programs like the one she first developed and implemented in Berkeley, California. Pinderhughes' Model embodies the spirit of sustainable development by addressing both poverty and environmental awareness in a way which produces only positive externalities for the local communities. Van Jones, the former President of Green for All (the policy arm of the OGJC) explained that green jobs are beneficial to the economy "because they cannot be easily outsourced, say, to Asia, if we are going to weatherize buildings, they have to be weatherized here. If you put up solar panels, you can't ship a building to Asia and have them put the solar panels on and ship it back. These jobs have to be done in the United States." (Greenhouse, 2008).

Case Study 2: YouthBuild USA

YouthBuild USA was started when a small group of teenagers in 1972 became interested in revitalizing abandoned buildings in New York. "These teenagers rehabilitated an East Harlem building damaged by neglect" explained Dorothy Stoneman, then Director of the Youth Action Program in East Harlem Block Schools (ETA, 2008b). The first YouthBuild program was launched in 1978 after these efforts. By 1988, the nonprofit YouthBuild Coalition was formed, and in 1990, YouthBuild USA was formed to provide national coordination of the different

independently-run programs spreading across the United States. By this time, 11 US cities had YouthBuild programs, each funded by a combination of public and private sources.

In 1992, YouthBuild became an official federal program under the Department of Housing and Urban Development (HUD). In 2000, Congress appropriated $42.5 million for YouthBuild, and this budget would grow to $60 million in 2001. From 145 programs in the United States in 2001, YouthBuild has today expanded to "273 programs in 45 states, Washington DC, and the Virgin Islands. 92,000 YouthBuild students have built 19,000 units of affordable, increasingly green, housing since 1994." (ibid.).

YouthBuild benefits 6-8,000 young people annually and constructs or renovates about 1,200 units of affordable and increasingly green housing each year. Program sizes vary to between 15 to 200 persons or more per program but average about 25 to 35 persons. YouthBuild targets persons aged 16-24 with low-income that have not yet earned a GED (General Educational Development High School Equivalency Test) or high school diploma, that may "have had experience with foster care, juvenile justice, welfare, and homelessness." (ETA, 2009g). Demographic information of YouthBuild participants can be seen in Tables 9 and 10. Each participant engages in 6-24 months of classroom and job site experience, developing practical occupational and workforce skills in an effort to place participants at the base of a career ladder or on the path to higher education. Participants are given classroom training and on-the-job training in the construction sector, usually on a rotating basis (one week of class followed by a week of work). They build affordable, energy-efficient new homes and retrofit or recycle older ones. Originally linked to the HUD in the early part of this decade, YouthBuild was placed under the DOL in 2006.

Primary funding is provided at the federal level through the DOL which distributes about $70 million a year supporting YouthBuild, and an additional $50 million was granted under the ARRA in February 2009. These stimulus funds directly support its burgeoning green activities. No less than one-third of the current YouthBuild grantees have incorporated green building techniques into their programs (about 90 to 100 total), and the remaining grantees will continue to adopt greener building standards or seek certification (BLS, 2009a, t 3). In total, some 183 Grants went to YouthBuild projects in 2009, worth about $114 million. Awards to YouthBuild programs around the country average about $620,000. With stimulus funds having increased DOL funding by 70 per cent, and given the current very high youth unemployment rates, the number supported is likely to increase proportionately. Additional funds for YouthBuild programs are also provided through the HUD, Health and Human Services, and various state sources. Private funding sources are also acquired by different YouthBuild programs.

Table 9: YouthBuild entrant outcomes, 2009

	Per cent
Attendance	79
Completed program	62
Placed in jobs or further education	71
Average wage after program	8.9
Received GED or Diploma (of those needing either)	36

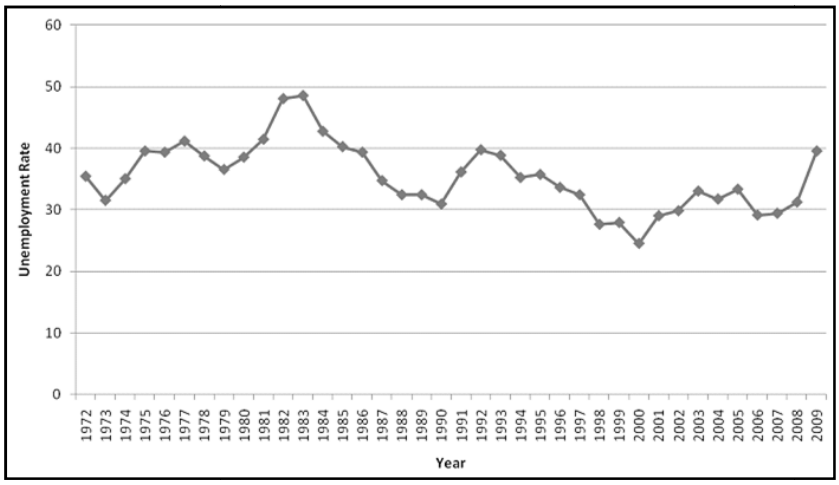
Source: YouthBuild USA Affiliated Network aggregate data.
Numbers may not add up to 100 per cent due to rounding

According to the BLS, there were 3,760,000 unemployed youths aged 16-24 in 2009, and this group had an unemployment rate of 17.6 per cent.

The unemployment rate

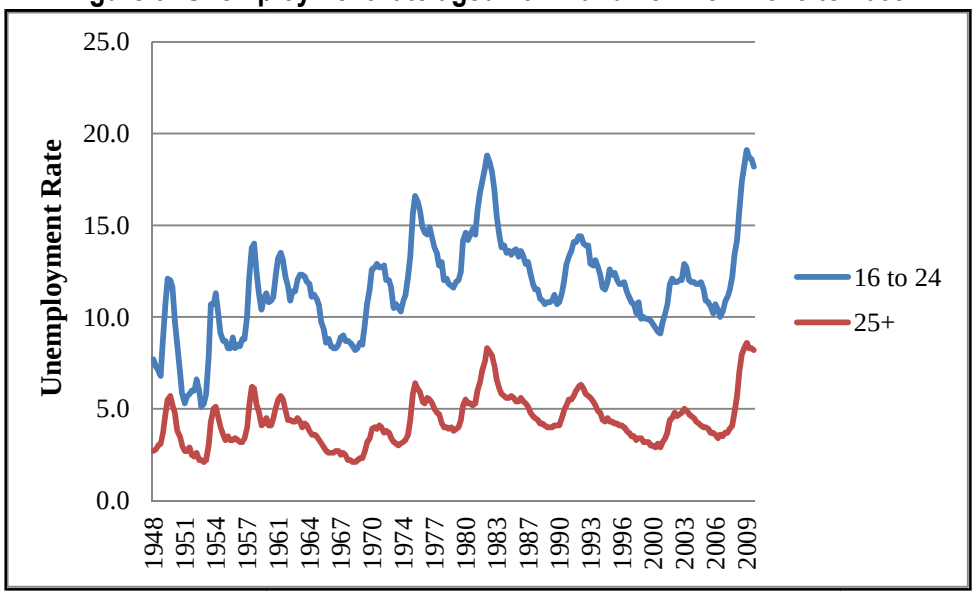
There were a total of 17,601,000 employed 16-24 year olds. The unemployment rate for African American youth can be seen in Figure 8, while a comparison for overall unemployment and youth unemployment can be seen in Figure 9. Youths aged 16-19 was 24.3 per cent and was 14.7 per cent for young adults aged 20-24 (BLS, 2009b; Boteach et. al., 2009). In comparison, the unemployment rate for persons 25 or older was 7.9 per cent. The unemployment rate among men aged 16-24 was 20.1 per cent in 2009, compared with 14.9 per cent for women in the same age range. Among those aged 16-24, unemployment rates were higher for African American and Latino youths than Whites. In 2009, the unemployment rate for African American men aged 16-24 was 32.6 per cent, compared with 18.2 per cent for white men in that age range.

Figure 8: African American aged 16-19 unemployment rates from 1972 to 2009



Source: BLS, 2009a.

Figure 9: Unemployment rate aged 16-24 and 25+ from 1948 to 2009



Source: BLS, 2009a.

YouthBuild's demographic breakdown reveals that participants are young (average age is 19), and a high percentage are male, African American, adjudicated, and lack a basic high school education. As Table 10 indicates, however, a high percentage of YouthBuild participants maintain good attendance, more than half complete the programs, and almost three-quarters find work or other educational opportunities upon program completion. Approximately 30 per cent of these participants find employment in the construction industry after finishing the program, and 40 per cent choose to continue their education. More than half of the young people entering the program each year complete it, a third also finish their GED or high school diploma at the same time.

Table 10: YouthBuild entrant demographics, 2009

	Per cent
Male	72
Female	28
African American	46
Latino	23
White	23
Native American	3
Asian American	3
Other	2
Adjudicated	41
Convicted of a felony	14
On public assistance at entrance	23
In public housing at entrance	13
Parents	22
Average age (in years)	19
Without GED/Diploma at entrance	92
Average reading level (grade) at entrance	7.4

Source: YouthBuild USA Affiliated Network aggregate data.
Numbers may not add up to 100 per cent due to rounding

YouthBuild's methods for providing workforce training, education support, and creating opportunities for disadvantaged young people include a core set of essential elements. Young participants learn basic skills like how to interview successfully, how to write resumes, search for jobs and apply. They are taught the value of drug-free living and working, and they are mentored in both the classroom and through on-the-job interaction and training episodes. It is a combination of soft skill, and hard skill transfer not entirely unlike that mentioned in the Pinderhughes Model previously. The programs are designed to promote successful job or apprenticeship placement, or post-secondary education placement. It is an impressive overlapping of practical human resource, job skill, and educational development with broad achievements in the United States (ibid.). The more recent attempt is to take advantage of emerging green building opportunities and incorporate them into the basic YouthBuild Model. Each YouthBuild Program is unique, dividing time about 50/50 between the classroom and the job site. The comprehensive approach that YouthBuild provides includes educational components and training components which expand skill relevance and employment opportunity for young adults. A summary of the program’s content can be seen in Table 11.

Table 11: YouthBuild program outline

Alternative School	Students alternate spending time in the classroom with job site activities (weekly rotations)
Job Training and Pre-Apprenticeship Program	Supervised training by qualified instructors
Community Service Program	Housing for homeless and low income persons
Leadership Development and Civic Engagement	Active participation in community affairs and election of policy committees
Youth Development Program	Counseling and Peer Support activities
Long-Term Mini-Community	Active appropriation and development of new positive friendships among participants
Community Development Program	Resource development activities within communities in effort to address unique community issues

Source: Blake, 2007. A full copy is available on: http://www.ybshadesofgreen.org/.

Green Initiative Development

The green training programs pioneered early within YouthBuild and rapidly expanding in the present, prepare youth for greening occupations in all three broad categories of Increased Green Demand, Enhanced Green Skills and New and Emerging occupations. YouthBuild USA partnered with Casa Verde/American YouthWorks in Austin, Texas, a leader in green and energy-efficient building techniques in 1994. This was the start of a broader attempt by YouthBuild to integrate green jobs into their basic program components. This partnership included integrating new materials and building techniques into the retrofitting or construction of homes. By 1998, with the leadership of Chris Cato's and Richard Halpin's commitment to better building practices and standards for excellence, all YouthBuild programs began building with much higher quality and EE in mind. Ongoing development of the green initiative has expanded to include the integration of thermal or PV solar systems into homes to provide power or heating applications, both active and passive. The net result contributes youth prepared for green building activities, but also ready to support solar PV installation needs.

The Green Initiative that has developed modifies construction techniques to include greener site management, greener materials, greener waste management, and minimizing community impact (such as by avoiding exposure to chemicals or preventing soil and mud run-off from site to neighboring properties). Finished homes are of higher quality and can consume from 30 to 40 per cent less energy than typical homes as a result. Casa Verde of Texas alone has served over 1,000 Corps members, and between 2008 and 2009, completed over 20,000 service hours with 65 members, graduating 40, sending 19 to college, and placing 21 in jobs (American YouthWorks, 2010). American YouthWorks today is the primary green training arm of YouthBuild, and the organization's own green building capabilities are expanding rapidly.

Many YouthBuild projects, such as the program in Boston (the second YouthBuild program launched after the New York pilot in 1990), register their building projects according to the LEED standard, which is administered by the Green Building Council. In Boston, home foundations are constructed with recycled materials, and solar heating and PV electricity are incorporated into construction. Recycling activities also occur during retrofit projects. Materials are taken out of homes, separated on-site, and taken to appropriate centers, reducing waste and total construction costs (YouthBuild USA, 2007). This is part of building with the product's life cycle in mind, improving not only the site-specific environmental impacts of construction, but also how the current and future waste streams are managed. While constructing 'green homes' can lead to higher upfront costs (12 per cent or so), the attention to detail creates returns in the form of lower monthly energy bills, reduced CO_2 generation, less toxic clean-up in the future, new

property taxes for cities, reduced sick days from work, and increased property values to be captured in the future.

ARRA grant solicitations highlight the integration of green jobs into YouthBuild Programs occurring from coast to coast. YouthBuild participants gain qualifications for apprenticeships after completing programs which can place them on a construction career ladder. They can earn certifications in OSHA compliance, construction basics and theory, finance, materials selection, solar thermal, solar PV, and wind. Some can pursue LEED certificates in environmental design in energy-efficient heating ventilation and air conditioning (HVAC) systems or an Energy Auditor certification. This is increasingly important in a depressed construction market, which will likely retrofit more homes in the near future relative to new construction. Basic YouthBuild training elements now have green modules added to just about all of the different occupations that make up the construction industry, learning, for example, about new green materials and how they are produced, used, and distributed. Many students graduate and enter entry-level construction jobs after completing programs, as maintenance and repair workers, construction laborers, painters, electricians, insulation workers, etc. But their contact and experience with the Green Initiative program puts them on a career track within the green building workforce.

American YouthWorks: Casa Verde

Casa Verde builders began in 1994. According to their web site, their main focus is to teach youth aged 17-24 green building techniques, literally from the foundation up. This is because while YouthBuild engages in some retrofitting activities, Casa Verde Builders focuses on first-time home buyers. There are currently 22 Building Partners, including Home Depot, Goodwill, LifeWorks, the Travis County Weatherization Assistance Program, and Browne Electric. They are partially funded by YouthBuild. Over 1,000 youth have moved through the program, and 80 homes have been built since this training program began (ibid.). During 2008-09, 65 incumbents put in over 20,000 hours of community service. Forty received a GED or a high school diploma, and about a third either went on to college or were placed in jobs. Even for a relatively small cohort, this is a turnout that mirrors YouthBuild's performance.

The founder, Richard Halpin, chooses to call the young people he works with "at promise" rather than "at risk" youth, and some of his early experiences trying to educate and develop skills of Austin, Texas, inmates inspired him to try working with youth before their first brush with the law. The program is also a combination of education with real-world experiences and training for jobs in the construction industry. Students earn a stipend for their work as well as a $5,000 award for the college or trade school of their choice. According to an article by Paul Sedan (2000), about 50 per cent of graduates decide to pursue higher education, and 10 per cent remain in the trades. The program builds low cost, LEED-certified housing.

3.2 New and changing skill needs

3.2.1 New green collar occupations

New and Emerging Green occupations by definition do not have a historical record of activity sufficient to project future employment. The drivers of the rate of employment growth in these occupations will depend on the rate of growth in demand for green goods and services, the change in costs of the production, and the relative rates of technological advance in the production processes of green products compared to the alternatives. Most importantly, projecting these costs or other constraints binding on environmentally un-friendly as well as directly promoting green products is contingent on political and policy forecasting as was made evident in the early sections of this report. Especially given the fragility of the global economy, projecting the staying power of recent policy developments is far from assured much less the uncertain but possible prospects of more intensive and extensive green policies. Projections of occupational employment of New and Emerging occupations each requires an in-depth case

study approach such as provided in this report for Wind Technicians and Wind Installers. The BLS, ETA and O*NET are in the process of developing systems for tracking changes in these occupations, but currently no existing consistent basis for forecasting exists. In fact, this report has selected one occupation, Energy Auditors, to classify as an Enhanced Skill occupation rather than as a New and Emerging occupation as classified by the O*NET GWW study as a New and Emerging occupation.

This report classifies Energy Auditors as an Enhanced Skill occupation exactly because it has a historical record to assess. The challenge for the O*Net classification as explained further below is because the tasks of energy auditing are so varied and integrated within other jobs that although they are expected to be significantly increasing in demand, they are not measured as a distinct occupation. We take this explanation alone as an important indication that the occupations connected to energy auditing are confronting significant requirements for enhancing skills. The New and Emerging occupations, because they are identified by their emerging character, they are expected to grow more rapidly than other occupations. However important this may be strategically for green economic development, they are occupations starting from much smaller baseline employment levels and thus will not generate as much absolute employment growth in the medium if not long term as Enhanced Skills occupations. This issue was also discussed in sections 3.1.1 and 3.1.2 as part of the discussion of green structural change and its effects on the labor market, and on the identification of new skills. The list of New and Emerging Green occupations developed by the O*NET GCC study is provided in Appendix Table 4.

3.2.2 Greening existing occupations

The web site CareerOneStop.Org (2010) recently published employment projections from 2008 to 2018 in occupations pertaining to the green economy. It identified the green economy occupations by using those identified in the DOL's O*Net GWW as existing occupations with Increased Demand, occupations with Enhanced Skills, and New and Emerging occupations. They explicitly noted that: "Employment projections data are not available for these New and Emerging Green occupations... (and further noted that even for) these occupations, wage and education information is presented for a broader occupation group." However relying on BLS's Employment Projection Program, national employment growth projections were obtained for Increased Demand and Enhanced Skills occupations. Many of the occupations identified by O*Net are not strictly defined by their role in the green economy and thus their growth cannot be entirely attributed to a greener economy. However, these figures can serve as baseline estimates to measure the rate of growth in existing occupations that will experience increased demand through 2018.

Employment projections were available for 56 of the 67 occupations listed as Increased Demand. The aggregate employment of these existing occupations that will experience Increased Demand as a result of green economic growth totaled nearly 12,761,500 in 2008. The total employment is expected to grow by over 6 per cent to 13,536,100 by 2018. Some extremely high-growth occupations include Boilermakers at 19 per cent, Computer Software and Systems Software Engineers at 30 per cent, and Environmental and Health Scientists at 28 per cent. The full list along with their employment levels and growth rates can be seen in Appendix Table 5.

Employment projections were available for 47 of the 60 occupations listed as Enhanced Skills occupations. The aggregate employment of these occupations expected to require enhanced skills as a result of green economic growth totaled nearly 13,437,600 in 2008. The total employment is expected to grow by over 8.2 per cent to 14,547,000 by 2018. Some extremely high-growth occupations include Environmental Engineering Technicians at 30 per cent, Environmental Engineers at 31 per cent, and Training and Development Specialists at 23 per cent. The full list along with their employment levels and growth rates can be seen in Appendix Table 6.

Prior discussion of demand for these occupational categories was also discussed in sections 3.1.1 and 3.1.2 as part of the discussion of green structural change and its effects on the labor market, and on the identification of new skills. The list of Enhanced Skills Green occupations developed by the O*NET GCC study is provided in Appendix Table 3.

3.2.3 Identification of skill needs

US Labor Market Information (LMI) is driven by the needs of national, state, and local economies to support changing development activities. Generally speaking, targeted studies are generated to address a need for information related to changing employment needs. In the United States, a recent example was the need to assess the growth prospects and need for an appropriately-educated workforce in the emerging high-tech sector, especially the Information Communication Technology industries. A similar information need is now perceived as required by the emergence and rapid expansion of green industries.

LMI systems develop labor market information, define labor market areas, and use primary and secondary sources of information to generate overviews of labor market trends that can then be used to identify education and skill needs. The Workforce Investment Act (WIA) of 1998 created legislation that created a "framework for a unique national workforce preparation and employment system designed to meet both the needs of the nation's businesses *and* the needs of job seekers and those who want to further their careers." (DOL, 1998). This included adapting training programs to local needs, improving access to workforce information for persons seeking opportunities, creating a "one-stop" system, new incentives, and new rules for accountability of public agencies. It also created funding streams for adults, dislocated workers, and youth ages 14-21 specifically, committing 85 per cent of the funding for activities directed to local areas, while the remaining 15 per cent went to state-wide efforts. Thus indicating that workforce opportunities and responses are intended to occur primarily at the local as opposed to state or national levels. An overarching goal is "to increase the employment, retention, and earnings of participants... [improving] the quality of the workforce." (ETA, 2010c).

The US LMI system relies on collaboration across state and federal agencies, under the Workforce Investment Council (WIC). This can involve, but is not limited to, the Secretary of Labor, BLS, and state employment agencies. The WIC Green Jobs Study Group (GJSG) included members of the BLS, O*NET, and state employment agency members from California, Colorado, Connecticut, Florida, New York, Pennsylvania and Washington. The original goal of the group in March 2009 was to define green jobs and identify measurement methodologies for green jobs, develop alternative measurement methods, and to create an action plan. This changed when the ARRA funded the BLS to conduct a survey of green jobs and industry that can apply nationally, while individual state-funded LMI programs were to develop their EE and RE data and make it more accessible. The scale and scope of green jobs and industry will be determined in part by these individual state activities, though the WIC GJSG relied mainly on surveys from California, Michigan, Oregon and Washington because these states were assessed as leading in the creation of a definition of green jobs and subsequent attempts to measure them. "In light of these efforts, the focus of the Study Group [shifted] to identifying lessons learned and sharing information among states" (WIC GJSG, 2009). A key issue identified by the redirection of focus from definitions to looking at information sharing activities between states was the need for surveys to have a clear purpose and clear parameters. A second key insight related to minding the connection between the survey and future implementation into occupational estimates, wage data, and O*NET data. Needs identified from the review included continued work on green definitions, a need to accelerate communications between state and federal agencies, and improvement of technical assistance. The latter included:

> "…survey planning, response modes, instrument design, testing and survey instrument, sampling, follow-up procedures data capture, and editing, estimation, and data analysis and dissemination. Surveying green jobs, by its very nature, introduces several issues that are

different from traditional industry and occupation surveys, so the lessons from the existing state LMI surveys are particularly instructive and useful to future studies." (ibid., pp. 6-7).

3.2.4 Skills response

Section 3.1.3 presented the policy response and program initiatives related to training principally focused on the $500 million allocated to training in relation to green training programs. While there are multiple institutional dimensions to the training (and retraining) system in the United States, this report will focus on the critically important community college system in meeting the shifting demands for green training and education. Private training programs are noted at several points in the case studies and key green occupations require bachelor's or advanced degrees. However, the largest and most immediate increases in skill and knowledge requirements for the newly-shaped green workforce will be middle skill jobs in both EE and RE sectors. Thus, most green jobs will require more than a high school diploma but less than a bachelor's degree.

Community colleges are ideally positioned to target populations that fit this general demographic and supply 1-2 year programs that can be designed around a variety of vocational needs (Feldbaum; States, 2009). For the needs of green jobs, many community colleges have integrated an environmental studies or sciences as base knowledge-building curriculum, along with courses, for example, specific to the green technologies students will specialize in, whether wind based, solar, or materials for green building. Efforts to expand training and education opportunities can occur as part of a collaboration or as an incumbent worker training initiative wherever green employers and colleges are co-located. Courses also cater to existing certifications such as solar installer certifications administered by the NABCEP through certification programs developed as part of collaboration between schools and business communities, unions, or other organizations that shape the dominant green industry opportunities present in different states or localities. Although a declining proportion of the workforce, unions can be important strategic partners since so many of the green jobs created in the United States will come out of the construction sector generally, as part of green building activities.

In addition to providing targeted certification and degree programs based on local workforce needs and available green job growth areas, community colleges have also responded to the emerging green industry by integrating sustainability, environmentally-progressive approaches to their campus design and resource management. In practical terms, this can mean expanded public commuting lanes to and from the college, construction of LEED-certified buildings, recycling activities, and the purchase of renewable energy. In short, community colleges will develop their reputations for environmentally-responsible leadership with a focus on sustainability. As noted in Feldbaum and States (2009, p. 27):

> "The success of community colleges in the green economy will be built on strategic regional partnerships that include industry, the workforce investment system, industry associations, unions, economic development organizations, K-12 education systems, universities, and community-based organizations. These partnerships will allow community college leaders to contribute to the green economic and workforce development strategy and vision of the region, leverage and align public and private funding sources, build on existing infrastructures and resources, and work with state, local, and national policymakers and leaders to create policies that support a sustainable, low-carbon economy. In doing so, community colleges will be considered the gateway."

The limitations on the success of these efforts for the United States would seem to relate more to a failure to make critical investments at the federal level, namely, providing additional stimulus and support for growing renewable energy and energy efficiency technologies and industries. The education and LMI systems are already responding to the perceived needs of an expanding green workforce but the long-term demand for labor can falter if these industries do

not receive sustained funding. As some of the green job demand estimates make clear, US policies can have a very large impact on the estimated number of green jobs.

3.2.5 Case studies on new green occupations

Case study 3: Photovoltaic Installers

The PV industry has been a major focus of the RE initiatives of policy-makers for over a decade. In recent years, the growth rates of residential installation have increased exponentially nationwide and even more steeply in those states with aggressive green-friendly legislation. At a federal level, the ARRA includes $40 billion allotted for EE and RE programs. Nearly $40 billion of the total $500 million is slated for green job training grants. In order to better understand what the most equitable and effective strategies to develop training programs and a skilled PV installation workforce, this case study is organized in relation to two major themes. First, a trend line for future growth in the industry must be established so demand can be estimated as well as a more comprehensive understanding of the composition of this employment growth. Secondly, we must analyze the skill requirements and investment in workforce development necessary to expand the PV labor supply of tomorrow. This must be done in a way which is sustainable but fast enough to meet the rapidly-increasing PV product demand. PV Installation is identified as a New and Emerging occupation according to the *Greening of the world of work* report (Dierdorff et al., 2009). This is likely the case now not because the occupation has not been increasing in recent years due to specific and significant state-based initiatives and fossil fuel price spikes, but mostly because of the expected increased expansion in this occupation in large part due to recent shifts in policy. This section identifies occupations closely related to additional PV and other occupations that are just as likely to be New and Emerging occupations in the near future if PV-installed capacity grows as rapidly as predicted.

The anticipated labor demand growth in the PV Industry

The ASES, in their January 2009 report (Bezdek, 2009), created three scenarios predicting the growth of the US RE industry through the year 2030. The first base model is described in the report as a "business as usual" scenario that assumes no change in policy or initiatives, the moderate scenario assumes incremental growth of both federal and state policy and incentives, and the advanced scenario is described in the report as "pushing the envelope" of what is realistically feasible. The advanced, moderate, and base scenarios predicted in the report show the creation of $560, $212, and $98 billion in revenues from the RE industry as well as the creation of 7,328,000, 2,846,000, and 1,305,000 jobs respectively. The report indicates that in the PV industry, under the assumption of the advanced scenario, nearly 700,000 jobs will be created, while in the base scenario about 200,000. A similar report done in November 2008 by the United Nations Environmental Programme (UNEP et al., 2008) group projected a slightly smaller employment number of 180,000 jobs created in the United States by 2025 in the PV industry. The Solar Energy Industry Association (SEIA) estimates that the PV industry will employ nearly 150,000 by 2020 (Weissman, 2008). It is safe to assume that the UNEP and ASES base scenario used similar dependant values in the multiple regression used to predict the trend line for employment growth in the industry. The slight variation can be explained by the five-year gap in the time period used in the prediction and if the same pattern of growth in the UNEP model were extended to 2030 it would predict nearly the same result. A slightly more optimistic base model prediction of 287,000 jobs created by 2030 was put out by the European PV Installation Association (EPIA) and Greenpeace project (EPIA; Greenpeace, 2007). PV jobs will help to rapidly reduce the massive unemployment rates seen in the construction industry in the aftermath of the collapse of the housing bubble. The labor supply of construction and trade workers already have a massive investment in human capital and will require little retraining to meet the demands for RE workers, specifically in the PV industry.

Dissecting the PV labor demand

The UNEP report also produced a relatively optimistic estimate that of about 50-53 total jobs are created per MW of installed capacity (UNEP et al., 2008). Similarly, the EIA (2009) reported 11,245 jobs as of 2008 in the PV industry. According to the SEIA (2008) report, *The US Solar Industry Year in Review 2008,* nearly 342 MW of installed capacity was added in 2008 with 292 MW tied to the grid. If we use the EIA estimate in conjunction with the SEIA figure, we get a slightly more pessimistic estimate of about 33 jobs per MW overall and 38.51 jobs per MW capacity. These EIA figures, however, do not consider the broad scope of jobs not specifically PV-related that are considered in the UNEP report. The scope of which jobs are being analyzed could account for the discrepancy in the ratio of jobs per MW created. The UNEP report also goes on to explain that the majority of the jobs created are at the point of installation. A further decomposition of its estimate reveals ten manufacturing, 33 installation, 3-4 wholesaling, 3-4 indirect supply, and 1-2 research jobs created per MW. Additional data in the EIA report (2009) was used to calculate that only 37 per cent of PV installed in the United States (both commercial and residential) is manufactured domestically. It is safe to assume that the UNEP report does not consider where the jobs are created but simply that they are created, thus, we can multiply the UNEP's ten jobs per MW in manufacturing by our EIA estimate that only 37 per cent is done domestically and we arrive at an estimate of about 43 jobs per MW. This figure is reasonably close to the estimate which we obtained through combining the SEIA report on installed capacity and the EIA estimate for total PV-related jobs. The UNEP estimate of 33 jobs per MW or about (33/53) 62.26 per cent of the total jobs created per MW of installed capacity to be from installation. This figure can be verified by combining two outside estimates from the BLS and EIA. The BLS report cites industry insiders as estimating the national number of PV installers to be about 7,000 when this is divided by the EIA's total PV industry employment estimate of 11,245 (Booz Allen Hamilton Consulting; USGBC, 2009) we get a total of about 62.25 per cent involved in installation (BLS, 2009d).

A great deal of attention is paid in past PV policy initiatives and debates on the issue of domestic manufacturing. Though the hardware is increasingly being imported from foreign countries and their manufacturing methods may increase the carbon footprint of the devices due to varying environmental policies, more attention needs be paid to the portion of installation jobs created. According to the EPIA and Greenpeace project (2007), "the manufacturing numbers will continue to decrease over time with greater automation" yet the installation jobs created domestically would be impossible to export. The total ratio of jobs per MW will undoubtedly fall as the yields of PV systems continue to increase as new technology is developed. It is not clear that the ASES, UNEP, and EPIA reports used a coefficient that took account of the rate of technological change to account for these yield increases when they conducted their projections of the employment growth in PV through 2025 (or 2030). The ASES deems the effect of implementing an aggressive strategy, outlined in its *Tackling Climate Change* report, to be "timely, because the broad, aggressive, sustained development of EE and RE addresses both climate change and economic stagnation… The solution to one is the solution for the other" (Bezdek, 2009). According to a study done by the PERI (Pollin et al., 2008), construction industry employment has declined from a peek during the housing bubble of 8 million in 2006 to about 5.6 million as of February 2010, creating an unemployment rate of about 27 per cent. Much of the analysis of the training of PV installers points to electricians but according to the BLS (2009d) article in *Occupational Outlook Quarterly*, there is a variety of skills required to become a PV installer and a certified electrician is only required at the point of inversion. The point of inversion is where direct current (DC) is changed to alternating current (AC) so that it can be fed back into the electrical grid (RESNET, 2010f).

Table 12: PV occupation profiles

PV occupations	Average annual wage ($)	Job level	Typical education requirements
PV Construction Foreman	53,500	Senior-Level	High School/Associate's Degree
Electrical Design Engineer	65,000	Mid-Level	Engineering Bachelor's Degree
Maintenance Technician	44,100	Mid-Level	High School/Associate's Degree
Research and Development	41,400	Mid-Level	Bachelor's Degree
PV System Installer	40,000	Entry-Level	High School/Associate's Degree
PV Systems Designer	42,600	Entry-Level	Bachelor's Degree
PV Fabrication Technician	43,800	Entry-Level	High School/Associate's Degree
System Integration Engineer	75,100	Mid-Level	Engineering Bachelor's Degree

Source: Pernick et al., 2009.

The occupation thus seems more likely to require a skill set not unlike that of HVAC installers. According to BLS (2008b) *Occupational Employment Statistics*, HVAC employment totaled 250,970 in May 2006. *The Current Pop*ulation (BLS, 2008c), which includes self-employed workers, estimates that nearly 405,000 people were employed in the HVAC industry.

> "As the potential for jobs grows in the solar industry, community colleges will increase enrollment by connecting courses and certifications to their existing construction and engineering programs and promoting careers in the solar industry to new or returning students who have worked in construction-related fields." (Feldbaum; States, 2009).

Occupational profiles for careers in PV installation can be seen in Table 12. The two estimates from the BLS seem to indicate that there is already a surplus of skilled craft workers available to be retrained and re-skilled to meet the demand for PV installers. Thus policy initiatives in the wake of the housing bubble's burst should focus on targeting the available funds at the unemployed workforce skilled in construction-related occupations, specifically electrical and HVAC workers. Jobs created in PV installation are impossible to export, good quality, and sustainable. The composition of the PV installation workforce will be heavily influenced by state regulation and certification. The manufacturing of PV units will, despite the heavy policy debate, compose little of the overall future labor supply.

Contested licensure standards in Massachusetts and the PV installer workforce

The situation surrounding PV licensure in Massachusetts is one of particular interest because it highlights a few of the critical issues policy-makers will be faced with as the demand for solar continues to grow amidst an otherwise depressed construction industry. Recently in 2009, the Massachusetts State Board of Examiners of Electricians held an administrative ruling reinterpreting longstanding state law regulating PV installations to require that all solar PV installations must be done by a licensed Master Electrician, which includes an apprentice if union job, or helper if non-union. (State licensure requires a one to one ratio of apprentice of helper per electrician.) These regulations are up to local electrical and building inspectors to enforce but as they are themselves licensed they are expected to enforce the new standard although to a degree unmeasured across municipalities. It is to be expected that skilled trades people are looking to set higher standards to ensure they get a higher share of jobs in a depressed market.

Previously PV system contractors that were not electricians opposed any licensure requirements but have now joined an effort to enact Massachusetts House Bill No. 4180 to create a separate and more specific PV installer license. The supporters argue that licensed electricians may have little to no experience with the positioning, bracketing, sealing, or the process of

applying for incentives which certified PV installers are required to learn in states with specific licensing requirements. The only part of the installation that arguably must be conducted solely by a licensed electrician is at the point of inversion where DC is changed to AC. Inversion is required to push the energy back into the grid and thus necessary on the increasing proportion of installations known as "grid connected installations" which have been the primary focus of policy-makers. However, most licensed electricians have had little experience working with DC because nearly all electrical installations in the United States deal with AC. Additionally, there is little information provided to the consumer about the process of applying for the rebates available to them because of the limited amount of PV experts in the state.

The solution like the one proposed in House Bill No. 4180 would only require an electrician at the point of inversion. The rest of the installation would require an NABCEP or an alternatively trained/certified PV expert to install the actual units and apply for state-funded and federal incentives. This process is similar to the one which HVAC installers in the state have to go through when installing units. The International Brotherhood of Electrical Workers (IBEW) has a strong presence in Massachusetts and has been opposed to legislation to change the regulations regarding PV systems in Massachusetts. Alternatively, in Vermont IBEW has been supporting training electricians in PV installation through the NABCEP course. Restricting the installation of PV by only allowing licensed electricians to conduct all aspects of solar installation would likely have a positive impact on the quality of the jobs created by the industry, especially given the depressed labor demand in the construction industry. The alternative policy under consideration in Massachusetts would implement a separate PV contractor's license. This license could require contractors who meet the prerequisites for experience (including eligible electricians) to take and pass a PV certification exam (possibly the NABCEP exam). This would not only allow the installation to be done by licensed electricians and other contractors who are properly trained but also allow for consumers to be assured that the installation is completed by qualified knowledgeable individuals. Since it is likely that the majority of these PV contractors will be electricians who hold dual licenses, it will be a matter of strategy as well as policy and labor market conditions whether the IBEW can effectively forestall the passage of a new PV installer license. Although the incentives are in place in Massachusetts, there is a lack of experts who are knowledgeable of them and can sell PV to the consumer. If Massachusetts were to make the regulations of PV installers similar to HVAC and require an electrician only at the point of inversion, it could accelerate the increases in installed PV capacity.

The development of a sustainable PV workforce: Certification, licensure, and training

Looking forward, a substantial investment in workforce training of PV installation will be necessary if the labor supply will expand to meet the growing demand. This presents an opportunity for existing skilled craft workers such as electricians, line workers, roofers, and HVAC workers to expand their skill set to include PV installation. As a result of the housing bubble, there is a surplus of these contractors available to meet the industries' growing demand for knowledgeable installers in the short run. In fact, Jim Dunlop in his report to the National Joint Apprenticeship and Training Committee (NJATC) for the electrical industry said that "It is unreasonable to expect that short term training, without specific entry qualifications and prerequisites, can qualify individuals to practice a trade or successfully enter the workforce installing PV systems" (Dunlop, 2008). In the long run, however, it will be necessary to focus on training PV installers from the ground up. Certification of installers and accreditation of the workforce training programs is necessary to prevent a situation similar to that of solar thermal, where the demand became stagnant as a result of faltering consumer confidence (BLS, 2009c). According to the Solar Energy Society of Canada (Pouyot, 2007):

> "One of the reasons why Solar (Thermal) got a bad reputation is that during the last Solar boom of the 1970s and early 1980s, too many unqualified installers put up solar systems that never worked properly. While it is important that high-quality, certified equipment be

installed, the best equipment may not operate if the installer has not been properly trained and demonstrated that he/she has the necessary competencies."

According to Dunlop (2008), "Unqualified and untrained installers and substandard and unsafe installation practices are perhaps the biggest threats facing consumer acceptance and market growth of the PV industry". In order to reassure this growing concern, a partnership program between the DOL DOE, and the Department of Education called the Solar Instructor Training Network (SITN) was launched in October 2009. The DOE has pledged nearly $27 million to the program, of which about $10 million comes from ARRA funds. The program was created with the goal of addressing the critical need for high-quality accessible training in solar system design, installation, sales, and inspection. SITN has a 5-year timeline and intends to produce a geographic network of training centers for solar installation across the United States. Additionally these efforts will ensure that there are a sufficient number of solar trainers and installation instructors as well as to disseminate the best industry training practices (DOE; EPA, 2010).

The NJATC differentiates workforce training into three categories which help compare the advantages and differences of each.

- **Licensing**, defined as a credential to legally practice a trade and issued by government agencies.
- **Certification**, defined as a voluntary credential awarded by training programs or industry stakeholder groups that recognize competencies or course completion; these certifications do not permit legal practice of a trade but can be used for competitive advantage.
- **Degree**, usually granted by educational institutions that recognize completion of established curriculum and competencies; but which does not constitute a license to practice.

Certification

Although installation of large-scale PV systems (those producing greater then 500kW) had a larger growth rate than the residential sector in 2008, nearly 90 per cent of the 19,000 installations completed were for residential use. Certification and training is a crucial issue when it comes to understanding the growth of the PV industry in the future. The level of licensure required to install both residential and commercial installations varies widely across states, municipalities, and incentive programs. To gain a better understanding of the nuances of these different certification requirements, an analysis of some of these procedures is necessary.

Nine states (Arizona, California, Connecticut, Florida, Hawaii, Nevada, Oregon, Puerto Rico, and Utah) all have specific solar contractor licenses (DSIRE, 2010b). All of which are included on the list of ten largest cumulative installed capacity of PV, with the exception of Puerto Rico and Utah (Sherwood, 2009). As the solar industry continues to grow and employment continues to rise, it is increasingly important to learn from the regulations of states which have successfully cultivated the growth of PV installation and those which have failed. California and Florida both have had a specialty contractor's license for a long period of time that has come to incorporate PV solar as the technology has developed. California, unlike Florida, has been able to successfully transform a technology from a gadget of the very rich (used to heat swimming pools) into a thriving RE industry through successful policy and incentives. The differences in the licensure of PV installation in the two states will be carefully compared and contrasted to gain a better understanding of the role the certification process has played in the development of the PV industries in California and Florida.

The NABCEP certification was created as a voluntary value-added program for PV installers to differentiate themselves from less-qualified installers (Hossain et al., 2009). The certification requires applicants to be at least 18 years of age, meet prerequisites of related experience and/or education, complete an Application Form documenting requirements, sign a

code of ethics, pay applicable fees, and pass a written exam. A recertification test must be taken every three years and during the period prior to recertification, 18 hours of continuing education must have been completed. The 18 hours of continuing education must consist of six hours related to National Electrical Code, six hours related to NABCEP task analysis, and six hours of instruction related to RE (may be unrelated to PV and may be non-technical). The program accepts a wide variety of credentials to fulfill its prerequisites for experience which include, but are not limited to, four years of electrical contracting work, two years of experience installing PV, as well as a variety of educational degrees. Maine, Minnesota, and Wisconsin, which do not as yet require PV installers to hold a specialized contractor license, are requiring the NABCEP certification of installers applying for state-funded incentives. California, Delaware, and Massachusetts recommend the certification and give preference to installations done by NABCEP-certified installers when issuing state-funded incentives. In Utah, a NABCEP certification must be obtained in order to qualify for the State's solar contractor license (ibid.). The NJATC outlines some of the challenges facing the NABCEP organization which include: diminishing pool of qualified candidates, entry paths widely varying in qualifications and prerequisites, validating experience, does not presently include a skills/performance assessment component, many roles and responsibilities in PV industry besides system installers – perhaps suggesting multilevel certifications. Credential must evolve to meet changing industry, and trends toward specialization, and consumer demands (Dunlop, 2008). According to unofficial figures from NABCEP, there are nearly 4,000 certified installers and most scheduled training classes are full for the next year. The NABCEP certification is an excellent way for contractors to differentiate their skills and stay in touch with changing industry trends. Some state incentives require a NABCEP certification even though the state does not require the certification to complete the installation.

Licensure

The California Contractors State License Board (CSLB, 2005) offers several different classifications which allow for PV installation. Previously some PV installations could be done by the C-7 Low Voltage and C-53 Swimming Pool licenses in addition to the official C-10 Electrical and C-46 Solar licenses but this is becoming increasingly, if not altogether, prohibited. The C-10 Electricians license allows for PV installation, however, it does not ensure that the individual knows or understands the semantics of installing this emerging technology (NABCEP, 2010). Additional certifications can be obtained through NABCEP and other similar programs which help reassure consumers that the installer is knowledgeable of the nuances of installing PV, but it is not required (ibid.). The C-46 official solar license allows for the installation of all aspects of PV but additionally certifies the contractor to also install solar thermal systems. The requirements for obtaining a C-46 license is four years of experience working under a licensed installer, of which a portion can be substituted by obtaining a relevant associate's degree (1.5 years), unrelated university bachelor's degree (2 years), accredited bachelor's degree in construction technology (3 years), or certificate of apprenticeship (3 years). To obtain the C-46 license, these prerequisites must be met before the test can be taken. The class "A" General Engineering Contractor and class "B" General Building Contractor licenses also cover PV installations in California. The NABCEP certification is not required of installers to obtain state-funded incentives but is highly recommended that applicants choose contractors with this certification. Solar installers will file forms for a customer's incentives directly with the Solar Clerk of the California Solar Initiative (CSI) office. Consumers installing a system less then 50 kW will receive an upfront rebate on the system's estimated performance, however, larger systems will receive the rebates over a period of five years based on the measured output of the PV system (CSI, 2010). Contractors from California have reported that municipalities often prevent the installation of PV by individuals who possess a C-10, Class A, and B license but do not have a C-46 license or NABCEP training, which indicates that some of the inspectorate remains unclear of the law (Kalb, 2006).

The State of Florida has standards similar to that of California; both states have an Independent solar installer's license. The State requires that a PV system must be installed by a state-licensed Master Electrician, Electrical Contractor, or Solar Contractor (FSEC, 2010a). Additionally, in order to qualify for state-funded incentives, the system must be installed by one of these professionals and certified that it meets the Florida Solar Energy Center (FSEC) standards regarding safety and performance prior to installation. The application must be submitted prior to installation and include a summary of the system design, complete three line electrical schematic, and a parts list of system components. The process can be expedited if the system design has been certified and stamped to meet the FSEC requirements by a professional engineer before the application for incentives is submitted (ibid.). Like California, Florida has similar prerequisites to obtaining the Division II-O contractor license for Solar which include four years of experience. A portion of this experience can be substituted by a four-year construction-related degree from an accredited college (three years), an associated degree (two years), or holding another I-B Building Contractor, and I-C Residential Contractor licenses also allow for the installation of PV systems in the State (FSEC, 2010b). A Contractor's license will substitute the entire requirements. Division I-A General Contractor, I-B Building Contractor, and I-C Residential Contractor licenses also allow for the installation of PV systems in the State (ibid.). Having a PV-specific contractor's license assures consumers that they will be hiring a knowledgeable installer. The PV contractor is the consumer's portal to the state and federal incentives and should be knowledgeable of how to apply all rebates available. Incentives and rebates drive the product demand, but this is only true to the extent they are used to sell PV units and show the affordability of a solar installation. Thus, PV contractors must be up to date with the constant changes in policy relating to RE.

Training

> "With governments largely footing the bill – to the tune of hundreds of billions in new stimulus backed programs – investment in clean-tech human capital is now a leading strategy to a sustained global economic recovery in the short term, and a targeted engine of growth through the 21st century. One group at the forefront is US community colleges, which are initiating new programs in high-demand fields that include… solar fabrication" (Pernick et al., 2009).

The federal government has initiated an effort to create a model for this training process through the creation of the SITN program.

Table 13: Solar Instructor Training Network (SITN) area map

Region	States	PV Training Centers
Northeast	Connecticut, Maine, Massachusetts, New Hamphsire, New York, Rhode Island, & Vermont	Hudson Valley Community College & Kennebec Valley Community College
Northern Mid-Atlantic	Delaware, New Jersey, Pennsylvania, & West Virginia	Pennsylvania State University
Southern Mid-Atlantic	District of Columbia, Maryland, North Carolina, South Carolina, Virginia	North Carolina State University
Southeast	Alabama, Arkansas, Florida, Georgia, Kentucky, Mississippi, Tennessee, Puerto Rico, & Virgin Islands	University of Central Florida
Midwest	Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, & Wisconsin	Midwest Renewable Energy Association
South-Central	Arkansas, Louisiana, Missouri, New Mexico, Oklahoma, & Texas	Houston Community College
Rocky Mountain	Alaska, Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, & Wyoming	Salt Lake Community College, Solar Energy International, & Utah Solar Energy Association
California & Hawaii	California & Hawaii	California Community Colleges Board of Governors, California Energy Commission, California Centers for Sustainable Energy, & Labor Management Cooperation Committee

Source: DOE, 2010c EE & RE.

The National Administrator of SITN regularly convenes and coordinates with experts to improve the instructional practices and training of installation contractors and other personnel working in the solar installation industry. This program provides resources to the regions listed in Table 13 above. Resources are disbursed at the regional level to selected training providers that are determined to be well-established solar training institutions offering expert instruction and top training facilities. Additionally, these regional entities and training providers are mandated to collaborate regularly with educators, solar industry representatives, workforce investment boards, and state and federal agencies to ensure the proper curriculum and allocation of resources (US Executive Office of President Barack Obama, 2009).

The NJATC has published the only official textbook for PV installation. The technical and curriculum coordinators for the book were Jim Dunlop and Todd Stafford. The NJATC joint program between IBEW and NECA has been training PV installers for over a decade. Stafford claims, “The new textbook is the culmination of years of experience, and now stands at the center of our training, together with other specially developed course materials.” (PR Newswire, 2009). The text and curriculum developed by the NJATC is being used by many training courses across the country such as Photovoltaic Practitioner Certificate Program (PPCP). The PPCP is an online course primarily aimed at retraining skilled contractors to understand the installation process of PV systems. The cost of the online course including the examination that certifies the completion of the course is $895 (+$100 test fee) (Springfield Technical Community College, 2010). ONTILITY is a similar training course which is based on the NABCEP curriculum but also uses

Jim Dunlop's training manual. The cost of the ONTILITY online course is $800 plus an additional $500 for a comprehensive training lab (Business Wire, 2010). The FSEC has focused its training programs on retraining contractors, electricians, utilities, engineers and other practitioners to install PV. These courses focus on systems knowledge rather than the basic skills development which would be necessary to train installers from the ground up. The cost of the course is $1,300, which is about the average for other PV training courses where the students are typically veterans of the construction industry. The FSEC course also additionally recommends a NABCEP certification upon its completion. In the Northeast and similarly in California, "community colleges and technical schools are responding to the increasing demand for a skilled workforce by offering RE courses" (US 110th Congress, 2008). The NJATC is taking the lead on retraining the existing skilled workforce in the electrical industry to meet the increasing demand for PV installers. Community colleges and trade schools are being used to provide the training for the PV industry and are using the curriculums of the NJATC and NABCEP.

Case Study 4: Wind Technicians

Like all RE sectors, the demand for labor in wind energy generation is highly contingent on the growth of REPS as well as various state and federal policies. A 2003 analysis entitled *Putting renewable to work*, conducted by the University of California Berkeley outlines the employment growth in the wind generation industry is directly dependant on RPS (Kammen et al., 2004). Estimates of labor demand are difficult to create because there is some discontinuity between selected occupations and the specific jobs created.

According to the REPP 2001 (Singh; Fehrs, 2001) study entitled, *The work that goes into renewable energy*, there are about 48 jobs per 10 MW of installed capacity of wind energy generation. Of these 48 jobs, about five were estimated to be related to installation, 12 were related to operation and maintenance, and about 31 from manufacturing. This study was later used to create a "Labor Calculator" in 2003 which bolstered its estimate slightly to a figure of about 48 jobs per 10 MW of installed capacity in the example used for Nevada. Of these 48 total jobs, about ten jobs are expected to be related to operations and maintenance, seven from installation, and about 31 from manufacturing of components (REPP, 2003). In reports done in 2004, the REPP revised this estimate of the number of wind operation and maintenance to six jobs per MW. According to a 2009 study done by Greenpeace and the European Wind Energy Association (EWEA) (Blanco; Kjaer, 2009), about 93 directly wind-related jobs per 10 MW of installed capacity are created through the use of wind energy generation. Of these 93 jobs, nearly 64 are directly related to manufacturing of components; 11 to installation; and 18 to operations and maintenance. The study also estimates an additional 58 indirect jobs are created per 10 MW of installed capacity According to a report done by the National Renewable Energy Laboratory (Lantz; Tegen, 2009), between 40 and 60 year-long jobs are created per 10 MW during the construction phase of a wind project. The same study estimates that about three to six long-term jobs are created during the operation and maintenance phase of a wind project.

According to a report by the ASES (Bezdek, 2009), wind energy generation revenues/budget totaled nearly $3.3 billion with the creation of 17,300 industry jobs and 39,600 overall jobs in 2007. The ASES also created three scenarios in this report predicting the growth of the US RE industry through the year 2030. The first base model is described in the report as a "business as usual" scenario that assumes no change in policy or initiatives; the moderate scenario assumes incremental growth of both federal and state policy and incentives; and the advanced scenario is described in the report as "pushing the envelope" of what is realistically feasible. The advanced, moderate, and base scenarios predicted in the report show the creation of $560, $212, and $98 billion in revenues from the RE industry as well as the creation of 7,328,000, 2,846,000, and 1,305,000 jobs respectively. The report indicates that in the Wind industry under the assumption of the advanced scenario would create nearly 1,040,000 jobs; 257,000 in the moderate scenario; and 66,200 in the base scenario.

The jobs created by wind energy generation can be divided by the specific tasks toward which they contribute. The three categories of wind energy generation jobs include manufacturing jobs, installation jobs, and operations and maintenance jobs. The first two categories constitute existing occupations that require some additional green-specific training. Installation is primarily done by large construction companies with minor additional skill requirements for the majority of workers. In this regard, wind generation could provide a much needed expansion of labor demand in the construction industry. Wind energy generation, like many RE industries, has the potential to re-skill and re-employ many displaced workers in the wake of the housing boom. The manufacturing jobs created mainly require knowledge similar to that of automobile assembly. In fact, even the turbines used to create electricity are not mechanically much different than an automobile transmission. Growth in wind energy could also help contract the unemployment seen as a result of the recession's effect on the manufacturing base in the Midwest.

Table 14: Wage profile of Wind Technicians

Median wages (2008)	$16.46 hourly, $34,240 annual
Employment (2008)	170,000 employees
Projected growth (2008-2018)	Average (7 to 13%)
Projected need (2008-2018)	41,800 additional employees

Source: EDF; MISI, 2008.

The jobs related to the operation and maintenance of wind energy generation require a hodgepodge of skills that classify them as New and Emerging occupations. The occupation which primarily composes the employment in the operation and maintenance of wind energy generation has been classified as a Wind Technician. A very comprehensive green jobs guide book prepared by the State of California, published in 2008 describes three types of Wind Technician jobs that involve increasing education, pay, and responsibilities (EDF; Ella Baker Center for Human Rights, 2008). A profile of a typical Wind Technician can be seen in Table 14. An entry level position pays $14-15 per hour and requires only a high school degree, or GED, the second tier pays slightly more and suggests trade school or apprentice training, although no degree is required, and the top level pays $22-26 per hour and requires trade school or apprenticeship and highly recommends college courses in technical areas such as Iron or Metal Shop, Mechanical or Electrical Engineering, or RE Studies.

As we see above, using Government figures from O*Net, if we take the estimates out to 2018, the growth of jobs rises to about 41,800. This estimate probably is an overestimate because it likely includes some jobs in addition to Wind Technicians. The category they use is Installation, Maintenance, and Repair Workers, All Others. *The O*Net summary report for Wind Technicians* (O*Net OnLine, 2010c) produced the following information on the wages and employment of Installation, Maintenance, and Repair Workers, All Others. Also included are the results of a survey of 25-44 year olds working as Installation, Maintenance, and Repair Workers, All Others, on the education levels they currently possess. This survey acts as a proxy for many of the educational requirements of the wind technician occupation. Nearly 61 per cent have a high school degree or less, 30 per cent have some college, and 9 per cent have a college degree or higher.

The Advanced Technology Environmental and Energy Center (ATEEC), a national organization funded in part by the National Science Foundation (NSF), and founded to promote green energy education, catalogs educational programs in RE at two-year colleges. They currently list 23-24 such programs in the United States. The DOE gives a list of wind technician, as well as somewhat more general technician education programs that include about 50 programs. The majority of these programs are housed in community colleges and four-year colleges and universities but there are programs provided by industry collaboratives, and

technical schools. See, for example, several of the programs in California listed on the DOE web page (DOE, 2010d). A well-known example of a community college program for wind technicians is located at Iowa Lakes Community College. It is the oldest such program in the United States, started in 2004, and its enrollment is now at 105.

Table 15: Occupational profile of Wind Technicians

Typical tasks
Inspect or repair fiberglass turbine blades.
Troubleshoot or repair mechanical hydraulic or electrical malfunctions related to variable pitch systems variable speed control systems converter systems or related components.
Climb wind turbine towers to inspect maintain or repair equipment.
Diagnose problems involving wind turbine generators or control systems.
Perform routine maintenance on wind turbine equipment underground transmission systems wind fields substations or fiber optic sensing and control systems.
Start or restart wind turbine generator systems to ensure proper operations.
Test electrical components of wind systems with devices such as voltage testers multimeters oscilloscopes infrared testers and fiber optic equipment.
Test structures controls or mechanical hydraulic or electrical systems according to test plans and in coordination with engineers.
Assist in assembly of individual wind generators or construction of wind farms.
Collect turbine data for testing or research and analysis.
Maintain tool and spare parts inventories required for repair installation or replacement services.
Operate manufacturing equipment to fabricate wind turbines.
Train end-users distributors installers or other technicians in wind commissioning testing or other technical procedures.

Source: EDF; MISI, 2008.

3.2.6 Case studies on greening existing occupations

Case Study 5: Energy Auditors

Historical background

Energy Auditors identify opportunities for increased EE in buildings in residential, commercial, and industrial settings. Energy Auditors can fit into many different education and wage categories as well. Despite having been an occupation appearing in the 1970s, accompanied by predictions of dramatic occupational growth following the energy crises of the decade, it is an occupational category poorly accounted for in the available data. While it is difficult to assess or project the number of Energy Auditors active in the United States, it is clear that green building, the broad activity requiring Energy Auditors, is a large and rapidly expanding sector of the economy.

The EPA traces the practice of green building back to the emergent environmental movements of the 1960s and 70s. In response to the energy crises of the 1970s, the National Energy Conservation Policy Act of 1978 established:

1. the Residential Conservation Service (RCS) requiring large electric and natural gas utilities to provide residential energy audits to their customers; and

2. created the Institutional Conservation Program, a matching grant program funding energy audits and energy saving retrofits in nonprofit institutional buildings (e.g. colleges, schools, and hospitals).

By the end of the RCS program in 1989, 11 per cent of the eligible population of 74 million customers had participated in the program. This was a third of the maximum expected participation rate. However, while its performance was seen as attaining some successes, the RCS had a poorly-designed incentive structure and did not effectively monitor the extent to which recommendations were implemented or the extent of actual as compared to projected energy savings. The RCS experience was a learning experience about the "key barriers and implementation problems confronted by federal programs aimed at reducing energy use in buildings" and thus was a platform that influenced subsequent program designs including those currently active under the ARRA as well as state and local programs. Yet at the time the RCS was created, "the Edison Electric Institute estimated that accomplishing the program's ambitious goals would require 320,000 auditors..." While this estimate was too rapid an increase for a new occupation to be attainable and an upper bound estimate as well, no estimates of the actual number of Energy Auditors actually employed are available (US 102nd Congress, 1992, pp. 90, 111-119). For reasons discussed at greater length below, Energy Auditor is still not an occupational category or an economic activity tracked as a component of work across a set of occupations, even though it has existed as a significant if not defining occupational role for a large number of workers for over 30 years.

The EPA (2010b) notes several milestones in the history of green building practices. One is the American Institute of Architects' creation of a committee on the environment in 1989. Other important milestones were the launch of the energy star program in 1992, the emergence of the first local green building program in Austin, Texas, in 1992 (for details, see 3.1.4, the case study 2 on YouthBuild), and the creation of the LEED building standard in 1998. One aspect of these changes is the reemergence of the Energy Auditor as an important occupation in the United States that will continue to support not just new green building projects but the ongoing retrofit of older homes in the United States. Given that the median year for construction of existing homes in the United States is 1973, ample opportunity exists for the expansion of energy auditing activities supported in part by funding provisions under the ARRA (US Census Bureau, 2007, t 1A.1).[15]

Recent policy initiatives from the federal to the local level promise an even more aggressive promotion of EE and the prospect of accelerating demand for Energy Auditors. In May 2010, the US House of Representatives authorized $6 billion in support of the Home Star Energy Retrofit Act of 2010 (commonly referred to as "Cash for Caulkers"). The Bill would fund rebates of as much as 50 per cent, up to $3,000, for energy-saving efforts such as insulation improvements and the replacement of windows, doors, heating and cooling systems. The installations will have to be completed by qualified contractors, increasing the demand for energy audits. The Bill also includes rebates up to $8,000 for those who conduct "comprehensive energy audits" and reduce their home's total energy consumption by at least 20 per cent. The appropriation of the funds for this program requires approval by the US Senate which was not approving any energy legislation prior to the midterm 2010 elections in November. Although a popular Bill with broad support across a wide spectrum of interests that appears will win final approval, its consideration in the Senate was caught up in at least a temporary if not longer deadlock over the so-called "spill bills" where the focus of controversy was raising the liability limits for off-shore oil "spills" after the eruption of the BP spill/oil well leak in April 2010 (Yousuf, 2010; Davenport, 2010; Neal, 2010; Mijn Cha; Dafoe, 2009).

New York City Council provided one important example of aggressive local EE program implementation when it introduced the "Greener, Greater Buildings Plan" in 2009. This Plan

[15] See section 3.1.4 on YouthBuild for additional information.

consisted of four pieces of legislation that require (residential, industrial or commercial) buildings over 50,000 square feet to benchmark their energy and water use, undergo periodic energy audits, and implement retrofit measures that can be paid back within five years. The first required step toward efficiency is conducting an energy audit to see what measures can be done and what needs to be replaced to make the home or business more energy efficient. These policy changes were expected to create over 2,000 new jobs in energy auditing as well as thousands of temporary construction jobs over ten years (Mijn Cha; Dafoe, 2009).

Others employed are the experts to train the program's 'green collar' workforce to use these new tools and to become skilled Energy Auditor/inspectors. (ibid.).[16] Energy Auditors are second only to Installers in their calculations of employment impact, where Installers represent about 70 per cent and Auditors about 17 per cent (about 1/6) of direct jobs created from Weatherization Assistance Programs (WAP). This study asserts the Bureau of Economic Analysis (BEA) estimate of the compensation for installers is overestimated at $19 per hour compared to a more appropriate $11 per hour and therefore estimates a proportionately greater number of installer jobs from WAP funding. The annual compensation of an Energy Auditor was $63,000, almost twice the level of Installer compensation. This report also advocated for:

> "A plan for a staged expansion of training resources to get thousands of highly trained auditors ready to supervise even more technicians as they acquire the essential skills (that) would be developed while the initial conventional investments are well underway." (EOS, 2010).

The additional investment in WAP is projected to add 12,860 direct jobs for Energy Auditors.

Occupational classification and Energy Auditors

Unfortunately, no source exists that both authoritatively describes the EE and green building sectors and identifies current and increased national demand for Energy Auditors. An analytic deficit exists due to the difficulty of separating energy auditing activities as part of work responsibilities in a number of diverse occupations in different industries and a data deficit exists due to the consequent difficulty in tracking the extent of increase in these activities across occupations. Despite this analytic and data gap, a review of available sources supports an estimate and projection of the number of Energy Auditors in full-time equivalent jobs (FTE) that may be needed to satisfy current and future economic trends. Energy Service Companies (ESCOs) and the construction sector, where most energy auditing activities will take place, will represent 1.34 to almost 5.4 million of those jobs (ibid.). In 2007, the EE sector of the US economy generated 53,000 jobs in ESCOs.

The Standard Occupational Classification (SOC) Policy Committee reviewed requests for revisions to SOC codes recently in order to assess whether or not they can be considered "new" green occupations. This has led to the creation of new SOC codes for Wind Turbine Service Technicians (49-9081) and Solar PV Installers (47-2111). It is instructive to examine the issues involved in locating Energy Auditors within current occupational classification systems in some detail. Particularly, since it is likely there are many more workers involved in energy auditing than in either of the former two occupations but the standards for evaluating worker activities that merit identification as a separate occupation do not allow a direct assessment of the number of workers involved in energy auditing. Thus, distinct occupational codes for Energy Auditors or

[16] The funding for WAP activities was approximately $700,000 in 2007 and 2008, and approximately $1 billion in 2009 before the Recovery Act was signed.

the equivalent do not exist, because the tasks performed by Energy Auditors were not sufficiently unique compared to several existing occupations to which it could be compared (BLS, 2009c).[17]

Dixie Sommers (2010), Assistant Commissioner for Occupational Statistics and Employment Projections and Co-Chair of the WIC GJSG, has provided examples and explanation of the Bureau's current grasp of the SOC codes and the activities of Energy Auditors. Based on this, we generated employment figures and projections from BLS data as seen above. A "Home Energy Auditor", for example, might draw on the same basic "skills, duty, and knowledge" as the three existing SOC job titles: Building Inspectors, Farm and Home Management Advisors, and Cost Estimators. More detailed information about the skills, tasks, and activities for Energy Auditors has been generated by O*Net, provided in Table 16 below that compares Cost Estimators and Energy Auditors. However, O*Net in certain contexts compares energy auditors to the SOC code for "Installation, Maintenance, and Repair workers, All Other", which requires an Associate's degree and earns a median annual income of about $35,000. In other contexts O*Net includes Energy Auditor in "Business Operations Specialists, All Other" with four other occupations, all of which require a bachelor's degree or higher, all earning approximately $60,000 annually. Finally, while the US Census does not have a formal category for Energy Auditors, it does classify "Energy Audit Advisors" under SOC 25-9021, or Farm and Home Management Advisors.

[17] In some cases, when an SOC code was not created for an occupation, a "direct match" title was used to link a green job to its appropriate SOC code. This means that while a SOC code may encapsulate a described "green job", that green job itself will not be treated as unique.

Table 16: O*Net Energy Auditor and Cost Estimator task descriptions

Cost Estimator	Energy Auditor
Consult with clients, vendors, personnel in other departments or construction foremen to discuss and formulate estimates and resolve issues.	Identify and prioritize energy saving measures.
Analyze blueprints and other documentation to prepare time, cost, materials, and labor estimates.	Prepare audit reports containing energy analysis results and recommendations for energy cost savings.
Prepare estimates for use in selecting vendors or subcontractors.	Collect and analyze field data related to energy usage.
Confer with engineers, architects, owners, contractors and subcontractors on changes and adjustments to cost estimates.	Inspect or evaluate building envelopes, mechanical systems, electrical systems, or process systems to determine the energy consumption of each system.
Prepare estimates used by management for purposes such as planning, organizing, and scheduling work.	Perform tests such as blower-door tests to locate air leaks.
Prepare cost and expenditure statements and other necessary documentation at regular intervals for the duration of the project.	Educate customers on energy efficiency or answer questions on topics such as the costs of running household appliances and the selection of energy efficient appliances.
Assess cost effectiveness of products, projects or services, tracking actual costs relative to bids as the project develops.	Calculate potential for energy savings.
Set up cost monitoring and reporting systems and procedures.	Prepare job specification sheets for home energy improvements such as attic insulation, window retrofits, and heating system upgrades.
Conduct special studies to develop and establish standard hour and related cost data or to effect cost reduction.	Recommend energy efficient technologies or alternate energy sources.
Review material and labor requirements to decide whether it is more cost-effective to produce or purchase components.	Quantify energy consumption to establish baselines for energy use and need.

Source: O*Net Online, 2010a; b.

The State of California (EDD, 2010b) made its own recommendations to the BLS for SOC code revisions for green jobs in 2010, The California Green Industry index, while not successful in leading to a new SOC code for Home Energy Auditors, also grouped them with Building Inspectors, Farm and Home Management Advisors, and Cost Estimators for two important reasons. Each occupation:

1. shares similar skills, and
2. does not require an engineering background.

Table 16 above outlines the typical tasks of an Energy Auditor and Cost Estimator.

The Booz Allen Hamilton Consulting *Green jobs study* in 2009 does not attempt to define or isolate a proportion of Energy Auditors, but does identify cost estimators in residential and non-residential construction sectors as comprising 2.61 and 1.93 per cent of the employment in those sectors, respectively. Non-residential construction employment for that sector for cost estimators is thus 60,813 for the period of 2000-08 and 195,686 for the period 2009-2013 (projected). This represents a 327 per cent increase in the latter period compared to the former. Residential construction employment for cost estimators in the period 2000-2008 was 2,760 and 8,906 for the period 2009-2013, also an increase of over 300 per cent. This study uses a definition of the green building sector drawn from McGraw-Hill, which includes both a green building standard that attains the LEED standard or a less demanding standard of completion of a number of

incremental activities enhancing the efficiency of a building. A job is again an FTE, so these numbers reflect recurring or continued employment of individuals (Booz Allen Hamilton Consulting; USGBC, 2009).

Table 17: Occupations compared to Energy Auditors

		Employment (in thousands)		Employment change (Per cent)		
Occupations	**SOC Code**	**2008**	**2018**	**2008**	**2018**	**Education or training**
Cost Estimators	13-1051	217.8	272.9	55.2	25.3	Bachelor's degree
Farm and Home Management Advisors	25-9021	13.1	13.2	0.2	1.2	Bachelor's degree
Construction and Building Inspectors	47-4011	106.4	124.2	17.9	16.8	Work experience in a related occupation
Environmental Engineering Technicians	17-3025	21.2	27.5	6.4	30.1	Associate degree

Source: BLS, 2010e, t 1.2.

Table 17 includes the occupational categories identified above as classifications common for the inclusion or comparison to jobs titles of Energy Auditor. The table summarizes current and project employment in 2018 as well as the common educational requirements. Based on studies and data sources noted above, we believe that there are approximately 80,000 Energy Auditors in the United States, or to put it another way, persons involved in green jobs that include a significant proportion of their activities conducting energy audits.

As indicated above, the pay range, skill and education requirements, and context for work can vary among energy auditing whether it occurs in a residential, commercial, or industrial context, and whether it is related to retrofitting activities or building design. Certifications and standards are a key driving factor and provide some of the career track potential for Energy Auditors. Although a decomposition of all the varied occupations engaged in energy auditing is not possible, the next section provides an overview of key considerations in such an assessment and the primary credentials sought by Energy Auditors.

Certification, training, education

Certification as an Energy Auditor requires, to a varying extent, meeting both emerging national workforce standards and training and also satisfying the building codes and standards set by local regulations that vary widely across the United States. The scope of work and skills involved in an energy audit vary depending on a building's size and the complexities of its systems. However, almost all city-, state- and utility-based energy conservation incentive programs require energy auditing for new or retrofit buildings. Almost all such programs require that an individual or company providing the audit has a professional certification from either the Residential Energy Services Network (RESNET) or the Building Performance Institute (BPI). This section describes the differences in their respective histories and certification standards and the steps toward collaboration in training and certification in light of the prospective Home Star federal legislation, a possible step toward greater convergence in creating national standards.

The BPI, a national nonprofit organization founded in New York in 1993, develops standards, provides professional certifications, and a company-level accreditation for the home energy retrofit sector. From its inception, BPI was an independent third party that aimed to verify worker skills in weatherization and the building trades, and currently offers an "integrated certification, accreditation, and quality assurance program" that works with local training

affiliates around the country to certify building performance technicians. In 1995, the National Association of State Energy Officials and Energy Rated Homes of America founded the nonprofit RESNET to develop a national market for home energy rating systems (HERS) and energy efficient mortgages. RESNET was established as a nonprofit in California in 2002. RESNET has provided the only national source of Verification Oversight by third party raters, inspectors that enforce quality control of installation and completion, for the EPA and DOE coordinated Energy Star program for new homes. BPI is the preferred certification of contractors including Energy Auditors for the Home Improvement with Energy Star program for retrofitting existing homes (BPI, 2010f).

BPI and RESNET both teach the same principles of building science, energy loss and heat flow in a building. Both review standard practices for Energy Auditors and home performance contractors. Both also test candidates on the use of the blower door, a pressurization testing tool that locates and measures air leakages since air sealing is a primary source of energy conservation. Both organizations also pre-approve and qualify third party training organizations to administer their training and examinations. Their major differences reflect the priorities that stem from their origins and the regional advantages to their respective market orientation. Historically, RESNET training has not included Combustion Safety Testing while emphasizing duct testing, and BPI Building Analyst training includes the former but not the latter. BPI focused on the energy audit process, the blower door and combustion safety testing. This makes sense because RESNET is based out of San Diego, which is in the Southwest where the rate of new building was generally higher and homes were more likely to have a forced air duct system for air conditioning. BPI is based out of New York, a heating climate more likely to have a combustion appliance. Finally, BPI requires a candidate to pass one proctored field audit, while RESNET requires the completion of five proctored audits prior to field experience. Until recently, BPI had more levels and specialties of certification, while RESNET focused on the HERS rater. In summary: “The general rule of thumb is that RESNET focuses on new and newer homes, while BPI focuses on older and existing homes.” (BPI, 2010e)

RESNET created the HERS, an index that is used to measure and assess a home’s EE performance. EPA has set standards so that when and if another national organization is sufficiently established to provide Verification Oversight it be required to “have at least the same level of accreditation, certification, and quality assurance as RESNET.” The EPA does not have the resources to oversee a proliferation of regional Verification Oversight Organizations. Instead, the EPA has developed a Builder Option Package where a builder working with a HERS rater uses a set of geographically-appropriate and climate-specific construction specifications developed by EPA (2008a). The RESNET standard is accepted as the Mortgage Industry National HERS Standard. Home energy performance assessments are provided at several levels - each requiring a different level of certification. The first level of assessment may be performed by a certified Home Energy Survey Professional.

The RESNET Home Energy Survey assesses “both the general energy performance of the home and the level of the commitment to action on the part of the homeowner. The survey may include data collected and reported on-line by the homeowner or by a home energy survey professional for the purpose of further analysis and general identification of home performance problems. The intent of the energy survey is to refer homeowners to the next level if it is determined that the home needs further analysis, and the homeowner is motivated to invest in improvements.” The additional services related to energy auditing provided at increasing levels of completeness are a Diagnostic Home Energy Survey which entails the use of building performance-testing equipment (e.g. blower door, duct blaster, flow hood, infrared camera, CO_2 monitor) to measure, assess and document specific performance characteristics of the building system. The most complete is the Comprehensive Energy Audit which encompasses the above activities as well as an evaluation, diagnosis and proposed treatment of an existing home. In addition to certification as a HERS rater, a qualified auditor must also be certified by BPI as a Building Analyst, a certification described further below. The Comprehensive Audit evaluation

may require further "measurement and performance testing, combustion appliance testing, and a computerized simulation analysis of the home's energy performance and a calculation of the energy and environmental savings from improving the energy performance of the home. The performance analysis shall determine the scope of work for the home." (RESNET, 2010e; f)

Becoming a certified rater traditionally required completing training administered by a RESNET-certified training organization. Numerous requirements are engendered by these requirements, including education related to building, building planning, energy systems, calculations, understanding of financial incentive systems, etc. Incumbents must also complete two ratings including use of approved software in the presence of trainers. There is also a RESNET National Rater Test and a RESNET National Rating Inspector Test. Both are on-line 50 question multiple-choice tests that must be completed with a 90 or higher for certification or re-certification (RESNET, 2010b).

In 2009, RESNET created an accredited "Green Rater" certification, which provides *some* prerequisite training for conforming to the LEED building standard administered through the USGBC and *all* certification necessary for the National Association of Home Builders (NAHB) green building programs. This has been achieved through a successful partnership with the USGBC and the NAHB (RESNET, 2010a). At this time, five training providers for the new RESNET Green Rater certification operate in the United States. Each of the training providers already is accredited through 2010 to administer the other RESNET certifications mentioned.

There are currently 51 accredited HERS rater training providers in the RESNET database which are located in 25 states, but a large majority are in southern states. Training opportunities are limited to four in the Northeast, while Texas offers nine training centers, followed by five in North Carolina (RESNET, 2010c). There are over 1,700 members in RESNET today, and the organization's support and alliance building to advance multiple building standards will be a factor in the increasing demand for certified personnel providing energy auditing services.

As of August 2010, the BPI had accredited 306 organizations to train and certify Building Performance Analysts. They were present in all but six states, however, most of the affiliated organizations were concentrated on the East Coast, particularly in New York and New Jersey (BPI, 2010c). BPI has developed background course materials on basic Home Energy Auditor knowledge and skills, and the Home Energy Auditor Standard, which includes competence in providing a cost-benefit analysis (using DOE or BPI approved software), as well as best practice installation procedures and recommendations for EE and health and safety measures. In addition, BPI has established training materials, processes, and standards for additional certifications including: (Building) Envelope Professional, Multi-Family Building Analyst Professional, Energy Efficient Multi-Family Building Operations Specialist, Manufactured Housing professional, Heating and Air Conditioning and Heat Pump Professional (BPI, 2010a;b;d).

It is important to repeat that standards set by RESNET and BPI are subordinate to whatever state or local codes might require as a more stringent practice or code. In all other cases, these organizations are providing services that are national in scope. Further, they are beginning to provide a one-stop training standard for Energy Auditors seeking to provide compliance with any number of the green building standards currently in practice.

Career paths and national standards

Most Energy Auditors are employed by private contractors that specialize in energy audits. Auditors also work as part of EE firms specializing in installing EE measures that provide audits as a first step. Analysis jobs are not entry level. Energy Auditors need some background in building science to assess the energy consumption of the building. Some small retrofit contractors have successfully trained small home auditors from retrofit crew members (Neal, 2010). Thus, home energy audits may also be performed by individuals or companies that are self-described as Home Performance Contractors, Building Analysts, Energy Inspectors or Home

Energy Raters. All of these titles can describe qualified personnel who competently perform an audit.

> Many "… auditors gravitate to offering contracting or remodeling services as well. The most successful auditors usually form referral partnerships with contractors (windows, insulation, air sealing, etc) and earn a referral fee for work performed. Additionally, many contracting businesses will market themselves as Home Performance Contractors rather than Energy Auditors since auditing may be just one of the services they offer, and many Home Performance Contractors prefer to make the improvements suggested by the audit themselves." (Ever Blue Training Institute, 2010).

Auditor training can be good preparation for a higher-level engineering career. Engineering degrees are more common among Energy Auditors working as consultants or in large firms that perform audits and retrofits for multifamily residential, commercial, and municipal buildings, and commission and retro commission building systems.

BPI has a greater range of current certification programs and an ongoing process for extending the range of professional certifications. In December 2007, RESNET created two additional certifications intended to create career paths in the rating field, formally recognizing differences in raters' experience, and facilitating client's and sponsoring program's ease in identification of raters by their extent of experience and level of certification. At the entry level, RESNET established the Rater Field Inspector certification for individuals entering the rating field or for those currently assisting raters in the field. At the high end, the Senior Certified Rater was created to recognize certified raters who have demonstrated increased knowledge to interpret the findings of a rating and make recommendations on home improvements. This certification was the first category of advanced rater certification in the rating industry (RESNET, 2007).

BPI and RESNET were spurred by the prospect of the passage of the $6 billion Home Star "Cash for Caulkers" legislation to begin collaboration on several initiatives. They have coordinated cross promotion and facilitated the development of training modules to make it easier for an energy professional certified by one to become certified to the standards of the other. However, it is other vendors and organizations that develop and provide these short courses. As appropriate for different government rebate programs, they began to develop a joint protocol for the quality assurance inspection as well as required energy audits, instrument-based testing, calculation of energy savings, and the follow up performance testing. Finally, they initiated collaboration to set standards for the recognition of the professional development of those holding certifications from either organization, as each requires continuing education credits necessary for certification renewal (RESNET, 2010d). However, their separate interests in advancing their own certifications makes it uncertain as to whether their initial efforts will actually result in realizing the potential of standardization in overlapping and complementary certification programs.

Case Study 6: Green construction

The USGBC was founded in 1993. It is responsible for the creation of the LEED building standard, the most aggressive and widely-used green building standard currently in use in the United States. The Council claims that the market for green construction represented 2 per cent of non-residential construction starts in 2000, and will reach 12 per cent of all starts by 2008 and up to 25 per cent by 2013 (USGBC, 2010a). Buildings in the United States represent about 40 per cent of US primary energy use and generate about 40 per cent of our CO_2 emissions, making the pursuit of EE an invaluable strategy for carbon mitigation and energy use reduction in the United States (ibid.). The EIA estimates that approximately 4.8 million commercial buildings and approximately100 million residential buildings currently exist in the United States.[18] Since the creation of the LEED and Energy Star standards in the 1990s, no less than 1 million buildings in the United States have benefited from green design or re-design.[19] Over the past 12 years there have been 55,000 LEED certified projects, and an additional 5,200 new projects were registered in the United States in 2010. Forecasts of the impact of the green construction industry from 2009 until 2013 can be seen in Table 18 below. It is these and other green building standards which are shaping and defining the green building sector. The USGBC highlights three key factors driving growth in the green building sector:

1. unprecedented levels of government initiatives;
2. heightened residential demand for green construction; and
3. improvements in sustainable materials.

This report has previously noted that billions in tax credits, incentives, or funding supports have been allocated under the ARRA to support weatherization and EE activities at the federal and state levels, and homeowners have access to funds for energy-efficient appliances and other energy-saving measures. The market for retrofits is very large and the relatively old homes and buildings in the United States provide ample opportunity for expansion of green building activities. The size of the EE sector has been described in several reports and estimates are provided below. Unfortunately, no source exists that both authoritatively describes the EE and green building sectors and identifies current and increased national demand for green building certified contractors. An analytic deficit exists due to the difficulty of separating green building and EE activities as part of work responsibilities in a number of diverse occupations in different facets of the construction industry. A data deficit exists due to the consequent difficulty in tracking the extent of increases in these activities across occupations.

[18] EIA, 2003, (t A1); EIA, 2005, (t A1). The data is based on the number of attached and detached single family units, apartment units with four units or less, and apartment units in buildings with five or more units. Total was rounded down from 104.2 million. The EIA confirmed that the Census American Housing Survey is used as a control for their housing data, and the number of housing units tracked by that survey is comparable.

[19] EPA, 2008b. The EPA has accounted for 996,750 certified, built, or enhanced buildings in the residential, commercial, or industrial sectors. Data from the USGBC on the number of registered LEED projects in the United States (from 1998-Jun 2010) accounts for approximately 49,783 projects completed (pre-2009) and 5,200 projects slated for completion, for a total of 54,983 projects throughout the United States.

Table 18: Estimates of the green building industry

Green construction economic impact		USGBC economic impact (2000-08)	
2000-08	**Forecasts 2009-13**	**2000-08**	**Forecasts 2009-13**
Generated $173 billion in GDP	Generate $554 billion in GDP	Generated $830 million in GDP	Generate $12.5 billion in GDP
Supported 2.4 million jobs	Support 7.9 million jobs	Supported 15,000 jobs	Support 230,000 jobs
Provided $123 billion in labor wages	Provide $396 billion in labor wages	Provided $703 million in labor wages	Provide $10.7 billion in labor wages

Source: Information collected from Booz Allen Hamilton Consulting; USGBC, 2008.

EE as an economic sector was described, in a 2009 McKinsey & Company Study led by Hannah Choi Granade, as heavily fragmented. Opportunities for efficiency and economic enterprise are quite literally everywhere in a given building, and thus the range of green activities that can occur to address EE goals is potentially similarly fragmented (Granade et al., 2009). The array of economic activities that contribute to EE appear equally from the manufacture of LED light bulbs as from recycling and other waste management activities. In general, the broad range of EE activities means that it is fragmented into a great number of industries and thus it is even more difficult to identify the occupations affected than for RE industries such as Solar PV Installers or Wind Technicians.

Two recent reports sponsored by the ASES estimate the EE sector was a *$1 trillion* sector in 2007, providing 3.7 million industry jobs directly and 9 million jobs total. The report's scenario analysis for EE employment in 2030 ranged from a "base" to an "advanced" forecast. The base scenario extended the trends of the past two decades as a "business as usual scenario" with no major policy initiatives. The advanced scenario required "favorable market conditions and a sustained commitment of public policy" that would transform US energy demand and supply. This great difference in assumptions about the future provides a rough "sensitivity" assessment of shifts in EE employment. Thus, these reports forecast the EE sector to support anywhere from 15 to 30 million jobs by 2030, dependent upon the relative aggressiveness of federal, state, and local policies, incentives, and standards in the coming decades (Bezdek, 2009). In 2007, the EE sector of the US economy generated 660,000 industry jobs in green construction. Thus, according to the projected scenarios the total employment in these two industries is expected to at least double in 20 years, with potential to nearly quadruple if there is a favorable economic and political environment. (US Executive Office of the President Barak Obama, 2009; Booz Allen Hamilton Consulting; USGBC, 2009).[20]

The Economic Opportunities Studies Organization (EOS, 2010, t B) assessed the impact of the ARRA stimulus on WAP activities in the United States. They claim that the 2008 weatherization program resulted in 21,000 jobs, and that the ARRA funding in concert with additional and related ongoing WAP funding support will amount to investments of approximately $6.75 billion, supporting 46,670 direct jobs related to construction employment and compensation, and 173,350 total jobs. Indirect jobs include the "suppliers of insulation, blower doors, infrared scanning equipment, vans, efficient appliances and heating systems, as well as conventional building materials and tools.

[20] An ESCO is defined by ASES as a professional business that designs and implements energy saving projects. Cost estimators in the construction industry will likely perform a similar role. Job titles that appear in the report related to these sectors include Energy Field Auditors, Residential, Commercial, and Industrial Auditors, Renewable Energy Consultants, Energy Conservation Representatives, and Energy Procurement Management & Analyst.

On 27 April 2009, the USGBC launched LEED version three and transferred the administrative responsibilities of this program to the Green Building Certification Institute (GBCI). The latest version of the LEED certification provided a dual-pronged system of accreditation. The GBCI provides LEED certification for specific projects through an intense submission process that unites a variety of stakeholders and occupations. The GBCI also provides personal LEED certification for a variety of specific project types through coursework and a written accreditation process. Many community college and construction management programs across the country have began administering certificate programs that result in a green building degree. Although the GBCI does not directly confer these degrees and certificates they provide a comprehensive curriculum to these programs so that they can provide advanced LEED certificates and degrees.

The LEED project certification is a third party accreditation process where the GBCI acts as an inspectorate for sustainability and performance of a building. This certification provides the developer with a variety of benefits that include the reduction of operating costs, increased property value, qualification for state and municipal tax rebates, ensured environmental health and safety, and permit the owner to express a commitment to the community and the environment. The project certification process is unique in that it requires that a variety of occupations to coordinate their efforts to create sustainable practices and systems. The project certification process itself may serve as a learning experience for many of the contractors involved who have never previously worked in a green building project. However, the inherent inter-disciplinary nature of the integrated cross-occupational LEED strategy requires an advanced level of occupational expertise and an erudite understanding of complimentary disciplines. The GBCI (2010a) offers LEED project certification that is explicitly tailored for a variety of applications including New Construction, Schools, Core and Shell (limited aspects of the project), Commercial Interiors, Existing Buildings, and Community Development. Although LEED is the most widely used standard and credentialing system, alternative green building project certifications are emerging. Some of the alternative green building project certifications include the National Green Building Program's National Green Building Certification, the World Wildlife Fund's (WWF) Gold Standard certification, and local initiatives such as the Built Green Santa Barbara certification.[21]

In 2001, the USGBC began offering personal certification in LEED building practices. The general LEED personal certification ensured that contractors understood and were successfully able to implement the LEED green building practices. In 2009, with the inception of LEED version three, the GBCI expanded the LEED personal certification to encompass a variety of specific project types. The different types of LEED personal certifications and the structure of the specific programs can be seen in Appendix Table 1. The majority of the programs involve a course that provides a brief overview of LEED certification for the specific project type, a credit by credit review, and a course on best practices for LEED implementation. Many community colleges and construction management programs are also offering degrees and certificates in green building. Some of these programs incorporate various levels of LEED certification into the core of their program. Some examples of programs that incorporate or encourage a LEED building credential system include the Colorado State University's (CSU) Green Building Certificate, the San Diego State University's (SDSU) Professional Certificate in Green Building, and the Wentworth Institute of Technology's (WIT) Construction Management Bachelors Degree.[22]

Green construction is not only an opportunity for existing workers to differentiate the products and services they offer in the marketplace but may potentially increase the amount of overall employment opportunities on construction sites. The BLS points to employment growth in green construction as stemming from many green building requirements that mandate

[21] For more information, see: NAHB Green, 2010; WWF, 2010; Built Green Santa Barbara, 2010.

[22] For more information, see: CSU, 2010; SDSU, 2010; and WIT, 2010.

materials be segregated and recycled, the implementation of reused and reconstituted materials, and the application of wind and solar power. All of the aforementioned activities lead to a greater per project employment in the green construction industry. As previously described, the practices mandated by many green building standards require more labor hours per project and are as a result inherently more expensive. The excessive labor cost is offset by the savings incurred from operational expenses and increasing from policy rebates. Essentially the cost of a green building project can be in part covered by these redistributed sources of asset allocation.

The BLS (2010a) states that the median hourly wage for all construction labor in May 2008 was $13.71 per hour, while the second and third quartile earned between $10.74 and $18.57 per hour. The lowest 10 per cent of construction laborers earned about $8.67 or less per hour while the highest 10 per cent earned more than $25.98 per hour. The BLS also noted that the earning of green construction laborers, similar to that of the construction industry as a whole, can be greatly reduced by inclement weather conditions and economic downturn. The employment and wages for occupations in the green construction industry are as a result more susceptible to regular fluctuation in both unemployment and earnings. The median hourly wages for employment in the construction industry in 2008 can be used to estimate those for occupations in the green construction industry. Although, as previously mentioned, personal green building certification does provide an opportunity for workers to differentiate themselves in the labor market and thus wages and employment in green construction are likely slightly higher than that of the construction industry as a whole.

4. Conclusions

4.1 Main economic and labor markets shifts

The Workforce Information Council (WIC), a unique federal-state structure, guides the development and improvement of the nationwide workforce and labor market information system. WIC includes cooperation among the DOL's BLS and other federal offices as well as with state LMI offices. The WIC GJSG surveyed the literature related to green jobs and provided a final report focused on leading studies conducted by state LMIs (WIC GJSG, 2009). The California Employment Development Department (EDD) provides a valuable and timely service by supporting a web portal to access many of these studies (Dierdorff et al., 2009; EDD, 2010a).

The BLS is undertaking national efforts to identify green industries, green employment, and national survey protocols for tracking their pattern and rate of change over time. However, the BLS standards are acknowledged to provide guidance to states in particular (and others) on the value of using the working definitions that emerge from the BLS study as a starting point; but also document any differences in definitions and scope to facilitate the sharing of information and methods among states and others conducting studies.

It will continue to be essential to publicize survey and study results, particularly using the web as a means of dissemination. However, it will be increasingly important to also create a metadata template associated with the various studies, including objectives of the study, the methodology, scope of the green economy covered by the study, items to be collected and measured, and type of data and information to be produced by the study. There is currently no designated agency, initiative or resources allocated to develop and create incentives for establishing and disseminating metadata protocols and standards. Given the support for studies by agencies with a range of priorities and goals, it becomes essential to have access to metadata as a key element in supporting appropriate comparisons of study results.

The federal agencies should provide technical assistance to maintain and assist especially federally-funded studies, and promote to others generating related studies, to adhere to the metadata standards. Frequently scheduled webinars and conferences will be important for

disseminating information about both methods conducting studies and their results. These opportunities for two-way communication will be important for identifying assistance needs and the best methods for providing support. The WIC and BLS target and prioritize support for research methodologies including survey instrument design and testing; sampling methods; response modes (both online and telephone responses); data editing; estimation methods; and effective analytical, presentation, and dissemination methods.

Currently, the DOL's Employment and Training Administration (ETA) sponsors Workforce3One, an interactive communications and learning platform designed to build the capacity of the Workforce Investment System. Workforce3One, in turn, supports the Green Jobs Community of Practice (CoP), an interactive platform to "discuss and share promising practices to create partnerships for Green Job Workforce Solutions and leverage Recovery Act investments." The Green Jobs CoP platform provides technical assistance through "webinars, discussion boards, blogs and other online resources to workforce professionals, particularly those at the state and Workforce Investment Board levels as well as green jobs grantees (including recipients of upcoming SGAs)." It is also a community of practice that includes all federal agency workforce professionals who focus on green jobs.[23]

The BLS, ETA or another appropriate entity should also encourage supporting training on additional and complementary research methods by reference to best practice resources. Even when there is limited opportunity for their inclusion, these complementary methodologies should include the more costly, but valuable, structured interviews of a cross-section of stakeholders and observational studies by subject matter experts conducting on-site inspection of targeted firms and industries.

4.2 Greening the economy and greening work

The BLS has decided to create at least two types of quarterly conducted surveys to identify environmental economic activity and count the associated jobs. These surveys will develop information related to:

1. the number of green jobs and their trend over time;
2. the industrial, occupational, and geographic distribution of the jobs; and
3. the wages of the workers in these jobs.

The BLS surveyed state, national and international studies of green jobs, consulted with stakeholders within federal and state agencies as well as across the private sector and academia. While no common definition of the green economy emerged, they found near universal inclusion of economic activities described as and related to RE, EE, pollution prevention and clean-up, and natural resources conservation. These sectors help define the production of Green Goods and Services (GGS) that will be linked with the definition of green jobs that emerge as a result.

The BLS has adopted a two-fold approach currently in the process of review for implementation for measuring and tracking green jobs. The first is an *output approach*, which identifies establishments that produce GGS and counts the associated jobs. The second method is the *process approach*, which identifies establishments that use environmentally-friendly production processes and practices and counts the associated jobs. The process approach is intended to include "jobs that favorably impact the environment although the product or service produced is itself not 'green'." While the output approach will more readily rely on the North

[23]For more about the Green Jobs Community of Practice (CoP) and Workforce3One, see: https://greenjobs.workforce3one.org/page/about and https://www.workforce3one.org/page/about (Workforce3One, 2010 a, b).

American Industry Classification System (NAICS)-defined industries, the process approach is relevant for any industry.[24]

BLS plans to collect data on jobs associated with producing GGS through a sample survey of establishments identified as potentially producing such products and services based on the NAICS. The BLS will conduct annual GGS surveys that will identify establishments that produce green goods and services and count the associated jobs. It is possible they will be able to tabulate data quarterly by benchmarking the survey results to the Quarterly Census of Employment and Wages industry employment data. For the process approach, BLS is developing a special employer survey "to test the feasibility of collecting data on jobs associated with use of environmentally-friendly production processes" that may or may not be repeated. The BLS recognizes that among its data users, many will desire to make different choices about which goods and services or green process activities they prefer to include or exclude from ''green". BLS intends to present results by industry, allowing users to choose those industries needed for their purposes.

Thus, in specifying GGS, and separately the extent of employment in green process improvements, the BLS seeks to identify whether a good or service or activity has a discernible positive impact on the environment or natural resources conservation. The BLS explicitly recognizes that some goods and services may have both a positive and a negative impact. The BLS clearly recognized the limitations of the scope of its activity when it explicitly stated: "BLS has not attempted to assess the net impact." However, BLS is considering in certain instances to use federal product ratings or standards (such as US Department of Agriculture Certified Organic and Energy Star ratings) or widely-recognized industry standards (such as the LEED Green Building Rating System) where they exist, to determine which goods and services to include as a GGS. Such standards will be used to provide an objective method to distinguish GGS from other goods or services generally used for the same purpose. These standards facilitate clear communication to both survey respondents and data users what goods and services are reported, however, some employers may not participate in these programs although they may in fact meet the standards. The task of rating industries is imperfect but valuable and should be broadened to cross establishment and industry comparison.

The greening of work implies a net impact of work to be of net positive environmental or natural resources conservation impact. If outside the scope of the BLS mandate, then associated agencies in the EPA, Health and Human Services, and DOE, among others, should coordinate ratings in review of the tradeoff between green impact and green employment impacts. The Apollo Alliance and other Blue-Green alliances (defined as coalitions of labor, business, environmental, and community organizations and leaders) were created in order to bridge the gap between job creation and sustained employment opportunities while still promoting policy and regulatory changes to promote greener economic outcomes. They largely emerged after the 9/11 tragedy when the national focus on energy security came to prominence and new prospects for success of such alliances emerged. Today the assessments of employment prospects may require tracking all economic activities labeled as "green", but the relevance for a greening economy must track the policy engagements that include life cycle analysis to avoid shifting pollution among media, demographic groups or geographic regions without net benefits.

Assessments should not ignore the challenges of comparative risk to attain improved outcomes by means of multi-media pollution prevention strategic planning. One specific example

[24] The preliminary description of these survey approaches can be found at BLS, 2010d, pp. 12571-12573. Among the initial specifications, an important early comment on the first approach explains: "Note that the proposed BLS methodology will estimate green jobs for a NAICS industry by summing the green jobs found at individual establishments classified within the industry. The methodology does not simply designate an industry as ''green'' and count all jobs in that industry as green jobs, since establishments in the industry may also produce goods and services that are not considered green outputs." For the follow up initial specifications of the second survey see BLS, 2010c, pp. 37839-37840. The final comments are available at BLS, 2010b, pp. 57506-57514.

is the assessment of whether net green outcomes are achieved if specific types of biofuel production result in the net increase in fossil fuel consumption rather than its reduction. Another is the assessment and debate noted in this report about the extent to which nuclear energy can be considered a net green energy sector as dependent on carbon mitigation priorities relative to other environmental impacts.

4.3 Development of a national skill credentialing system: A green boost[25]

Given the current context of a severely-contracted economy, the incentives for and promise of green jobs has stimulated a near avalanche of workforce initiatives too numerous, rapidly developing and diverse - from federal to local governments, private, academic and nonprofit organizations - for any set of contemporary researchers to adequately summarize, much less characterize, in detail. It is, however, clear that inadequate and fragmented training systems within and across states, along with inconsistent credentials and associated competencies across employers and training providers, undercuts the best efforts of workers, employers, and communities to participate in building a greener economy. As a rule and across most economic sectors, the United States is notable among advanced economies as to the relatively limited extent of nationally-recognized skill standards and credentialing systems. On the one hand, this lack generally impedes the introduction of new skill standards and validated training programs to promote green industries, on the other hand, the very priority of current policy initiatives to promote greening the economy and work provides a generational opportunity to advance the development of such a national system. The degree to which such a system is not advanced, centrifugal forces within the existing training system will continue to inhibit and impede the establishment of an effectively skilled workforce for greening occupations.

The current misalignment of social interests and political power makes these long-term rather than short-term goals. However, there are relatively shorter-run actions more likely to aid in achieving desirable long-term goals. These social goals, reflecting the benefits of a competency-based credentials system, include validation of individuals' skill acquisition, the reduction of employer hiring and promotion costs, and reliable workforce data to facilitate private and public sector workforce development planning. At the same time, credentialed workers have increased security on external labor markets and are more likely to find greater flexibility in internal labor markets. Students/trainees and incumbent workers have clearer paths for career progression, increasing incentives to take the necessary steps to do so. The public gains greater transparency and performance accountability over public and private training providers. The sum effect is greater and better-directed training efforts, advancing the breadth and depth of workforce knowledge and skill. National standards are most important for portability so that the credentials are not limited to a particular region, employer, or institution.

Political power in the United States is historically and currently heavily weighted toward business interests. If standards are to be effective as national standards, then there must be an obligatory, compulsory regulation; however, if compulsory, and without business leadership in their design, they will not be adhered to in any meaningful degree of hiring and compensation practices. If business has the leadership in design, "the standards (if taken to be binding) are likely to be set lower and broader than is desirable, or (if purely voluntary) narrower and higher than desirable." (ibid., p. 31). Given the lack of corporatist integration and internal cohesiveness within either business or labor on a national scale in the United States, it is unclear what organizations exist generally (rather than exceptionally) with the technical and political capacity to coordinate standard setting for a national credentialing system.

[25] The case studies conducted in this report that uncovered issues related to credentialing systems resonated with and draw heavily upon the recommendations in White et al., 2010.

There are differences among green sectors and industries in their degree of support and impetus toward credentialing systems. In the RE sectors, which are largely newer industries, product and service reputation are more important and credentialing becomes integral to industry promotion. Even in these industries there are design disagreements over credential systems with political dimensions (witness the political dynamics noted in the PV installer case in 3.2.5). However, where both old and new industries, firms and activities overlap if not inseparable, such as in the Gray versus the Green aspects of the construction industry, the latter are nowhere so intimately intermingled as in the EE sector as reflected in the case study of Energy Auditors (see 3.2.6).

Shorter-term policies can make a difference in pursuit of a greener workforce and a better foundation for a national credentialing system. Public investments (federal, state, local) can be used as highly influencing, if not determining, leverage to support existing and emerging high-quality national standards by encouraging, if not requiring, local connections to them. Such broadly-operational considerations are also reflected in the case of Energy Auditors where the degree of collaboration between RESNET and BPI is advancing most significantly because the dire condition of the market for new construction is priming interest in common certifications for the retrofit market where BPI has greater strength. Finally, in order to more effectively allocate training resources, where possible, training providers should focus less on creating new courses of study and curricula and focus more on incorporating green curricula modules aligned with initial and medium credential upgrades for greener skills into existing courses of study. This is most apt within the largely construction-based EE sector, but applies more generally to upgrading a greening workforce.

4.4 The high road and community development

Across green sectors, but particularly in the EE sector, there are prospects for business development where much of the employment growth may occur in low wage, insecure and dead-end jobs. The concern for equity is a democratic goal but also a goal for a stronger, more rooted and politically-sustainable commitment to greener economic development. The authors of this report believe that the current state of political party divisiveness in the United States impedes action on green priorities, and indicates the fragility of a sustained commitment to greener, particularly cleaner energy, policies despite the coalescence and mutually-reinforcing forces highlighted at the beginning of this report on job creation, climate change and energy security. Nowhere is this more evident than in the delay and potential derailment of the “Cash for Caulkers” legislation, despite its support and aggressive lobbying for its passage by The Home Star Coalition, a highly-unusual broad-based group of over 2,700 organizations, including thousands of small- and medium-sized businesses from every state in the country, along with nationally-recognized companies, labor and environmental organizations, and trade associations.

A national strategy that prioritizes from-the-bottom-up local initiatives will be important to deepen and further embed support in a widening range of communities that can capture not only employment but living wage and business development advantages which will be necessary for sustaining a coalition to ensure green policies endure. In this sense, it is clear that the more inclusive the label of green industry is in application, the stronger the potential political strength of the supporting coalition. Clearly this approach may be at odds with the second recommendation that argues for multi-agency rating of green economic activities and multi-media pollution prevention strategic planning and prioritization. Similarly, the local capture of gains to greener development may also pit local interests against powerful national or international interests and risk weakening the coalition of support. Nonetheless, equity and democratization goals can be reconciled with the promotion of national certification standards through local support that ratchets up standards most easily where the markets are local.

“Low road” businesses are characterized by jobs that pay extremely low wages; fail to provide health, pension, or other benefits; and do not provide career paths toward higher skilled

and higher pay jobs. “High road” employers attain some of these or all three. The higher costs in compensation and training must be associated with higher productivity or community standards that take low road business out of the competition and enable potential productivity gains to be realized. These community standards can be reinforced by enabling federal policies that promote or at minimum are permissive of local policy standards such as the three briefly described below (Foshay; Connelly, 2010).

5. Recommendations

5.1 Bundling and community outreach

Federal funding utilizing ARRA weatherization and the possible additional funds if the “Cash for Caulkers” legislation wins congressional approval, as well as state or local programs for retrofitting buildings for energy conservation, should promote the local bundling of homes and buildings “within geographic areas to aggregate demand for weatherization and achieve the economies of scale that will attract high road contractors.” (Foshay; Connelly, 2010). These programs should encourage working in partnerships with community-based organizations that have a track record with local constituents and are thus more likely to successfully recruit home and building owners to participate in the program.

5.2 Assistance to local contractors to qualify for program participation

A condition of bidding on neighborhood ‘bundles’ as described above should be the incorporation of quality standards for contractor certification at all levels, including lead contractors, subcontractors and a proportion of supervisor and installer workforce. Given the more limited resources of small (more likely local) contractors, federal and state programs should be established to assist these smaller contractors in attaining certification standards. In particular, “the federal Department of Transportation’s Office of Small and Disadvantaged Business Utilization, for example, has several model programs offering financial and technical assistance to small women- and minority-owned construction contractors interested in working on federal highway projects(.)” (ibid., p. 27) that may serve as a model for such programs.

A Community Workforce Agreement should be implemented that includes high road standards for: wages and benefits, health and safety, and diversity by the inclusion of underrepresented communities and demographic groups. Wages should be consistent with the Family Economic Self-Sufficiency Standard[26] or another established quality wage benchmark. All workers should be required to complete health and safety training, in their own languages, and all contractors should be required to have a comprehensive health and safety plan. Programs should create pathways for new employees drawn from communities and demographic groups that are currently under-represented in the construction and EE workforce.

5.3 Prioritize programs for “At Promise” youth and groups facing barriers to employment

Both “At Promise” youth and groups facing barrier to employment require case management and after employment support as well as targeting training coordinated with job placement. A more credentialed workforce will be a more assuredly skilled and higher-paid workforce. However, as politically marginalized, these groups require nationally-scaled resources to be applied at local levels to promote their initial steps on career pathways. The policies

[26] WOW, 2010a, b. “Self-Sufficiency Standard” http://www.wowonline.org/ourprograms/fess/sss.asp and “Family Economic Security” http://www.wowonline.org/ourprograms/fess/index.asp . The second web site provides the wage standards for 34 states.

promoting their skill development and higher career trajectories are in a manner analogous and overlapping with localized community development as described in section 4.4.

The Pathways Out of Poverty grants and the success of the YouthBuild programs demonstrate how the early support for vulnerable youth can realize long-term benefits from greater success in the pursuit of higher rungs on career ladders generally and green careers more specifically. The YouthBuild programs are an example of a successful local model made national, then later again adapted to local conditions as the model diffuses with national-scale resources, with the additional benefits of facilitated learning across localities along with national program development resources.

The Pinderhughes Model begins with building broad, inclusive local coalitions. For the national policies to reach the demographic groups confronting the highest barriers to employment, it is most critical to mobilize local partners. Federal and state policies can create the opportunities for the formation of these coalitions by requiring diverse local group representation on oversight boards and diversity in persons trained with public funding. Furthermore, these local coalitions can be encouraged to adopt the most distinctive and important elements in two dimensions that create bridges for workers facing barriers to employment. Where most successful, these coalitions have won local employment ordinances ensuring the capture of a proportion of employment opportunities, and these ordinances are matched with incentives to hire local training or educational program graduates. The other distinctive aspect is the inclusion in training for green (Increased Demand) jobs; even those that may primarily consist of traditional gray construction skills, of basic and general environmental education to build a systems thinking orientation. Not only does this help promote a sense of importance of work and associated self-esteem but it also promotes capacities and motivations conducive to further career development. As stated forcefully in White et al. (2010), *Greener skills: How credentials create value in the clean energy economy*:

> "To help workers advance from unemployment, disconnection, or dead-end, poverty-wage work into better, greener jobs, policy-makers at every level should work with local partners to develop career pathways — and bridges onto them. This may be the greatest challenge and the one most easily neglected. This is our moment, however, to make systems work for those who need the support the most."

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Appendix

Appendix Table 1: Outline of LEED Personal Certification

Certification Type	Project Site Factors	Water Management	Project Systems and Energy Impacts	Acquisition, Installation and Management of Project Materials	Improvements to the Indoor Environment	Stakeholder Involvement in Innovation	Project Surrounding and Public Outreach
Retail Series	N/A	N/A	1	1	N/A	N/A	N/A
Strategies for Success	1.5	1.5	1.5	1.5	3	N/A	N/A
Understanding the Building Design + Construction Rating Systems	1.5	1	1.5	1	1	0.5	0.5
New Construction Credit-by-Credit Review	1.5	1	1.5	1.5	1.5	0.5	N/A
Implementing the Building Design + Construction Rating Systems	1.5	1	1.5	1	1	0.5	0.5
Implementing the Interior Design + Construction Rating System	1.5	0.5	1	1.5	1.5	0.5	0.5
Understanding the Building Operations + Maintenance Rating System	1	1	1.5	1	1.5	0.5	0.5
Existing Buildings: Operations & Maintenance Credit-by-Credit Review	1.5	1	1.5	1.5	1.5	0.5	N/A
Existing Buildings: Operations & Maintenance: Stories from Practice	N/A	0.5	0.5	0.5	1	N/A	N/A
Implementing the Building Operations + Maintenance Rating System	1	1	1.5	1	1.5	0.5	0.5
Neighborhood Development: Sustainability Beyond Buildings	1.5	N/A	N/A	N/A	N/A	N/A	3

Certification Type	Project Site Factors	Water Management	Project Systems and Energy Impacts	Acquisition, Installation and Management of Project Materials	Improvements to the Indoor Environment	Stakeholder Involvement in Innovation	Project Surrounding and Public Outreach
Understanding the Neighborhood Development Rating System	2.5	0.5	1	N/A	N/A	0.5	2.5
Neighborhood Development Credit-by-Credit Review	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Implementing the Neighborhood Development Rating System	2.5	0.5	1	N/A	N/A	0.5	2.5
The Keys to Green Affordable Housing: A Guide for Existing Multi-Family Properties	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Homes Program Review	1.5	1	1.5	0.5	1.5	1	0.5
Implementing the Homes Rating System	1	1	1.5	1	1	1	0.5
Green Rater Training	2	2	2.5	2	2.5	2	0.5
REGREEN Revolution Series	N/A	1.5	N/A	N/A	N/A	N/A	N/A
Home Performance Audits	N/A	N/A	1.5	N/A	N/A	N/A	N/A
Implementing Residential Remodeling	2	2	2.5	2.5	2.5	2	0.5

Source: GBCI, 2010b.

Appendix Table 2: O*Net "Green Increased Demand" occupations

O*NET-SOC Code	O*NET-SOC Title
45-2011.00	Agricultural Inspectors
17-3011.01	Architectural Drafters
47-2011.00	Boilermakers
53-3021.00	Bus Drivers, Transit and Intercity
47-2051.00	Cement Masons and Concrete Finishers
17-2041.00	Chemical Engineers
51-9011.00	Chemical Equipment Operators and Tenders
51-8091.00	Chemical Plant and System Operators
19-4031.00	Chemical Technicians
19-2031.00	Chemists
27-1021.00	Commercial and Industrial Designers
15-1032.00	Computer Software Engineers, Systems Software
51-4011.00	Computer-Controlled Machine Tool Operators, Metal and Plastic
47-2031.01	Construction Carpenters
43-4051.00	Customer Service Representatives
51-4031.00	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic
43-5032.00	Dispatchers, Except Police, Fire, and Ambulance
51-4032.00	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic
51-2022.00	Electrical and Electronic Equipment Assemblers
49-2094.00	Electrical and Electronics Repairers, Commercial and Industrial Equipment
49-9051.00	Electrical Power-Line Installers and Repairers
47-2111.00	Electricians
17-3023.01	Electronics Engineering Technicians
51-2031.00	Engine and Other Machine Assemblers
19-2041.00	Environmental Scientists and Specialists, Including Health
25-9021.00	Farm and Home Management Advisors
45-1011.07	First-Line Supervisors/Managers of Agricultural Crop and Horticultural Workers
45-1011.05	First-Line Supervisors/Managers of Logging Workers
49-1011.00	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers
51-1011.00	First-Line Supervisors/Managers of Production and Operating Workers
33-3031.00	Fish and Game Wardens
19-4093.00	Forest and Conservation Technicians
45-4011.00	Forest and Conservation Workers
49-9098.00	Helpers--Installation, Maintenance, and Repair Workers
47-3012.00	Helpers--Carpenters
19-2043.00	Hydrologists
17-2112.00	Industrial Engineers
49-9041.00	Industrial Machinery Mechanics

O*NET-SOC Code	O*NET-SOC Title
11-3051.00	Industrial Production Managers
17-2111.01	Industrial Safety and Health Engineers
53-7051.00	Industrial Truck and Tractor Operators
47-2131.00	Insulation Workers, Floor, Ceiling, and Wall
53-7062.00	Laborers and Freight, Stock, and Material Movers, Hand
53-4011.00	Locomotive Engineers
19-2032.00	Materials Scientists
49-9044.00	Millwrights
51-9023.00	Mixing and Blending Machine Setters, Operators, and Tenders
11-9121.00	Natural Sciences Managers
29-9011.00	Occupational Health and Safety Specialists
47-2073.00	Operating Engineers and Other Construction Equipment Operators
51-8012.00	Power Distributors and Dispatchers
43-5061.00	Production, Planning, and Expediting Clerks
13-1021.00	Purchasing Agents and Buyers, Farm Products
53-4031.00	Railroad Conductors and Yardmasters
47-4061.00	Rail-Track Laying and Maintenance Equipment Operators
49-9021.02	Refrigeration Mechanics and Installers
47-2031.02	Rough Carpenters
51-4121.07	Solderers and Brazers
51-8021.00	Stationary Engineers and Boiler Operators
47-2221.00	Structural Iron and Steel Workers
51-2041.00	Structural Metal Fabricators and Fitters
51-2092.00	Team Assemblers
51-4121.06	Welders, Cutters, and Welder Fitters
19-1023.00	Zoologists and Wildlife Biologists

Source: Dierdorff et al., 2009.

Appendix Table 3: O*Net "Green Enhanced Skills" occupations

O*NET-SOC Code	O*NET-SOC Title
17-2011.00	Aerospace Engineers
19-4011.01	Agricultural Technicians
51-2011.00	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers
23-1022.00	Arbitrators, Mediators, and Conciliators
17-1011.00	Architects, Except Landscape and Naval
19-2021.00	Atmospheric and Space Scientists
49-3023.02	Automotive Specialty Technicians
17-2051.00	Civil Engineers
47-4011.00	Construction and Building Inspectors
47-2061.00	Construction Laborers
11-9021.00	Construction Managers
47-5041.00	Continuous Mining Machine Operators
17-3023.03	Electrical Engineering Technicians
17-2071.00	Electrical Engineers
17-3024.00	Electro-Mechanical Technicians
17-2072.00	Electronics Engineers, Except Computer
11-9041.00	Engineering Managers
17-3025.00	Environmental Engineering Technicians
17-2081.00	Environmental Engineers
19-4091.00	Environmental Science and Protection Technicians, Including Health
11-9012.00	Farmers and Ranchers
13-2051.00	Financial Analysts
11-1021.00	General and Operations Managers
19-4041.02	Geological Sample Test Technicians
19-4041.01	Geophysical Data Technicians
19-2042.00	Geoscientists, Except Hydrologists and Geographers
47-4041.00	Hazardous Materials Removal Workers
49-9021.01	Heating and Air Conditioning Mechanics and Installers
17-3026.00	Industrial Engineering Technicians
51-9061.00	Inspectors, Testers, Sorters, Samplers, and Weighers
17-1012.00	Landscape Architects
51-4041.00	Machinists
49-9042.00	Maintenance and Repair Workers, General
11-2021.00	Marketing Managers
17-2141.00	Mechanical Engineers
17-2161.00	Nuclear Engineers

O*NET-SOC Code	O*NET-SOC Title
19-4051.01	Nuclear Equipment Operation Technicians
51-8011.00	Nuclear Power Reactor Operators
29-9012.00	Occupational Health and Safety Technicians
13-2052.00	Personal Financial Advisors
47-2152.01	Pipe Fitters and Steamfitters
47-2152.02	Plumbers
51-8013.00	Power Plant Operators
27-3031.00	Public Relations Specialists
53-7081.00	Refuse and Recyclable Material Collectors
27-3022.00	Reporters and Correspondents
47-2181.00	Roofers
41-4011.00	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products
51-9012.00	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders
47-5013.00	Service Unit Operators, Oil, Gas, and Mining
47-2211.00	Sheet Metal Workers
43-5071.00	Shipping, Receiving, and Traffic Clerks
19-1031.01	Soil and Water Conservationists
11-3071.02	Storage and Distribution Managers
13-1073.00	Training and Development Specialists
11-3071.01	Transportation Managers
53-6051.07	Transportation Vehicle, Equipment and Systems Inspectors, Except Aviation
53-3032.00	Truck Drivers, Heavy and Tractor-Trailer
19-3051.00	Urban and Regional Planners
13-1022.00	Wholesale and Retail Buyers, Except Farm Products

Source: Dierdorff et al., 2009.

Appendix Table 4: O*Net "Green New and Emerging" occupations

New and Emerging Occupation	Description
Air Quality Control Specialists	Perform a wide range of air quality compliance duties including equipment and facility permitting, compliance auditing, emissions control research, recordkeeping and reporting, participation in planning processes.
Automotive Engineering Technicians*	Assist engineers in determining the practicality of proposed product design changes, and plan and carry out tests on experimental test devices and equipment for performance, durability and efficiency.
Automotive Engineers*	Develop new or improved designs for vehicle structural members, engines, transmissions and other vehicle systems, using computer-assisted design technology. Direct building, modification, and testing of vehicle and components.
Biochemical Engineers*	Apply knowledge of biology, chemistry, and engineering to develop usable, tangible products. Solve problems related to materials, systems and processes that interact with humans, plants, animals, microorganisms, and biological materials.
Biofuels/Biodiesel Technology and Product Development Managers	Define, plan, or execute biofuels/biodiesel research programs that evaluate alternative feedstock and process technologies with near-term commercial potential.
Biofuels Production Managers	Manage operations at biofuels power generation facilities. Collect and process information on plant performance, diagnose problems, and design corrective procedures.
Biofuels Processing Technicians	Calculate, measure, load, mix, and process refined feedstock with additives in fermentation or reaction process vessels and monitor production process. Perform, and keep records of, plant maintenance, repairs, and safety inspections.
Biomass Plant Engineers	Design plants that generate electricity from the combustion of biomass.
Biomass Production Managers	Manage operations at biomass power generation facilities. Direct work activities at plant, including supervision of operations and maintenance staff.
Biomass Plant Technicians	Control and monitor biomass plant activities and perform maintenance as needed.
Brownfield Redevelopment Specialists and Site Managers	Participate in planning and directing cleanup and redevelopment of contaminated properties for reuse. Does not include properties sufficiently contaminated to qualify as Superfund sites.
Carbon Capture and Sequestration Systems Installers	Install and maintain carbon energy capture or carbon sequestration facilities.
Carbon Credit Traders	Represent companies in the sale and purchase of carbon emissions permits.
Carbon Trading Analysts	Analyze pricing and risks of carbon trading products; develop solutions to help clients hedge carbon exposure and risk.
Chief Sustainability Officers	Communicate and coordinate with management, shareholders, customers, and employees to address sustainability issues. Enact or oversee a corporate sustainability strategy.
Climate Change Analysts	Research and analyze policy developments related to climate change. Make climate-related recommendations for actions such as legislation, awareness campaigns, or fundraising approaches.
Compliance Managers*	Plan, direct, or coordinate activities of an organization to ensure compliance with ethical or regulatory standards.
Electrical Engineering Technologists*	Apply engineering theory and technical skills to support electrical engineering activities such as process control, electrical power distribution, and instrumentation design. Prepare layouts of machinery and equipment, plan the flow of work, conduct statistical studies and analyze production costs.
Electromechanical Engineering Technologists*	Apply engineering theory and technical skills to support electromechanical engineering activities such as computer-based process control, instrumentation, and machine design. Prepare layouts of machinery and equipment, plan the flow of work, conduct statistical studies and analyze production costs.
Electronics Engineering Technologists*	Apply engineering theory and technical skills to support electronics engineering activities such as electronics systems and instrumentation design and digital signal processing.
Energy Auditors*	Conduct energy audits of buildings, building systems and process systems. May also conduct

New and Emerging Occupation	Description
	investment grade audits of buildings or systems.
Energy Brokers*	Purchase or sell energy for customers.
Energy Engineers*	Design, develop, and evaluate energy-related projects and programs to reduce energy costs or improve energy efficiency during the designing, building, or remodeling stages of construction. May specialize in electrical systems; heating, ventilation, and air-conditioning (HVAC) systems; green buildings; lighting; air quality; or energy procurement.
Environmental Restoration Planners	Collaborate with field and biology staff to oversee the implementation of restoration projects and to develop new products. Process and synthesize complex scientific data into practical strategies for restoration, monitoring or management.
Environmental Certification Specialists	Guide clients such as manufacturers, organic farms, and timber companies through the process of being certified as green.
Environmental Economists	Assess and quantify the benefits of environmental alternatives, such as use of renewable energy resources.
Financial Quantitative Analysts*	Develop quantitative financial products used to inform individuals and financial institutions engaged in saving, lending, investing, borrowing, or managing risk. Investigate methods for financial analysis to create mathematical models used to develop improved analytical tools and advanced financial investment instruments.
Freight Forwarders*	Research rates, routings, or modes of transport for shipment of products. Maintain awareness of regulations affecting the international movement of cargo. Make arrangements for additional services such as storage and inland transportation.
Fuel Cell Engineers*	Design, evaluate, modify, and construct fuel cell components and systems for transportation, stationary, or portable applications.
Fuel Cell Technicians*	Install, operate, and maintain integrated fuel cell systems in transportation, stationary, or portable applications.
Geographic Information Systems Technicians*	Assist scientists, technologists, and related professionals in building, maintaining, modifying, and using geographic information systems (GIS) databases. May also perform some custom application development and provide user support.
Geospatial Information Scientists and Technologists*	Research and develop geospatial technologies. May produce databases, perform applications programming or coordinate projects. May specialize in areas such as agriculture, mining, health care, retail trade, urban planning or military intelligence.
Geothermal Production Managers	Manage operations at geothermal power generation facilities. Maintain and monitor geothermal plant equipment for efficient and safe plant operations.
Geothermal Technicians	Perform technical activities at power plants or individual installations necessary for the generation of power from geothermal energy sources. Monitor and control operating activities at geothermal power generation facilities and perform maintenance and repairs as necessary. Install, test, and maintain residential and commercial geothermal heat pumps.
Green Marketers	Create and implement methods to market green products and services.
Greenhouse Gas Emissions Permitting Consultants	Conduct data gathering, data analysis, calculation, inventories and reduction planning, and be familiar with emerging regulations on greenhouse gas management.
Greenhouse Gas Emissions Report Verifiers	Conduct data audits of reported greenhouse gas emissions inventories.
Hydroelectric Plant Technicians	Monitor and control activities associated with hydropower generation. Operate plant equipment, such as turbines, pumps, valves, gates, fans, electric control boards, and battery banks. Monitor equipment operation and performance and make necessary adjustments to ensure optimal performance. Perform equipment maintenance and repair as necessary.
Hydroelectric Production Managers	Manage operations at hydroelectric power generation facilities. Maintain and monitor hydroelectric plant equipment for efficient and safe plant operations.
Industrial Ecologists	Study or investigate industrial production and natural ecosystems to achieve high production, sustainable resources, and environmental safety or protection. May apply principles and activities of natural ecosystems to develop models for industrial systems.

New and Emerging Occupation	Description
Industrial Engineering Technologists*	Apply engineering theory and technical skills to support industrial engineering activities such as quality control, inventory control and material flow methods. May conduct statistical studies and analyze production costs.
Investment Underwriters*	Intermediate between corporate issuers of securities and clients regarding private equity investments. Underwrite the issuance of securities to provide capital for client growth. Negotiate and structure the terms of mergers and acquisitions.
Logistics Analysts*	Analyze product delivery or supply chain processes to identify or recommend changes. May manage route activity including invoicing, electronic bills, and shipment tracing.
Logistics Engineers*	Design and analyze operational solutions for projects such as transportation optimization, network modeling, process and methods analysis, cost containment, capacity enhancement, routing and shipment optimization, and information management.
Logistics Managers*	Plan, direct, or coordinate purchasing, warehousing, distribution, forecasting, customer service, or planning services. Manage logistics personnel and logistics systems and direct daily operations.
Manufacturing Engineering Technologists*	Apply engineering theory and technical skills to support manufacturing engineering activities. Develop tools, implement designs and integrate machinery, equipment and computer technologies to ensure effective manufacturing processes.
Manufacturing Engineers*	Apply knowledge of materials and engineering theory and methods to design, integrate, and improve manufacturing systems or related processes. May work with commercial or industrial designers to refine product designs to increase reducibility and decrease costs.
Manufacturing Production Technicians*	Apply knowledge of manufacturing engineering systems and tools to set up, test, and adjust manufacturing machinery and equipment, using any combination of electrical, electronic, mechanical, hydraulic, pneumatic and computer technologies.
Mechanical Engineering Technologists*	Apply engineering theory and technical skills to support mechanical engineering activities such as generation, transmission and use of mechanical and fluid energy. Prepare layouts of machinery and equipment and plan the flow of work. May conduct statistical studies and analyze production costs.
Mechatronics Engineers*	Apply knowledge of mechanical, electrical, and computer engineering theory and methods to the design of automation, intelligent systems, smart devices, or industrial systems control.
Methane Capturing System Engineers/Installers/Project Managers	Design gas recovery systems and oversee installation and development process, including recovery modeling, permitting, specifications preparation and project oversight. Develop client relationships and arrange for sales of energy.
Methane/Landfill Gas Collection System Operators	Direct daily operations, maintenance, or repair of landfill gas projects, including maintenance of daily logs, determination of service priorities, and compliance with reporting requirements.
Methane/Landfill Gas Generation System Technicians	Monitor, operate, and maintain landfill gas collection system components and environmental monitoring and control systems.
Microsystems Engineers*	Apply knowledge of electronic and mechanical engineering theory and methods, as well as specialized manufacturing technologies, to design and develop microelectromechanical systems (MEMS) devices.
Nanosystems Engineers*	Design, develop, and supervise the production of materials, devices, and systems of unique molecular or macromolecular composition, applying principles of nanoscale physics and electrical, chemical, and biological engineering.
Nanotechnology Engineering Technicians*	Operate commercial-scale production equipment to produce, test, and modify materials, devices, and systems of molecular or macromolecular composition. Work under the supervision of engineering staff.
Nanotechnology Engineering Technologists*	Implement production processes for nanoscale designs to produce and modify materials, devices, and systems of unique molecular or macromolecular composition. Operate advanced microscopy equipment to manipulate nanoscale objects. Work under the supervision of engineering staff.
Photonics Engineers*	Apply knowledge of engineering and mathematical theory and methods to design technologies specializing in light information and light energy.
Photonics Technicians*	Build, install, test, and maintain optical and fiber optic equipment such as lasers, lenses and mirrors using spectrometers, interferometers, or related equipment.

New and Emerging Occupation	Description
Precision Agriculture Technicians*	Apply geospatial technologies, including geographic information systems (GIS) and Global Positioning System (GPS), to agricultural production and management activities, such as pest scouting, site-specific pesticide application, yield mapping, and variable-rate irrigation. May use computers to develop and analyze maps and remote sensing images to compare physical topography with data on soils, fertilizer, pests or weather.
Recycling and Reclamation Workers	Prepare and sort materials or products for recycling. Identify and remove hazardous substances. Dismantle components of products such as appliances.
Recycling Coordinators	Supervise curbside and drop-off recycling programs for municipal governments or private firms.
Regulatory Affairs Managers*	Plan, direct, or coordinate production activities of an organization to ensure compliance with regulations and standard operating procedures.
Regulatory Affairs Specialists*	Coordinate and document internal regulatory processes, such as internal audits, inspections, license renewals or registrations. May compile and prepare materials for submission to regulatory agencies.
Remote Sensing Scientists and Technologists*	Apply remote sensing principles and methods to analyze data and solve problems in areas such as natural resource management, urban planning, and homeland security. May develop new analytical techniques and sensor systems or develop new applications for existing systems.
Remote Sensing Technicians*	Apply remote sensing technologies to assist scientists in areas such as natural resources, urban planning, and homeland security. May prepare flight plans and sensor configurations for flight trips.
Risk Management Specialists*	Analyze and make decisions on risk management issues by identifying, measuring and managing operational and enterprise risks for an organization.
Robotics Engineers*	Research, design, develop, and test robotic applications.
Robotics Technicians*	Build, install, test, and maintain robotic equipment or related automated production systems.
Securities and Commodities Traders*	Buy and sell securities and commodities to transfer debt, capital, or risk. Establish and negotiate unit prices and terms of sale.
Solar Energy Installation Managers	Direct work crews installing residential or commercial solar photovoltaic or thermal systems.
Solar Photovoltaic Installers	Assemble, install, or maintain solar photovoltaic (PV) systems on roofs or other structures in compliance with site assessment and schematics. May include measuring, cutting, assembling, and bolting structural framing and solar modules. May perform minor electrical work such as current checks.
Solar Power Plant Technicians	Monitor and repair the instrumentation, controls, and electrical systems in a utility-scale solar power generating facility.
Solar Sales Representatives and Assessors	Contact new or existing customers to determine their solar equipment needs, suggest systems or equipment, or estimate costs.
Solar Energy Systems Engineers	Perform site-specific engineering analysis or evaluation of energy efficiency and solar projects involving residential, commercial, or industrial customers. Design solar domestic hot water and space heating systems for new and existing structures, applying knowledge of structural energy requirements, local climates, solar technology, and thermodynamics.
Solar Thermal Installers and Technicians	Install or repair solar energy systems designed to collect, store, and circulate solar-heated water for residential, commercial or industrial use.
Solar Thermoelectric Plant/Concentrating Thermal Power (CSP) Plant Operators	Direct the operations of a commercial solar-generated power production plant.
Supply Chain Managers*	Direct, or coordinate production, purchasing, warehousing, distribution, or financial forecasting services and activities to limit costs and improve accuracy, customer service and safety. Examine existing procedures and opportunities for streamlining activities to meet product distribution needs. Direct the movement, storage, and processing of inventory.
Sustainability Specialists	Address organizational sustainability issues, such as waste stream management, green building practices, and green procurement plans.
Sustainable Design Specialists	Design from the outset for recycling, reuse or remanufacturing.
Testing Adjusting and Balancing	Test, adjust, and balance HVAC systems so they perform as designed.

New and Emerging Occupation	Description
TAB Technicians	
Transportation Engineers*	Develop plans for surface transportation projects according to established engineering standards and state or federal construction policy. Prepare plans, estimates, or specifications to design transportation facilities. Plan alterations and modifications of existing streets, highways, or freeways to improve traffic flow.
Transportation Planners*	Prepare studies for proposed transportation projects. Gather, compile, and analyze data. Study the use and operation of transportation systems. Develop transportation models or simulations.
Validation Engineers*	Design and plan protocols for equipment and processes to produce products meeting internal and external purity, safety, and quality requirements.
Water Resource Specialists	Design or implement programs and strategies related to water resource issues such as supply, quality, and regulatory compliance issues.
Water/Wastewater Engineers	Design or oversee projects involving provision of fresh water, disposal of wastewater and sewage, or prevention of flood-related damage. Prepare environmental documentation for water resources, regulatory program compliance, data management and analysis, and field work. Perform hydraulic modeling and pipeline design.
Weatherization Installers and Technicians	Perform a variety of activities to weatherize homes and make them more energy efficient. Duties include repairing windows, insulating ducts, and performing heating, ventilating, and air-conditioning (HVAC) work. May perform energy audits and advise clients on energy conservation measures.
Wind Energy Operations Managers	Manage wind field operations, including personnel, maintenance activities, financial activities, and planning.
Wind Energy Project Managers	Lead or manage the development and evaluation of potential wind energy business opportunities, including environmental studies, permitting, and proposals. May also manage construction of projects.
Wind Energy Engineers	Design underground or overhead wind farm collector systems and prepare and develop site specifications.
Wind Turbine Service Technicians	Inspect, diagnose, adjust, or repair wind turbines. Perform maintenance on wind turbine equipment including resolving electrical, mechanical, and hydraulic malfunctions.

* denotes occupations that are linked to multiple sectors

Source: Dierdorff et al., 2009.

Appendix Table 5: Existing occupations employment projections

Occupation	2008	2018	% change
Agricultural Inspectors	16600	18700	13
Architectural Drafters	N/A	N/A	N/A
Boilermakers	20200	24000	19
Bus Drivers, Transit and Intercity	193900	209900	8
Cement Masons and Concrete Finishers	201000	226900	13
Chemical Engineers	31700	31000	-2
Chemical Equipment Operators and Tenders	53000	46600	-12
Chemical Plant and System Operators	45100	35800	-21
Chemical Technicians	66100	65500	-1
Chemists	84400	86400	2
Commercial and Industrial Designers	44300	48300	9
Computer Software Engineers, Systems Software	394800	515000	30
Computer-Controlled Machine Tool Operators, Metal and Plastic	141000	150300	7
Construction Carpenters	N/A	N/A	N/A
Customer Service Representatives	2252400	2651900	18
Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	236800	203500	-14
Dispatchers, Except Police, Fire, and Ambulance	195700	190700	-3
Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	33000	24200	-27
Electrical and Electronic Equipment Assemblers	213300	182000	-15
Electrical and Electronics Repairers, Commercial and Industrial Equipment	78100	81000	4
Electrical Power-Line Installers and Repairers	113900	119000	4
Electricians	695000	777900	12
Electronics Engineering Technicians	N/A	N/A	N/A
Engine and Other Machine Assemblers	39900	36700	-8
Environmental Scientists and Specialists, Including Health	85900	109800	28
Farm and Home Management Advisors	13100	13200	1
First-Line Supervisors/Managers of Agricultural Crop and Horticultural Workers	N/A	N/A	N/A
First-Line Supervisors/Managers of Logging Workers	N/A	N/A	N/A
First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	448600	467600	4
First-Line Supervisors/Managers of Production and Operating Workers	681200	645500	-5
Fish and Game Wardens	8300	9000	8
Forest and Conservation Technicians	34000	36900	9
Forest and Conservation Workers	12900	14000	9
Helpers--Carpenters	79800	98500	23
Helpers--Installation, Maintenance, and Repair Workers	150900	163500	8
Hydrologists	8100	9600	18
Industrial Engineers	214800	245300	14

Occupation	2008	2018	% change
Industrial Machinery Mechanics	287700	308700	7
Industrial Production Managers	156100	144100	-8
Industrial Safety and Health Engineers	N/A	N/A	N/A
Industrial Truck and Tractor Operators	610300	627000	3
Insulation Workers, Floor, Ceiling, and Wall	27600	31700	15
Laborers and Freight, Stock, and Material Movers, Hand	2317300	2298600	-1
Locomotive Engineers	51200	56200	10
Materials Scientists	9700	10900	12
Mechanical Engineering Technologists	N/A	N/A	N/A
Millwrights	45200	45900	1
Mixing and Blending Machine Setters, Operators, and Tenders	141500	163500	15
Natural Sciences Managers	44600	51500	15
Occupational Health and Safety Specialists	55800	62000	11
Operating Engineers and Other Construction Equipment Operators	404500	453200	12
Power Distributors and Dispatchers	10000	9800	-2
Production, Planning, and Expediting Clerks	283500	287800	2
Purchasing Agents and Buyers, Farm Products	14200	14000	-1
Railroad Conductors and Yardmasters	41300	44100	7
Rail-Track Laying and Maintenance Equipment Operators	15500	17800	15
Refrigeration Mechanics and Installers	N/A	N/A	N/A
Rough Carpenters	N/A	N/A	N/A
Solderers and Brazers	N/A	N/A	N/A
Stationary Engineers and Boiler Operators	41600	43800	5
Structural Iron and Steel Workers	70200	78900	12
Structural Metal Fabricators and Fitters	114100	113700	0
Team Assemblers	1112300	1112700	0
Welders, Cutters, and Welder Fitters	N/A	N/A	N/A
Zoologists and Wildlife Biologists	19500	22000	13
ALL Increased Demand	**12.761 million**	**13.536 million**	**6.07**

Source: Careeronestop.org., 2010. (Occupations from Dierdorff et al., 2009; employment projections from the BLS Employment Projections Program, and aggregate projections are authors' tabulations).

Appendix Table 6: Enhanced Skills occupations employment projections

Occupation	2008	2018	% change
Aerospace Engineers	71600	79100	10
Agricultural Technicians	N/A	N/A	N/A
Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	44100	48200	9
Arbitrators, Mediators, and Conciliators	9900	11300	14
Architects, Except Landscape and Naval	141200	164200	16
Atmospheric and Space Scientists	9400	10800	15
Automotive Specialty Technicians	N/A	N/A	N/A
Civil Engineers	278400	345900	24
Construction and Building Inspectors	106400	124200	17
Construction Laborers	1248700	1504600	20
Construction Managers	551000	645900	17
Continuous Mining Machine Operators	11200	10600	-5
Electrical Engineering Technicians	N/A	N/A	N/A
Electrical Engineers	157800	160500	2
Electro-Mechanical Technicians	16400	15600	-5
Electronics Engineers, Except Computer	143700	144100	0
Engineering Managers	184000	195400	6
Environmental Engineering Technicians	21200	27500	30
Environmental Engineers	54300	70900	31
Environmental Science and Protection Technicians, Including Health	35100	45200	29
Farmers and Ranchers	985900	906700	-8
Financial Analysts	250600	300300	20
General and Operations Managers	1733100	1730800	0
Geological Sample Test Technicians	N/A	N/A	N/A
Geophysical Data Technicians	N/A	N/A	N/A
Geoscientists, Except Hydrologists and Geographers	33600	39400	18
Hazardous Materials Removal Workers	42500	48800	15
Heating and Air Conditioning Mechanics and Installers	N/A	N/A	N/A
Industrial Engineering Technicians	72600	77400	7
Inspectors, Testers, Sorters, Samplers, and Weighers	464700	447800	-4
Landscape Architects	26700	32000	20
Machinists	421500	402200	-5
Maintenance and Repair Workers, General	1361300	1509200	11
Marketing Managers	175600	197500	12
Mechanical Engineers	238700	253100	6
Nuclear Engineers	16900	18800	11
Nuclear Equipment Operation Technicians	N/A	N/A	N/A

Occupation	2008	2018	% change
Nuclear Power Reactor Operators	5000	6000	19
Occupational Health and Safety Technicians	10900	12500	14
Personal Financial Advisors	208400	271200	30
Pipe Fitters and Steamfitters	N/A	N/A	N/A
Plumbers	N/A	N/A	N/A
Power Plant Operators	35400	34800	-2
Public Relations Specialists	275200	341300	24
Refuse and Recyclable Material Collectors	149000	176700	19
Reporters and Correspondents	61600	56900	-8
Roofers	148900	154600	4
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	432900	475000	10
Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	40800	45100	11
Service Unit Operators, Oil, Gas, and Mining	39100	33400	-15
Sheet Metal Workers	170700	181800	6
Shipping, Receiving, and Traffic Clerks	750500	701200	-7
Soil and Water Conservationists	N/A	N/A	N/A
Storage and Distribution Managers	N/A	N/A	N/A
Training and Development Specialists	216600	267100	23
Transportation Managers	N/A	N/A	N/A
Transportation Vehicle, Equipment and Systems Inspectors, Except Aviation	N/A	N/A	N/A
Truck Drivers, Heavy and Tractor-Trailer	1798400	2031300	13
Urban and Regional Planners	38400	45700	19
Wholesale and Retail Buyers, Except Farm Products	147700	144400	-2
ALL enhanced skills	13.437 million	14.547 million	8.26%

Source: Careeronestop.org, 2010. (Occupations from Dierdorff et al., 2009; employment projections from the BLS Employment Projections Program, and aggregate projections are authors' tabulations).