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EMPLOYMENT ESTIMATES IN THE ENERGY SECTOR: CONCEPTS, METHODS, AND RESULTS

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Summary

A large body of literature exists regarding the estimation of the number of jobs that can be created by energy related projects and policies. The majority of studies are reports from universities, national laboratories, and consulting entities. There appear to be few peer-reviewed journal publications, and there are substantially more estimates related to renewable energy sources than there are for fossil fuel and nuclear technologies. There are also few projections based on energy efficiency. Estimates from one study are often used to produce estimates in another study, and there seems to be a relative absence of studies that estimate the employment effects of different generation technologies in terms of both constant cost and constant effective output.

Employment estimates in the energy sector tend to vary widely even within a given generation technology due to differences in assumptions and data reporting methods. This is true even when similar estimation methods and identical models are used. Studies that report direct, indirect, and induced job creation show that the indirect and induced jobs created by a given project often outnumber the creation of direct jobs. In addition to determining the number of job openings that may be created by a project or policy, examining the types of positions that will be created and the occupational characteristics of the unemployed labor force can be important. Creating numerous opportunities via government spending when there is a low rate of unemployment or an absent skill set may result in job displacement and wage inflation. Or, job openings may remain unfilled if there is not an adequately trained workforce available during a temporary stimulus or short-term program. Estimates of increases in employment can usually be considered upper bounds on actual increases because most studies do not account for constraints on worker availability, potential job destruction, and double counting of jobs that may have been created under business as usual conditions. Very few validation or *ex post* studies have been done for comparison, and those that have been completed are not project specific.

An important theme that has resulted from this literature review is the broader conclusion by several authors that employment should not be used in isolation when making energy sector investment decisions. Employment estimates in the energy sector need to be tailored for specific projects or policies and should be used as only one metric of more extensive cost-benefit and economic impact analyses. Without consideration of other factors such as cost to consumers and businesses, global economic competitiveness, natural resource management, system reliability, and environmental impact, the estimated number of jobs that can be created by any energy related project or policy would seem to have limited utility for sound long-term decision making.

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1.0. Introduction

When it comes to energy, policymakers have traditionally focused on price, availability of supply, and environmental impact. Recession and associated unemployment can lead to the addition of economic and employment growth to that list of traditional concerns (Yergin et al., 2012). In addition to being used by government organizations to analyze the potential impact of a given energy policy or investment, employment studies may also be used by technology advocates for promotional purposes or may be used to identify skill shortages. Employment estimates may also be used to assess the impact of shifting spending from one federal budget category to another (Levine, 2009). Some agencies such as the California Energy Commission require project job estimates as part of their permitting process (California Code of Regulations, 2012). However, businesses are unlikely to perform a study to report how many jobs they may create unless required to so by regulation or political expedience.

Given that the consequences of policy decisions are rarely immediately evident, models and forecasts are often used to gain insights into the employment impact of a given policy or investment decision (Pollin et al., 2009). Models that attempt to forecast the future are inherently uncertain and job creation models are no exception. The initial assumptions used to begin a study, counterfactuals used to simulate economic response, and the method used to create the estimate will all contribute to uncertainty in results. Adding to that inherent uncertainty, employment impacts are not always defined or measured in a uniform manner, resulting in often misleading results if two studies are compared (Bacon and Kojima, 2011). Due to the uncertainties inherent in the estimation process and the complexities of simulating labor markets, it is important to remember that any job creation estimate will likely differ from what actually occurs in the real world.

This literature review focuses on examining the existing public body of knowledge related to energy sector job creation studies with the goals of identifying fundamental characteristics of the studies, pointing out strengths and weaknesses, identifying trends and key arguments, and discovering gaps. The review provides an introduction to basic terminology and concepts, introduces commonly used methods and models, provides examples and analysis of estimate variation, discusses the importance of assessing the types as well as the number of jobs created, and a few other important topics. A strong emphasis has been placed on using studies primarily related to the United States although some studies pertaining to other nations have been included. This review is extensive but by no means exhaustive, especially since job impact studies are increasing as the focus on job creation and unemployment remains strong. In addition, this review in no way attempts to identify or recommend which energy technologies should be supported on the basis of job creation or any other metric. This review also makes no assumptions or conclusions as to the role that government should play in the energy sector. These limitations are an acknowledgement of the difficulty in assessing long-term government support for technologies that may require decades to be cost-competitive without significant public investment and/or subsidization.

2.0. Employment Study Fundamentals

Interpreting results and discussions presented in employment studies relating to the energy sector requires an understanding of the common terms and concepts used by such studies. This section provides a primer on those terms and concepts.

2.1. Four General Classes of Employment Studies

In their report for the World Bank, Bacon and Kojima identify four general classes of employment study related to the energy industry (Bacon and Kojima, 2011).

1) *Incremental employment by a specific project* – These studies are used primarily to assess localized impacts making the treatment of labor and capital imports very important.

2) *Incremental employment from a stimulus program* – The primary concern of such studies is to identify areas for spending that may have the potential to rapidly generate employment opportunities.

3) *Total employment supported in a sub-sector at a moment in time* – These studies usually seek to show the importance of a given industry to a national or regional economy. These are gross job estimates that suggest current value rather than future impact.

4) *Comparing employment creation of alternate technologies to achieve a constant goal* – Researchers use a common metric such as electrical output or project cost to compare the employment potential of different technologies.

2.2. Direct, Indirect and Induced Jobs

Estimating the number of jobs that may be created by a specific energy project or by a proposed energy program can be more difficult than just surveying how many people were hired to construct and operate a given power plant. Energy related jobs are often divided into three broad categories: direct jobs, indirect jobs, and induced jobs. Indirect and induced employment are calculated less often than direct employment due to increased information needs and difficulty in estimation (Bacon and Kojima, 2011). Different studies often define the three types of job categories differently. The definitions and examples given below provide a general idea of the activities that each primary employment category encompasses.

- **Direct jobs** are jobs that are involved in producing and delivering energy products to a final consumer (Yergin et al, 2012). The construction workers required to build a wind farm, employees at a wind turbine manufacturing facility and operations and maintenance personnel would all be considered examples of direct jobs related to the installation of wind generation.

- **Indirect jobs** are jobs related to supplying the energy industry with goods and services (Yergin et al., 2012). The production of steel and raw wiring used in the manufacturing of a wind turbine generator would be classified as indirect employment.

- **Induced jobs** are those jobs that are created when the compensation paid to direct and indirect employees is spent in the wider economy when procuring goods and services (Yergin et al., 2012). When the construction workers on the wind farm go to their favorite diner for lunch, the extra cook and servers hired to feed the workers would be considered induced jobs.

Indirect and induced jobs are estimated to account for what is termed the macroeconomic multiplier effect of increasing demand. These are Keynesian multipliers that provide a way to estimate the macroeconomic impact that an initial change in demand has on a particular economy (Bess and Ambargis, 2011). There are two types of multipliers, Type I and Type II. Type I multipliers help account for industrial linkages and are calculated by dividing the sum of direct employment and indirect employment by direct employment. Type II multipliers help account for ties between the economy at large and the industry of interest and are calculated by dividing the sum of all three employment categories by direct employment. Multipliers are generally provided in Input/Output (I/O) tables and are subsequently used by I/O models (discussed below) for estimates of industry and economy wide effects (Swenson, 2002).

$$Type\ I\ Multiplier = \frac{Direct + Indirect}{Direct}$$

$$Type\ II\ Multiplier = \frac{Direct + Indirect + Induced}{Direct}$$

An examination of the formulas presented above for Type I and Type II multipliers leads to an important insight: a project or policy that creates a large proportion of direct jobs relative to indirect and induced jobs will have a small multiplier (Jerrett et al., 1978). Reporting multipliers for different energy technologies in the absence of direct, indirect, and induced jobs numbers has the potential to provide misleading results.

2.3. CIM Versus O&M Jobs

Employment estimates are usually subdivided into construction, installation, and manufacturing (CIM) jobs and operations and maintenance (O&M) jobs (Breitschopf et al., 2011). Separately identifying CIM jobs is important because the jobs are relatively short-lived and will not last unless further orders are received. In contrast, operations and maintenance jobs are long term and will last for the life of the plant (Fulton et al., 2011). The number of CIM jobs may be more relevant for a stimulus program looking to boost employment quickly while O&M jobs may be a more important consideration for long-term economic impact. When combined with direct, indirect, and induced estimation methods, CIM and O&M jobs can create an output of six different employment estimates that must be combined to determine total employment impact. Most of the studies reviewed for this paper identified jobs as either CIM or O&M.

2.4. Gross Versus Net Jobs

Estimating a gross number of jobs accounts only for the positive employment effects of a given project or policy. Calculating net jobs takes into account both positive and negative impacts. Ideally, it is the net number of jobs that should be used to estimate the wider economic impact of an action (Breitschopf et al., 2011). When evaluating a proposed policy, an analysis should evaluate spending on both alternative packages and on a business as usual scenario. The difference between the proposed policy and the business as usual case or an appropriate alternative gives a net jobs estimate (Bacon and Kojima, 2011). For example, an appropriate counterfactual may be a case in which no new government spending takes place or in which an equivalent dollar value is applied to household tax breaks. A counterfactual at the project level is likely to be an alternative technology that either costs the same or produces the same energy services (Bacon and Kojima, 2011). A minority of the studies reviewed reported net jobs numbers. However, it should be pointed out that this is not necessarily an oversight. Calculating net impacts can be difficult due to the multiplication of assumptions and scenarios for a robust study. Net jobs studies may also draw criticism for cherry-picking unlikely assumptions or alternative costs and investment to support or oppose certain technologies or projects. Many project specific studies explicitly state their intent to examine gross numbers only, likely due to expense and time required for a net jobs study.

2.5. Economic Leakage from Labor and Capital imports

Economic leakage is a measure of income that is spent outside the region of interest of a study. Leakages decrease the multiplier effect and generally grow as the size of the regional economy analyzed gets smaller. In general, small economies are less likely to be able to supply all of the needs of a project or its employees (Yusuf et al, 2009). Unmet project needs usually result in the need to import labor and manufactured goods while the needs of project's employees may include anything that an employee desires to purchase that is not available in the local area. Importing manufactured goods results in money flowing out of a region of interest to create manufacturing jobs elsewhere. Importing employees can result in employees sending a proportion of their disposable income home rather than spending or saving it inside of a region of interest.

2.6. Opportunity Cost

Opportunity cost refers to alternative options and benefits that must be forgone in order to finance a proposed policy or project and is an issue that is relevant for both public and private spending. For example, a stimulus program has to be financed by reducing spending in other areas, increasing, borrowing or increasing taxes. Any of those options can lead to a reduction of aggregate demand, which will in turn lead to employment losses in the wider economy (Bacon and Kojima, 2011). Preferably, a study that reports the creation of jobs due to government spending would also include an analysis of the opportunity costs involved in financing such spending.

2.7. Displacement and Crowding Out

Deriving an estimate of potential job creation is made difficult due to the necessity of determining if a job that was created did not merely displace an existing job (Cray et al., 2011). **Displacement** occurs when investment in one area of the economy reduces economic activity in another area (BIS, 2011). For example, increased electricity prices may lead to decreased consumption as energy efficiency measures are instituted to offset rising prices. In such a case, jobs may be created in energy efficiency related sectors while jobs are lost in electricity generation sectors. Jobs may also be displaced in the event that a new energy investment replaces an existing investment with the result that existing jobs are eliminated (CEE, 2008). **Crowding out** occurs in the event that government investment takes the place of private investment (Cray et al., 2011). Views vary on the extent to which crowding occurs with some taking the position that crowding out should be of little concern where infrastructure investment is concerned (Cray et al, 2011) while others find that government spending often crowds out private investment (Ramey, 2012).

2.8. Deadweight and Substitution

Deadweight is the proportion of jobs that would have occurred without any intervention (BIS, 2009). This can be thought of as a business-as-usual scenario. Determining deadweight is necessary to show that net new jobs were created due to a specific policy (Cray et al., 2011). **Substitution** occurs when persons or businesses shift activity in order to take advantage of an intervention in the economy (BIS, 2009). For example, if a new ethanol subsidy allows ethanol producers to pay premium rates for corn, then farmers may choose to shift sales of their crop away from other traditional customers or maximize corn production relative to other crops. In that very simplified example, economic activity shifts without creating any new farming jobs.

2.9. Limitations Imposed Due to Inadequate Infrastructure

Many studies that report job growth inherently assume that there will be no problems with integrating intermittent sources into the existing grid or permitting and siting new electric transmission or other infrastructure needed to accommodate any new energy plant (CEE, 2008). In reality, siting new transmission lines and pipelines is often difficult due to high costs and NIMBY or place-based opposition. This could be a major stumbling block for a stimulus style program. However, it may be difficult to adequately account for integration and siting roadblocks.

2.10. Interpreting results

Different employment studies often report results in different ways (i.e. not all jobs are created equal). Some studies (and headlines) will simply report that a given project or program will create X number of "jobs" without qualifying the nature of those "jobs." The jobs reported may be full-time jobs or part-time jobs. They could last for 3 months or 30 years. CIM jobs are usually reported in terms of person-years per Megawatt (MW) while O&M jobs are reported in terms of jobs per MW. Job-years per MW denote the total amount of labor needed to manufacture equipment or construct a power plant that will deliver a peak output of one megawatt of power. One job-year may also be referred to as a full-time equivalent (FTE) job (Wei et al., 2010). Some studies sum part-time jobs into equivalent FTE numbers. Operations and maintenance jobs per MW indicate the number of people necessary to operate a power plant per each megawatt of capacity (Kammen et al., 2006). Similar conventions are used for estimating employment in the production of oil, natural gas and coal.

In addition to the proposition that not all jobs are created equal, not all megawatts are created equal. Megawatts can be reported as peak megawatts (MWp) or average megawatts (MWa). The peak megawatt rating of a power plant refers to the nameplate capacity of a plant; however, the actual power production of a plant is more closely tied to the average megawatt rating. The average capacity of a plant is found by multiplying the capacity factor of a given plant by the nameplate capacity of the same plant (Kammen et al., 2006). For example, a 500 MWp coal plant with a capacity factor of about 80% would have an average capacity of 400 MWa. A 500 MWp onshore wind farm would likely have a capacity factor closer to 30% and thus have an average power production capacity of about 150 MWa.

The situation can be further complicated if the effective load carrying capacity (ELCC) of the type of plant under consideration is taken into account. ELCC is a metric that is used to measure the ability of a power plant to consistently deliver power during periods of high demand. ELCC is especially applicable to intermittent power sources such as wind and solar, which may not always be available during peak demand periods for reasons other than mechanical availability (Milligan and Porter, 2005). If ELCC is relevant when scoping an analysis, then the average megawatt rating of a plant or technology may be further multiplied by the applicable ELCC factor (expressed as a percentage). The result of accounting for capacity and ELCC factors in job estimates is generally to boost the number of jobs required per MW of solar and wind capacity relative to other technologies due to their low relative efficiencies and fundamental intermittent nature.

Ultimately, it is the change in employment that matters, not the total level of current employment when evaluating investment and policy decisions (Bacon and Kojima, 2011). Actual impacts will be determined, in part, by how labor markets react to the implementation of a given project or policy. It is also important to consider the types of jobs that are being created and/or lost and how those jobs may scale during industry expansion (Kammen et al., 2006). The studies examined for this review suggest that constraints on worker or skill level availability are rarely seriously considered.

3.0. Estimation Tools

Several different approaches can be used to estimate the economic and employment impacts of different energy policies and projects. Three common approaches are surveys, model plant data, and I/O modeling. Different methods may be used in series. For example, a survey may be used to determine project costs and direct employment, which is then input into an I/O model in order to generate indirect and induced job estimates.

3.1. Surveys

Surveys are used to gather data from relevant industry and other knowledgeable parties and are usually used to develop direct employment estimates. Surveys have the advantage of targeting a specific type of investment. Researchers generally seek responses from multiple firms to build a more robust basis for estimation (Singh and Fehrs, 2001). Surveys can be particularly useful in identifying the types of jobs and relevant skill sets that will be needed to construct and operate a project. Due to resource intensity, surveys are generally not used to produce estimates of indirect or induced jobs (Bacon and Kojima, 2011).

3.2. Model plant data

Some countries have industry standards that can be used to calculate cost, output, and employment for projects of a given technology and size. The method can work well as long as there is standardized data available that is updated regularly. Data generated using the model plant method is usually limited to estimating direct jobs and is often paired with an I/O model to produce indirect and induced jobs estimates (Bacon and Kojima, 2011).

3.3. I/O Modeling

Input-Output (I/O) models are often used due their cost-effectiveness (Levine, 2009). Existing I/O tables and multipliers are developed from, or supplied by government data that is readily available. More proprietary data may be developed by private firms for finer granularity or in cases where government data may be inadequate. I/O models provide the most complete picture of the economy as a whole by capturing multiplier effects (indirect and induced jobs) and macroeconomic impacts of shifts between sectors (Kammen et al., 2006). I/O models describe the relationships between industries during the production process and show how final demand for a product or service is distributed across all industries at a given point in time. The output requirements of each industry can then be converted into employment requirements.

Most I/O models are static in that they provide a snapshot in time and as such, freeze technology and do not account for learning and other productivity gains over time. While resources in the real economy are limited, many I/O models assume that labor and capital are not constrained. That lack of constraint can lead to differences between estimates and actual new jobs created. I/O models may also not differentiate between local and imported goods and may report both full-time and part-time jobs as simply jobs created (Levine, 2009). Additionally, I/O models may be out of date and not allow for thorough disaggregation of some sectors due to limitations on data collection. Finally, the models are linear and do not account for economies of scale or substitution (Bacon and Kojima, 2011).

Experienced modelers or economists may create custom, hybrid I/O models that are more dynamic by linking general equilibrium models, including alternate scenarios that evolve over time, developing modules for improvements in technologies or processes, and integrating national and/or regional economic forecasts of their own design. If so, they must make their model, scenarios, and modules transparent for evaluation purposes—avoiding a “black box”—and run the risk of creating an excessively customized or overly complicated model that may not necessarily be an improvement over simpler ones.

A few of the more popular I/O models are listed below:

- IMPLAN is a model that is developed and maintained by the Minnesota IMPLAN Group (MIG). The model is a continuation of original work done at the University of Minnesota in partnership with the US Forest Service. IMPLAN divides the US economy into hundreds of sectors and allows a user to define the expenditure allocations associated with a given expansion in demand to all relevant parts of the economy in order to assess the economic impacts of the demand expansion. Outputs from IMPLAN can include direct, indirect and induced impacts on employment, earnings and economic output (Pfeifenberger et al., 2010). There are several versions of IMPLAN that can be ordered at: http://implan.com/V4/index.php?option=com_content&view=frontpage&Itemid=70

- JEDI is series of a spreadsheet based models developed by the National Renewable Energy Laboratory (NREL) that estimate direct, indirect and induced economic impacts. Employment numbers are given in terms of full time equivalent jobs thus eliminating ambiguity regarding counting full-time versus part-time jobs. As with other I/O models, JEDI represents the entire economy as a system of interactions between subsectors of the economy. The models use project-specific data to estimate gross jobs, earnings and other economic outputs. The JEDI models do not account for the displacement of jobs or economic activity (Steinberg et al., 2012). The JEDI models can be downloaded free of charge from the NREL website at: http://www.nrel.gov/analysis/jedi/about_jedi.html

- RIMS II is an I/O model that was developed by the Bureau of Economic Analysis (BEA). RIMS II provides users with multipliers for output, earnings, employment and direct-effect multipliers for earnings and employment. The multipliers are used to estimate the economic impact of a change in final demand on earnings or employment in regions economy. RIMS II requires specific project input on the affected region, which industries are initially impacted, if the project will require multiple phases, the initial changes in output, earnings and employment and if the initial changes should be separated into production costs, transportation costs and trade margins (Department of Commerce, 1997). RIMS II can be ordered at: https://www.bea.gov/regional/rims/rimsii/rimsmaint.htm

- REMI models are different from the three I/O models listed above in that they are dynamic in nature. The models incorporate aspect of four different modeling approaches including I/O, general equilibrium, econometric and economic geography models. REMI operates by first forecasting the future of a regional economy and then runs a second time to evaluate the impact of an alternate forecast. The difference between the two forecasts is then used to present a net effect (REMI, 2012). Information can be found at: http://www.remi.com/products

4.0. Examining the Data

Employment estimates in the energy sector, both within and between technologies, tend to vary significantly for a variety of reasons. This section provides examples of estimate variation within a given technology and shows how results can vary by reporting method. This section also provides a comparison of jobs per megawatt, dollars per megawatt and dollars per job created for seven different technologies.

4.1. Sample of Results within a Technology Group

Energy project developers are often required to report on potential socioeconomic impacts as part of state permit application processes. The three tables below provide normalized CIM and O&M job estimates for five projects in three different technology areas: concentrating solar power (CSP), natural gas combined cycle (NGCC), and onshore wind power. Jobs numbers for CSP and NGCC plants were taken from California Energy Commission (CEC) documents while the wind power results were obtained from applications submitted to the Wyoming Department of Environmental Quality (DEQ). The estimates in all three tables include direct, indirect, and induced jobs. The tables show that even within a given technology group and state boundary, job estimates can vary substantially.

Table 4.1: CIM and O&M jobs estimates for parabolic trough CSP projects in California

Project	CIM job-years/MWp	O&M jobs/MWp
Abengoa Solar Inc., 2009	22.02	0.64
Beacon Solar Energy Project, 2008	6.46	0.66
Blythe Solar Power Project, 2009	6.30	0.36
Genesis Solar Energy Project, 2009	13.47	0.76
Palen Solar Energy Project, 2009	5.02	0.42
Maximum percent difference*	**126%**	**71%**

*Difference of two numbers divided by the average of the same two numbers, in this case the maximum and minimum values in each column.

Table 4.2: CIM and O&M jobs estimates for NGCC projects in California

Project	CIM job-years/MWp	O&M jobs/MWp
Carlsbad Energy Center, 2007	2.23	0.08
CPV Vaca Station, 2008	1.60	0.07
Huntington Beach Generating Station, 2012	3.03	0.08
Kings River Power Project, 2007	1.36	0.14
Lodi Energy Center, 2008	2.66	0.07
Maximum percent difference	**76%**	**68%**

Table 4.3: CIM and O&M jobs estimates for wind power projects in Wyoming

Project	CIM job-years/MWp	O&M jobs/MWp
Campbell Hill Windpower Project, 2009	2.26	0.42
Glenn Rock Wind Energy Project, 2007	2.22	0.34
Pioneer Wind Park, 2011	1.25	0.11
Rolling Hills Wind Energy Project, 2007	1.92	0.17
Top of the World Wind Power Project, 2009	2.28	0.19
Maximum percent difference	**59%**	**118%**

The maximum percent difference figure at the bottom of each table is included to provide a quick measure of relative variation in the range of results for each column in each table. The point is that even when deploying similar technologies within a given state, normalized estimates of job creation can vary significantly. The differences in the estimates given in the above three tables arise largely due to assumptions made about the extent to which labor and manufactured components would have to be imported from outside the region of interest for a given study. For example, a project sited near San Diego will probably not have to import as much labor as a project sited near Bakersfield. However, these *ex ante* studies are of questionable utility, beyond the governmental mandate for carrying out the study or demonstrating the potential for leakage to researchers, without *ex post* and project specific studies for validation.

4.2. Sample of Results across Technologies

Table 4.4 is a selection of seven studies that estimate job creation for six different electricity generation technologies and one energy efficiency project. The purpose of Table 4.4 is not to provide a definitive answer as to which generation technology creates the most or least jobs. The table is meant to provide an example of differences in direct, indirect, and induced job numbers and demonstrate a common method of reporting CIM and O&M results. Table 4.4 and the tables that follow will also be used to demonstrate how results can change with the chosen reporting method. The sum of indirect and induced jobs is often greater than the magnitude of direct jobs created by a given project. That tendency is visible in Table 4.4. Direct jobs are given in terms of total job-years while O&M jobs are given as the number of permanent jobs supported per year by the plant. The job estimates in Table 4.4 and subsequent tables are given as gross jobs with the exception of the energy efficiency (EE) project, which was reported as net jobs.

Table 4.4: CIM job-years and permanent O&M jobs for a selection of generation technologies

Study	Tech	Direct CIM (job-years)	Indirect CIM (job-years)	Induced CIM (job-years)	Total CIM (job-years)	Direct O&M (jobs)	Indirect O&M (jobs)	Induced O&M (jobs)	Total O&M (jobs)
Leatherman, 2010	Coal	3,284	1,585	1,045	**5,914**	76	114	71	**261**
Koson, 2012	EE	197	50	69	**316**				
Blackrock, 2009	Geo	1,238	2,392	935	**4,566**	69	24	48	**141**
Carlsbad, 2007	NGCC	375	445	434	**1,254**	14	12	19	**35**
Oxford, 2008	Nuclear	16,415	14,774	22,324	**53,513**	900	153	558	**1,611**
Yusuf, 2009	Solar PV	675	1,209	480	**2,367**	35	1	13	**49**
Reategui, 2011	Wind	600	1,000	500	**2,100**	60	100	80	**240**

Table 4.4 shows that the nuclear project creates the most CIM job years and permanent O&M jobs. The jobs numbers given in Table 4.4 can be expressed solely in terms of job-years by multiplying O&M jobs by the expected number of years a plant will operate. Table 4.5 converts the O&M jobs from Table 4.4 into job years by multiplying the annual O&M job numbers by the expected plant lifetime given in Table 4.5. For example, the 261 permanent coal O&M jobs from Table 4.4 are multiplied by 40 years to get

10,440 job-years of O&M employment over the lifetime of the plant. O&M jobs-years are then added to CIM jobs-years to get total job-years created for each plant. A similar comparison can be carried out by dividing CIM job-years for a given plant by the expected lifetime of that plant to get average CIM jobs per year. The CIM jobs per year number can then be added to the O&M jobs per year number to get results in terms of total average jobs per year. It is assumed that jobs from energy efficiency (EE) are solely CIM jobs with no induced job destruction or creation from changes in electricity consumption.

Table 4.5: Total expected job years per generation technology

Study	Tech	Lifetime (years)	Total CIM (job-years)	Total O&M (jobs-years)	Total Job-Years
Leatherman, 2010	Coal	40	5,914	10,440	16,354
Koson, 2012	EE	20	316	0	316
Blackrock, 2009	Geo	40	4,566	5,640	10,205
Carlsbad, 2007	CCGT	40	1,254	1,400	2,654
Oxford, 2008	Nuclear	40	53,513	64,440	117,953
Yusuf, 2009	Solar PV	20	2,367	1,225	3,592
Reategui, 2011	Wind	20	2,100	6,000	8,100

While Tables 4.4 and 4.5 may be adequate for supplying information about the expected gross jobs that may be created by a given project, they do not provide any real means for comparison between generation technology options. Table 4.6 takes the total CIM and O&M estimates from Table 4.4 and divides them by the peak generation capacity of each plant. Table 4.6 shows that the nuclear project still creates the most jobs per peak megawatt, but the different between results is not as stark as in Table 4.4. Table 4.7 provides an estimate of CIM and O&M jobs per effective capacity for each project. The effective capacity measure adjusts for capacity factor. The results given in Table 4.7 show that the solar project now creates the most jobs in contrast to the nuclear project creating the most jobs in previous tables.

Table 4.6: CIM job-years and O&M jobs normalized by peak capacity

Study	Tech	Peak Capacity (MWp)	Total CIM (job-years/MWp)	Total O&M (jobs/MWp)
Leatherman, 2010	Coal	895	6.6	0.29
Koson, 2012	EE	16	19.8	0
Blackrock, 2009	Geo	159	28.7	0.89
Carlsbad, 2007	CCGT	600	2.2	0.06
Oxford, 2008	Nuclear	1400	38.2	1.15
Yusuf, 2009	Solar PV	75	31.6	0.65
Reategui, 2011	Wind	75	2.1	0.24

Table 4.7: CIM job-years and O&M jobs normalized by average capacity

Study	Tech	Capacity Factor	Total CIM (job-years/MWa)	Total O&M (jobs/MWa)
Leatherman, 2010	Coal	0.80	8.3	0.36
Koson, 2012	EE	1.00	19.8	0
Blackrock, 2009	Geo	0.90	31.9	0.99
Carlsbad, 2007	CCGT	0.85	2.6	0.07
Oxford, 2008	Nuclear	0.90	42.5	1.28
Yusuf, 2009	Solar PV	0.20	157.8	3.27
Reategui, 2011	Wind	0.35	6.0	0.69

It is often difficult to compare the results of different employment studies due to differences in how results are calculated and reported. Wei, Patadia and Kammen present a normalization methodology that compares total job-years per gigawatt-hour to produce a simple metric that can be used for comparison between studies (Wei et al., 2010). This method has been dubbed the WPK model by Deutsche Bank's Climate Change Advisors group (Fulton et al., 2011). The WPK method is as follows:

1) CIM and any other temporary factors (job-years/MWp) are averaged over the plant lifetime to get average employment (jobs/MWp)

2) The employment per unit of average output is calculated by dividing jobs/MWp terms by the technology capacity factor to get jobs/MWa
3) Jobs/MWa terms can be multiplied by a factor of 1000/8760 to get jobs per Gigawatt hour if desired
    a. 1000 MW/GW
    b. 1 year = 8760 hours

Any attempt to normalize disparate jobs numbers is likely to have a downside. Annual averaging, such as that used in the WPK model, can favor projects with shorter lifetimes by resulting in a higher-rate of annual job creation (Bacon and Kojima, 2011). The spreadsheet used by Wei et al. for their 2010 paper can be found at http://rael.berkeley.edu/node/20. Table 4.8 applies the WPK model to the six projects addressed in this section, but omits the final normalization into jobs/GWh because it would simply amount to multiplying by a constant in this instance and would thus add no comparative value. The results given in Table 4.8 are similar to those of 4.7 in which the solar project creates the most jobs, followed by the nuclear project.

Table 4.8: Average jobs per MWa

Study	Tech	Capacity Factor	Lifetime (years)	CIM job-years/MWp	O&M jobs/ MWp	CIM jobs/ MWp	O&M jobs/ MWp	CIM jobs/ MWa	O&M jobs/ MWa	Total jobs/MWa
Leatherman, 2010	Coal	0.80	40	6.6	0.29	0.17	0.29	0.21	0.36	0.57
Koson, 2012	EE	1.00	20	19.8	0	0.99	0	0.99	0	0.99
Blackrock, 2009	Geo	0.90	40	28.7	0.89	0.72	0.89	0.80	0.99	1.79
Carlsbad, 2007	CCGT	0.85	40	2.2	0.06	0.06	0.06	0.07	0.07	0.14
Oxford, 2008	Nuclear	0.90	40	38.2	1.15	0.96	1.15	1.06	1.28	2.34
Yusuf, 2009	Solar PV	0.20	20	31.6	0.65	1.26	0.65	6.30	3.27	9.57
Reategui, 2011	Wind	0.35	20	2.1	0.24	0.08	0.24	0.24	0.69	0.93

4.3. Cost, Jobs and Output

The number of jobs that could be created by a project is only one of several metrics that can be used to evaluate one project relative to another. Table 4.9 reproduces the CIM jobs/MWa numbers from Table 4.8 and allows for a side by side comparison of those jobs numbers with the overnight cost per CIM job generated and the overnight cost per MWa of each project; overnight costs are a common industry measure and refer to what it would cost if the project were built "overnight" without financing costs over the course of a long construction project. Table 4.9 shows that while the solar PV project is estimated to create the most CIM jobs/MWa, the effective capacity per MW is expected to cost several times that of any of the other representative projects. The energy efficiency project would cost the least per CIM job created and the natural gas project would cost the least per MWa. Performing a similar analysis for O&M jobs would require including fuel costs for the nuclear, coal, and natural gas plants. The result would be to increase the cost of those three technologies over the lifetime of the plant and may also result in raising estimates of the number of O&M jobs created depending on how the region of interest is defined. The impact on cost per MWa would likely be the most pronounced for the natural gas project given the high proportion of lifetime costs normally attributed to fuel purchases.

Table 4.9: Average CIM jobs per MWa, cost per CIM job and cost per MWa

Study	Technology	Overnight Cost ($)	CIM jobs/MWa	$/CIM job-year	$/MWa
Leatherman, 2010	Coal	2,240,000,000	0.21	378,762	3,128,492
Koson, 2012	EE	13,500,000	0.99	42,722	843,750
Blackrock, 2009	Geo	911,000,000	0.80	199,450	6,366,177
CECP, 2007	CCGT	400,000,000	0.07	299,043	784,314
Oxford, 2008	Nuclear	4,900,000,000	1.06	91,567	3,888,889
Yusuf, 2009	Solar PV	325,000,000	6.30	137,305	21,666,667
Reategui, 2011	Wind	1,925,000,000	0.24	916,667	5,500,000

5.0. Examples of results from selected policy studies and proposals

Employment assessments related to policy can take on several forms. They may be used to estimate employment for a proposed policy, or for a policy that is already in place. The policies in question can vary from studies that evaluate the recent American Recovery and Reinvestment Act of 2009 (ARRA), or "stimulus," legislation, to investigations into the economic impact of renewable energy portfolio standards and cap-and-trade programs. Some studies seek to estimate the types of jobs that might be created by a given policy and reveal potential skills shortages that could arise in the labor force that may limit policy effectiveness. This section briefly summarizes three different studies that estimate employment for a given program. Each study is critiqued with regard to some of the study attributes discussed in Section 2.0.

5.1. The Economic Benefits of Investing in Clean Energy (Pollin et al., 2009)

The Economic Benefits of Investing in Clean Energy is a report produced by the Department of Economics and Political Economy Research Institute (PERI) at the University of Massachusetts, Amherst, on behalf of the Center for American Progress. The report examines the employment that could potentially be generated in the U.S. economy by a mixed public/private investment of $150 billion per year in the expansion of renewable energy and energy efficiency over a ten year period. The investments would be the result of the combination of direct spending and incentive programs passed as part of the American Recovery and Reinvestment Act (ARRA) and regulations and programs that would have been established under the American Clean Energy and Security Act of 2009 that passed the House of Representatives but was never addressed in the Senate.

The authors of the report conclude that an investment of $150 billion dollars per year would create approximately 2.5 million gross jobs per year, or 16.7 jobs per $1 million dollars. The study uses job losses in fossil fuel sectors as a counterfactual to calculate net jobs and estimates that if $150 billion dollars of investment were displaced from those sectors, the result would be a loss of roughly 800,000 jobs per year. The final result is a net increase of 1.7 million jobs per year from the proposed $150 billion annual investment.

Pollin et al. include direct, indirect and induced jobs in their gross estimates of energy efficiency, renewable energy and fossil energy jobs. The fossil energy jobs estimate is then used as a counterfactual to derive a net jobs estimate. It is assumed that due to the relatively high rate of unemployment in the U.S. economy that no jobs are imported from overseas. The jobs numbers presented in the report are not broken down into CIM and O&M jobs. The importance of domestic manufacturing in creating jobs is discussed, but not quantified. The opportunity cost of public funding as well as the impact on household budgets was also not quantified. It was not possible to directly discern from the report if the jobs numbers given distinguished between full-time and part-time jobs.

5.2. Task force on America's Future Energy Jobs (NCEP, 2009)

The *Task Force on America's Future Energy Jobs* report was issued by the Bipartisan Policy Center's National Commission on Energy Policy and focuses on assessing the skills and educational requirements that will be necessary to meet expected labor demand in the U.S. electric power industry. The report first estimates the number and general type of jobs that will be required and then provides recommendations on how to avoid labor shortages. The authors of the report used EPRI's PRISM analysis results (EPRI, 2008) to project generation capacity additions that would be necessary to reduce greenhouse gas emission by 45% over the business as usual case over a period of 20 years.

The scenario used for the report called for the installation of 210 GW of new generation capacity by 2030. Assumed additions by generation technology were:

- 80 GW nuclear
- 90 GW coal
- 40 GW wind
- 1 GW solar thermal
- 300 MW of solar PV

The report gives job estimates as peak jobs in the year of the expected peak. The authors of the report conclude that the PRISM program would result in the need for 113,000 to 189,000 design and construction workers in 2022 and 53,500 to 105,000 O&M workers by 2030. In addition, the authors estimate that 120,000 to 160,000 workers will be needed by 2013 to replace retiring personnel. The report also provides an estimate of peak jobs needed in supporting areas such as the construction of transmission lines and Carbon Capture and Sequestration (CCS) related pipelines, the deployment of smart grid technology and the installation of energy efficiency measures.

The task force report gives employment estimates in terms of direct, peak jobs only. Jobs are broken down into CIM + development jobs and O&M jobs. Jobs are not distinguished as full-time or part-time. Labor and capital leakages are not quantified. There is also no assessment of any potential price impact on the consumer. However, given that the focus of the study is to project future skill shortages and education needs in the electric power sector, the impact on the consumer is not really relevant to the report. There is also no counterfactual and, consequently, no net jobs estimate. As with assessing the impact on consumers, estimating net jobs is not very applicable according to the authors' stated purpose.

5.3. The Apollo Jobs Report (Apollo, 2004)

The Apollo jobs report uses I/O modeling to estimate the number of jobs that would be created in the U.S. by spending $300 billion per year of federal funds on what they term their "model investment agenda." The agenda would direct funds toward increasing energy diversity, investing in industries of the future (i.e. manufacturing), high performance buildings, and rebuilding public infrastructure. The report concludes that such an investment would result in the creation of roughly 19,463,949 job-years over the 10 year duration of the program and result in the creation of 1,392,415 permanent jobs. A combination of the temporary and permanent jobs results in the creation of a total of roughly 3.3 million short-term and long-term jobs.

The jobs creation numbers given in the Apollo report are given as total numbers with no indication of a breakdown between direct, induced, and indirect jobs. Jobs are not broken down into short term and long-term, but there is no mention of differences between CIM and O&M jobs. There is no quantified discussion of labor and manufacturing imports. No counterfactual is assessed, nor is there an assessment of the impact of the program on consumers. The opportunity cost of the program is also not considered. Temporary jobs are given in terms of job-years, which can be converted into an estimate of FTE jobs. There is no full-time/part-time differentiation of long term jobs.

5.4. Assumptions and Results Compared to Attributes Discussed in Section 2.0

Table 5.1 provides a brief summary of the headline numbers from the three reports reviewed and then compares the assumptions made and outputs produced by the reports to some of the criteria discussed in Section 2.0.

Table 5.1: Characterization according to inclusion of common employment study attributes

Metric	Pollin et al., 2009	NCEP, 2009	Apollo, 2004
Money Spent/Invested	$150 billion/year	N/A	$300 billion total
Duration	10 years	20 years	10 years
Jobs Created	1.7 million/year net	Various peak figures	3.3 million gross
Direct Jobs	Yes	Yes	No
Indirect Jobs	Yes	No	No
Induced Jobs	Yes	No	No
CIM v. O&M	No	Yes	Partial
Full-time v. Part-time	No	No	Partial
Labor Imports	Yes	No	No
Manufacturing Imports	No	No	No
Counterfactual/Net Jobs	Yes	No	No
Impact on Consumers	No	No	No
Opportunity Cost	No	No	No
Infrastructure Support	No	Yes	No

The three reports presented in this section did not address crowding out or substitution affects in the economy. The vast majority of the material read as part of this literature review did not attempt to take those accounts into effect. It is generally not because the authors are unaware of the effect, rather, crowding and substitution are difficult to quantify. The same can be said for determining the number of jobs that would have been created without any intervention. In the case of the NCEP report, some of the metrics listed in Table 5.1 such as the impact on consumers and evaluation of opportunity costs are not very relevant to the report's goals.

6.0. Types of Jobs Created

A main goal of a stimulus program is to create jobs. However, simply creating jobs may not be enough if the "wrong" jobs are created. Tables 6.1 and 6.2 provide information on unemployment by occupation and educational attainment, respectively. Looking at the two tables it can be concluded that a stimulus program which creates jobs for university educated professionals may be more likely to spur wage inflation than job creation. Stimulus efforts focused on creating jobs that require less than a four year degree may be more likely to have a short-term positive impact on the unemployment rate simply because workers without a four year degree are more likely to be unemployed. However, the skills possessed by the unemployed workforce will still need to match any job openings created to result in actual employment. As noted by Rothwell (2012), even before the most recent recession, there were fewer job opportunities for those with little education.

Table 6.1: Unemployment by occupation for persons aged 16 and older (numbers are in thousands)

Occupation	Labor Force	Unemployed	Unemployment Rate
Management and business operations	23,699	868	3.7 %
Professional and related	32,554	1,688	5.2 %
Service	28,309	2,400	8.5 %
Sales and related	16,900	1,455	8.6 %
Office and administrative support	18,773	1,437	7.7 %
Farming, fishing and forestry	1,202	131	10.9 %
Construction and extraction	8,139	969	11.9 %
Installation, maintenance and repair	5,187	343	6.6 %
Production	9,577	913	9.5 %
Transportation and material moving	9,446	1,023	10.8 %
Total	**155,254**	**12,696**	**8.2 %**

Data source: BLS, 2012. Persons with no previous experience or whose last job was in the U.S. armed forces are included in the unemployment total.

Table 6.2: Employment status of the civilian population age 25 years and over by educational attainment (numbers in thousands)

Education	Labor Force	Unemployed	Unemployment Rate
Less than high school	11,179	1,346	12.0 %
High school graduate	36,703	3,217	8.8 %
Some college or associate degree	37,375	2,480	6.6 %
Bachelor's degree and higher	48,404	2,004	4.1 %
Total	**133,661**	**9,047**	**6.8 %**

Data source: BLS, 2012.

Several of the policy focused jobs studies that were reviewed acknowledged the need to look at both the numbers and types of jobs created. The studies by Pollin et al. and NCEP reviewed in the last section both attempted to break down the types of jobs that would be created. Figure 6.1 is adapted from the Pollin et al. report and shows that different energy technologies would create varying proportions of employment in different sectors. For example, fossil fuels would appear to create a large proportion of professional jobs where the unemployment rate is low. Fossil fuels would also create proportionally more jobs in extraction and transportation where unemployment is relatively high. Renewables projects create proportionally more manufacturing and construction jobs than fossil fuels, both of which are high unemployment categories.

Figure 6.1: Percentage of total jobs for each energy-related sector

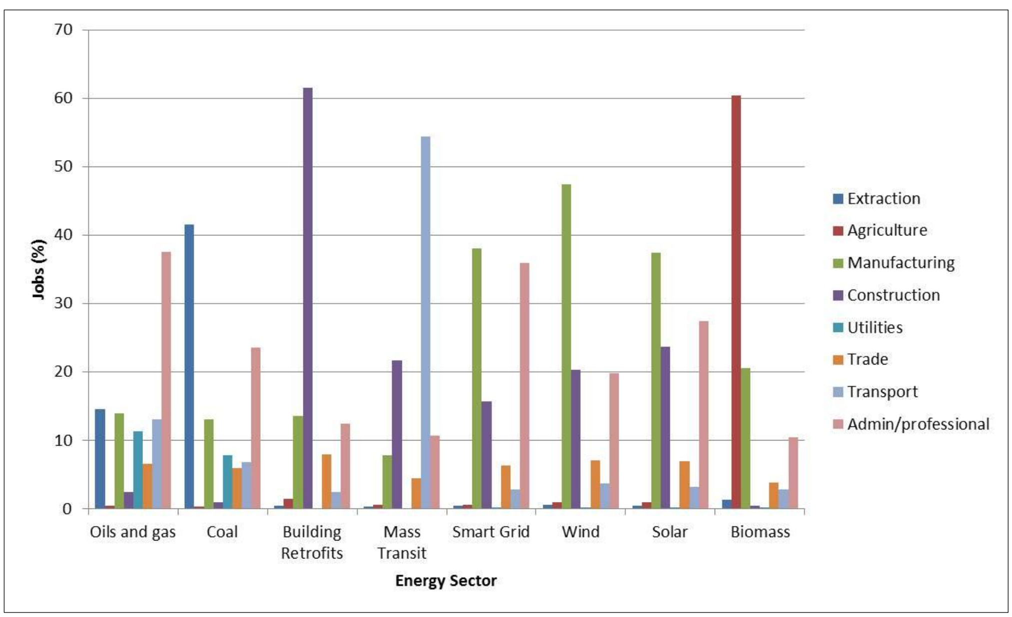

Figure adapted from Pollin et al., 2009.

Figure 6.1 examines the types of jobs that may be created from a stimulus project based on the energy sector, but does not provide information on a more fundamental question. Is the energy sector an effective place to spend funds if the primary goal is job creation? Another report from PERI estimates the number of jobs that would be created in the U.S. economy if $1 billion dollars were spent on the military, tax cuts for household consumption, clean energy, healthcare or educational services (Pollin and Garrett-Peltier, 2009). The results, as depicted in Table 6.4, suggest that if the primary goal of spending is to create jobs, then the money might be better spent on educational services than on clean energy. This is especially true given that the department of labor statistics cites the unemployment rate in educational services as 9.2% (BLS website, 2012). However, it is important to note that estimates of increases in employment can usually be considered upper bounds on actual increases. This is because most studies do not take into account constraints on worker availability from lack of skill set or the need to bid workers away from other projects (Bacon and Kojima, 2011).

Table 6.3: Job creation in the U.S. through $1 billion in spending

Spending category	Number of jobs created
Military spending	11,600
Tax cuts for household consumption	14,800
Clean energy	17,100
Health care	19,600
Educational services	29,100

Table adapted from Pollin and Garrett-Peltier, 2009.

7.0. Jobs Versus Economic Impact

There appears to be a general conclusion in the literature, that all things being equal, renewable energy technologies produce more jobs per dollar and more jobs per megawatt of effective capacity than fossil fuel generation sources. The advantage for renewables in jobs created per dollar spent is potentially the result of three general characteristics: labor intensity, domestic content, and the level of compensation per worker (Pollin and Garrett-Peltier, 2009). While the domestic content of the natural gas and coal sectors is roughly the same as that for renewable sources, labor intensity is generally greater for renewables. Wages appear to be roughly similar for fossil and renewable sources with renewables creating more jobs across all wage categories (Pollin et al., 2009). The greater number of wind and solar jobs per effective megawatt is primarily the result of the low capacity factors characteristic of intermittent generation sources (Croucher, 2011).

Compared to renewable sources, fossil fuel based generation is generally cheaper in terms of dollars spent per effective megawatt of capacity. This creates a potential conflict in which job creation may be at odds with the long-term goals of increasing efficiency and reducing production costs (CEE, 2008). The basic supply and demand argument suggests that we should expect the consumption of electricity to be inversely correlated to the price of electricity. Given that electricity is a primary input for nearly every good and service produced in the country, a rise in price should be expected to have a negative impact throughout the national economy. If residential consumers reduce consumption in response to higher prices, the result would be jobs lost in the electricity generation sector due to decreased need for fuel, construction and operation. Increased cost to industry and commerce would result in increased cost of production, resulting in more expensive goods and services. Consumption would decline because goods are more expensive and consumers have less money in their pocket due to higher electricity bills. The result could be job losses in all good and service producing sectors. The basic argument would be:

- Jobs are created by increasing the share of electricity produced from renewable sources.
- Jobs are destroyed through the economic impact of higher electricity prices.

The above argument is somewhat simplistic given that it ignores time effects. Over the short-term, demand for electricity is very inelastic because there is no substitute. However, over the long-term consumers and businesses have the ability to adjust to higher prices by increasing the use of efficiency measures (Garen et al., 2011). Although domestic consumers may be able to adapt to price rises in the long-term, higher electricity prices and the increased capital cost of efficiency measures may create an underlying competitive disadvantage for domestic businesses competing in a globalized economy unless business opportunities for design and products targeting energy efficiency are realized and sustained. Even though the extra cost may be justified by the environmental benefit, if the labor intensity of renewables does not improve, the cost disadvantage may remain permanent (CEE, 2008). This argument then leads to a key question that is most definitely beyond the scope of this review: what is the cost of responding to climate change?

Ultimately, while there are multiple arguments in the jobs literature concerning the macroeconomic impacts of increased generation from renewables, there appears to be an absence of conclusive quantitative examination suggesting either net creation or net destruction of jobs in the national economy.

8.0. Conclusion

Investment in the expansion of any sector within the energy industry will result in some increase in gross employment. The difficulty in estimating gross employment lies in the assumptions that have to be made regarding the details of any proposed policy or project. This is especially true for assumptions regarding the availability of labor and manufacturing capability in a study's region of interest. In general, smaller regions of interest require more labor and more manufactured goods to be imported. Those imports create a capital leakage out of the region of interest that results in reduced indirect and induced employment. The impact on an estimate can be substantial given that the sum of indirect and induced employment is often greater than direct employment. A gross job estimate for a policy or project should be considered the maximum possible number of jobs that can potentially be created.

Estimating net jobs rather than gross jobs can be substantially more difficult and time consuming, but provides a more realistic assessment. It can be challenging to determine what jobs would have been created under business as usual conditions and what jobs are attributable to the action under study. Conducting a full net study also necessitates the estimation of potential job destruction due to worker displacement and the impact of changing electricity prices on consumers. At a minimum, creating a net job estimate requires comparing the gross results of two alternative projects or policies.

A review of recent studies shows a large variation in results. That variation is not surprising given the different estimation methods that can be used and the number of assumptions that often have to be made in creating an estimate. The way in which results are presented and the degree to which terms are specified tend to vary, making it necessary to understand what the authors of a study mean by the word "job." Knowing whether the jobs are short-term or long-term, part-time or full-time, or given as job-years rather than "jobs" is essential to understanding any job creation study. A breakdown of the types of jobs that may be created can also be an important tool to be used in identifying skill shortages or determining the impact of a given policy on labor markets. Creating a lot of jobs for skills that are already in high demand may fail to have a positive short-term economic impact.

In some instances, such as stimulus programs aimed at job creation, employment estimates may provide a primary input into decision-making. However, in all cases employment estimates should be treated as just one metric of many to be used in evaluating the costs and benefits of an investment. Many studies in the literature point out that renewables create more jobs per megawatt and more jobs per dollar than fossil energy sources. However, renewables also tend to cost more per effective megawatt of output. This creates an issue where using the installation of renewables to create jobs may have a short term employment benefit while decreasing total economic efficiency and ability to compete globally. As Croucher (2011) has facetiously pointed out, if we really just want to create the most jobs per effective megawatt (or GWh) the installation of Solar PV panels in San Diego and Phoenix should be shifted to Portland and Seattle.

This literature review has looked at the assumptions, methods, and results of a large number of studies. While individual studies may have been thoroughly and competently conducted, the numbers presented and their relation to reality are of questionable reliability and utility on their own, particularly as there have been few *ex post* studies conducted (Brown et al., 2012), and virtually none at the individual project level. The general trends gained from a body of studies are probably more useful than the results from any single study. Only a minority of studies attempt to produce a net job estimate, and those that do generally fail to account for effects such as job displacement, crowding out or impact on consumers. Not one of the studies reviewed that compared job creation resulting from different generation technologies adequately compared the technologies using both constant output and constant cost. This literature review generally agrees with the conclusion of a recent World Bank report which stated:

> "This review of existing literature suggests that this relatively new area does not tend to provide robust evidence. Data are scarce and there are large uncertainties with published numbers, so that point estimates should be treated with caution. Generally, this literature merits closer scrutiny before taking estimates for employment generation as being reasonably reliable." (Bacon and Kojima, 2011).

Appendix A: Brief Summary of Reviewed Employment Studies

Source	Type[1]	Synopsis	Headline Numbers
Coal-Fired Generation			
Abt, 2009	Consulting Report	Estimated the economic impact from constructing a new coal-fired power plant in Virginia under various carbon emission regulatory programs. Counterfactual: meeting demand using investments in energy efficiency.	585 MW coal plant. The energy efficiency alternative, with no carbon emissions program created about 8,350 net jobs. (direct, indirect and induced)
Labovitz School of Business and Economics, 2005	Academic Report	Estimates the economic impact of the construction of an IGCC power plant.	Plant size is not given. 1,682 full-time, part-time and temporary peak construction jobs. 290 full and part-time jobs during operations. (direct, indirect and induced)
Leatherman and Golden, 2010	Academic Report	Examines the economic impact that would result from building a coal-fired power plant in Finney County, KS.	895 MW coal plant. 5,900 CIM jobs and 261 OM jobs. (direct, indirect and induced)
TXP, Inc., 2008	Consulting Report	Economic and tax benefit of constructing a supercritical steam, pulverized coal plant employing CCS for use in enhanced oil recovery.	765 MW plant. 1500 peak jobs during construction. 176 permanent jobs during operations. (direct, indirect and induced jobs)
Geothermal			
Blackrock, 2009	Industry Permitting Application	Amended permit application to site three geothermal power plants	159 MW total. 1191 average CIM jobs per month. 141 average OM jobs per month.

[1] "Consulting Report" is used as a catch-all for reports issued by consulting firms, not-for-profit groups, etc. "Academic Reports" are produced by universities or colleges but are "grey literature." Peer-reviewed publications are noted as PRP to distinguish them from the others.

Entingh, 1993	Consulting Report	Estimates the number of jobs created by the construction and operation of a geothermal power plant	50 MW plant. 300 direct job-years and 1200 "dispersed" job-years for CIM. 39 direct jobs and 32 "dispersed jobs for OM.
Hance, 2005	Consulting Report	Assessment and characterization of the current geothermal workforce	4583 total direct jobs in 2004. 1.7 direct jobs per MW of capacity. 6.4 job-years per MW from manufacturing and construction. 3.1 job-yeas per MW for construction.
Peterson et al., 2004	Academic Report	Analyzes the economic impacts of multiple geothermal energy projects in Idaho	10 MW plant. 105 CIM jobs and 26 OM jobs.
WGA, 2006	Task Force Report	Assessed geothermal power potential in the West, development costs, policy and regulatory recommendations and economic impact from development.	5600 MW. 10,000 job. 36,000 person-years of construction and manufacturing business. 9580 operations jobs.
Energy Efficiency			
Burr et al., 2012	Consulting/Academic Report	Analyzes the potential for a national building energy rating and disclosure policy to create jobs and increase energy efficiency in commercial and residential buildings.	23,000 net jobs in 2015 and 59,000 net jobs in 2020 from installation and reinvestment of energy cost savings. (Direct, indirect and induced)
Laitner and McKinney, 2008	Consulting Report	Review of 48 different efficiency assessments.	Estimates that a 20% to 30% efficiency gain in the U.S. economy might lead to a net gain of 500,000 to 1,500,000 jobs by 2030.
Paul et al., 2010	Consulting/ Academic PRP	Analyzes economic impact of increased state spending on efficiency in Maryland.	1700 to 4300 new net jobs by 2020.
Roland-Holst, 2008	Academic Report	Examines the economy-wide employment impacts resulting from California's past efficiency policies. Also forecasts the benefits of new policies.	Proposed policies would create as many and 403,000 new jobs. (Direct and indirect)

Scott et al., 2008	National Laboratory PRP	Analyzes potential impact from DOE-EERE programs designed to raise efficiency in U.S. residential and commercial buildings. Uses ImSET. Estimates energy savings and employment and income gains through 2030.	Potential to increase employment by 446,000 jobs by 2030.
Natural Gas-Fired Electricity Generation			
Bureau of Indian Affairs, 2004	Gov. Report	FEIS for the proposed Wanapa Energy Center. A CCGT complex to be built near Umatilla, OR.	1,200 MW. 320 to 820 temporary construction jobs. 30 permanent operations jobs.
Carlsbad Energy Center Project, 2007	Industry Permitting Application	Permit application for the construction of a CCGT plant in California.	558 MW. 2.23 job-years/MW CIM. 0.08 jobs/MW OM.
Contra Costa Generation Station, 2009	Industry Permitting Application	Permit application for the construction of a CCGT plant in California.	624 MW. 1270.75 person years for CIM. 31 jobs/year OM.
CPV Vaca Station, 2008	Industry Permitting Application	Permit application for the construction of a CCGT plant in California.	660 MW. 1.60 job-years /MW CIM. 0.07 jobs/MW OM.
Economic Research Development Group, 2009	Consulting Report	Economic impact of the construction of a CCGT power plant and sulpher distillate facility near Brockton, MA.	Size of plant not given. 395 CIM jobs. 43 OM jobs.
Huntington Beach Generating Station, 2012	Industry Permitting Application	Permit application for the construction of a CCGT plant in California.	565 MW. 1.36 job-years for CIM. 0.14 jobs/MW OM.
Kings River Power Project, 2007	Industry Permitting Application	Permit application for the construction of a CCGT plant in California.	939 MW. 3.03 job-years for CIM. 0.08 jobs/MW OM.
Knudson, 2011	Academic Report	Economic impact of fuel switching in Michigan, coal with natural gas.	19,000 construction jobs/ year (direct, indirect, induced). Up to 1,200 direct and 6,300 indirect jobs/year from operations.
Lodi Energy Center, 2008	Industry Permitting Application	Permit application for the construction of a CCGT plant in California.	255 MW. 2.66 job-years for CIM. 0.07 jobs/MW OM.
Toquop Energy Facility, 2003	Gov. Report	Appendix F of the Final Environmental Impact Statement	1,100 MW CCGT. Average of 875 jobs/year during construction and 50 jobs per year during operations. (Direct, Indirect and Induced).

Nuclear			
Bubb et al., 2005	Gov. Report	Assesses the adequacy of construction infrastructure for a nuclear buildout. Includes breakdown of labor and equipment requirements for a GEN III+ plant.	2400 peak personnel per average single plant.
Kenley et al., 2009	Peer Reviewed Publication	Nuclear job creation based on a survey performed by Bechtel, a Dominion study on new reactor construction and several NEI studies on the regional economic impact of several operating reactors. This is a summary of a full report printed in 2004.	50,000 MW by the year 2024: 37838 manufacturing jobs, 35375 construction jobs, 43712 operations jobs, 249692 indirect jobs, 242315 induced jobs
Kenley et al., 2004	National Laboratory Report	Nuclear job creation based on a survey performed by Bechtel, a Dominion study on new reactor construction and several NEI studies on the regional economic impact of several operating reactors.	50,000 MW addition results in 37,000 to 38,000 nuclear manufacturing jobs, 72,000 to 79,000 plant construction and operations jobs, 181,000 to 250,000 indirect jobs and 218,000 to 242,000 induced jobs.
NEI, 2011	Consulting/Industry Report	Discusses current and future economic benefits of nuclear generation. Results are from 23 different NEI studies on existing plants.	400 to 700 direct permanent jobs per plant. 3,500 workers during peak construction. Every$1 billion of exports represents 5,000 to 10,000 jobs.
NEI, 2004	Consulting/Industry Report	Assesses the economic impacts of Duke Power owned reactor in North and South Carolina.	Plants employ 4,203 people. Economic activity generated by the plants adds another 3,567 jobs.
Oxford Economics, 2008	Consulting Report	Estimates the employment and other economic benefits from building and operating 52 new reactors, 1 new recycling facility and 4 new enrichment plants over 20-25 years.	268,000 jobs for reactor build, 136,000 jobs for recycling and enrichment plant build and 96,000 jobs from operations of all reactors and facilities.

Perryman Group, 2008	Consulting Report	Looks at the potential impact from Exelon's proposed construction of a new nuclear power facility in Victoria County, TX.	Capacity not given. 74,845 person-years for construction and development at the county level. 700 OM jobs at the plant, 6,650 in the surrounding area.
Perryman Group, 2010	Consulting Report	Economic impact from the proposed expansion of the South Texas Project. Used two scenarios assuming different fuel prices.	2,700 MW. 91,607 person years of total incremental employment in the state for construction and development. 8,407 total jobs during operations.
Oil and Gas Extraction and Transport			
Cornell, 2011	Academic Report	Analysis of the economic benefits likely to result from construction of the Keystone XL pipeline.	2,500 to 4,650 construction jobs. Most jobs are likely to be temporary and non-local.
IHS, 2009	Consulting Report	Quantifies the economic impact of the U.S. natural gas industry in 2008.	600,000 direct jobs, 700,000 indirect jobs and 1.5 million induced jobs
IHS, 2012	Consulting Report	Assessment on the contribution of unconventional gas to the U.S. economy.	Unconventional natural gas will support 1.5 million jobs by 2015
NPC, 2011	Consulting Report	Upstream, downstream and related construction and support activities. Excludes petrochemical and electricity production.	Uses numbers from the PWC and HIS studies.
PWC, 2011	Consulting Report	Quantifies the direct, indirect and induced impacts of the U.S. oil and gas industry on national and state economies.	Combined operating and capital investment in 2009 accounted for 9.2 million full-time and part-time jobs.
Snead and Barta, 2008	Academic Report	Economic impact of oil and gas industry in Oklahoma.	Total employment of 76,297 in 2007 with 22,500 jobs added between 2002 and 2007.

Center for Business and Economic Research, 2008	Academic Report	Economic impact of natural gas industry in the Fayetteville shale play.	For 2007: 3,776.4 direct jobs, 1,904.6 indirect jobs, 3,852.0 induced jobs.
Weber, 2012	Gov. PRP	Examines job creation as a result of natural gas expansion in CO, TX and WY.	2.35 jobs per million dollars in the county of production.
Solar			
Abengoa Solar Inc., 2009	Industry Permitting Application	Estimates the economic impact of the construction of a parabolic trough concentrating solar plant in California.	250 MW. 22.02 CIM Job-years/MW. 0.64 O&M jobs/MW.
Ban-Weiss et al., 2004	Academic Report	Estimates the jobs that would be created from the installation of 2,700 MW of PV capacity on roofs in California through 2018.	20 manufacturing jobs per MW. 13 installation and maintenance jobs per MW. Approximately 19,000 annual jobs created by the end of 2017.
Beacon Solar Energy Project, 2008	Industry Permitting Application	Estimates the economic impact of the construction of a parabolic trough concentrating solar plant in California.	250 MW. 6.46 CIM Job-years/MW. 0.66 O&M jobs/MW.
Blythe Solar Power Project, 2009	Industry Permitting Application	Estimates the economic impact of the construction of a parabolic trough concentrating solar plant in California.	250 MW. 6.30 CIM Job-years/MW. 0.36 O&M jobs/MW.
Genesis Solar Energy Project, 2009	Industry Permitting Application	Estimates the economic impact of the construction of a parabolic trough concentrating solar plant in California.	250 MW. 13.47 CIM Job-years/MW. 0.76 O&M jobs/MW.
Grover, 2007	National Laboratory Report	Calculates economic benefits of the Solar America Initiative for high and low deployment scenarios. Uses IMPLAN.	Gives direct, indirect and induced numbers for both CIM and OM for two different scenarios in 2015 and in 2030.
Makower and Pernick, 2002	Consulting Report	Describes a program and resulting economic impacts from encouraging the manufacturing and installation of Solar PV in California.	1,400 MW. Create up to 15,000 new full-time jobs in the state.
Palen Solar Energy Project, 2009	Industry Permitting Application	Estimates the economic impact of the construction of a parabolic trough concentrating solar plant in California.	250 MW. 5.02 CIM Job-years/MW. 0.42 O&M jobs/MW.

Scehll, 2009	Consulting Report	Looks at benefits of non-utility investments in large scale concentrated solar power in California. Uses natural gas as a counterfactual.	10 GW by 2020. 0.848 OM FTE jobs/ MW. 10.1 net CIM jobs/MW
Schwer and Riddel, 2004	National Laboratory Report	Impact of constructing 100 MW trough-based CSP plants in Nevada. 3 different scenarios.	100 MW. 817 direct CIM jobs, 1,570 indirect and induced CIM jobs. 104 OM jobs per year.
Solar Generation, 2011	Consulting Report	Seeks to compile a quantitative knowledge base from which extrapolations can be made on the likely development of the solar electricity market to 2020+	345-688 GW capacity by 2020, up to 3.62 million jobs. 1,081-1,845 GW by 2030, up to 4.64 million jobs. (30 FTE jobs/MW)
UNM, 2004	Academic Report	Economic impacts from constructing CSP plants of varying size in New Mexico.	15.88 to 31.45 full and part time jobs per MW during construction. 0.67 to 1.24 full and part time jobs per MW per year for operations.
Yusuf et al., 2009	Consulting Report	Initial economic analysis of the installation of 75 MW of PV in Kittitas County, WA	75 MWdc. 789 construction jobs and 49 OM jobs.
Wind			
AWEA, 2010	Consulting Report	Discusses the number of manufacturing jobs that exist and could be created in the future. Discusses several policy initiatives that could expand wind manufacturing.	Wind energy currently employs 18,500 workers in the U.S. manufacturing sector.
Campbell Hill Windpower Project, 2009	Industry Permitting Application	Permit application for the construction of a wind power project in Wyoming.	99 MW. 2.26 job-years for CIM. 0.42 jobs/MW OM.
Glenn Rock Wind Energy Project, 2007	Industry Permitting Application	Permit application for the construction of a wind power project in Wyoming.	99 MW. 2.22 job-years for CIM. 0.34 jobs/MW OM.

Lantz, 2009	National Laboratory Report	Estimates the economic impacts that would result from the construction and operation of 1,000 MW of wind power and 7,800 MW of wind power in Nebraska. Four different deployment scenarios are analyzed. JEDI model.	Development and construction of 7,800 MW will support 20,600 to 36,500 construction period jobs. Operations would support to 2,200 to 4,000 operations-period jobs. Total average employment of a 40 year development period is 1,600 to 2,925 full-time jobs.
Loomis et al., 2012	Academic Report	Analyzes the expected economic impact from 23 wind power projects greater than 50 MW in Illinois. Uses JEDI model.	3,334.91 MW of capacity. Created 19,047 FTE jobs during construction. Support 814 jobs during operation.
Pioneer Wind Park, 2011	Industry Permitting Application	Permit application for the construction of a wind power project in Wyoming.	255 MW. 1.25 job-years for CIM. 0.11 jobs/MW OM.
Reategui and Hendrickson, 2011	National Laboratory Report	Analyzes the employment and economic impacts of installing 1,000 MW of wind energy capacity in TX. Uses JEDI model.	2,100 FTE jobs (2,080 hrs) during construction. 240 permanent jobs per year.
Reategui and Tegen, 2008	National Laboratory Report	Analyzes the economic impact resulting from the past installation of 1,000 MW of wind generation capacity in Colorado. JEDI model.	1,700 full-time-equivalent jobs during the construction period. Supports 300 permanent jobs from operations in rural CO.
Rolling Hills Wind Energy Project, 2007	Industry Permitting Application	Permit application for the construction of a wind power project in Wyoming.	49.6 MW. 1.92 job-years for CIM. 0.17 jobs/MW OM.
Slattery et al., 2011	Academic PRP	Estimates the economic impact for 1398 MW of wind power in four counties in TX. Uses the JEDI model.	1398 MW. 4100 FTE jobs during construction. 250 Operations jobs.
Top of the World Wind Power Project, 2009	Industry Permitting Application	Permit application for the construction of a wind power project in Wyoming.	200 MW. 2.28 job-years for CIM. 0.19 jobs/MW OM.

Transmission and Distribution			
KEMA, 2008	Consulting Report	Job creation from $16 billion in smart grid incentives, which spur $64 billion in total investment between 2009 and 2012. Steady state period from 2013 to 2018.	278,600 total net jobs during deployment period. 139,000 total net jobs during the steady state period.
Pfeifenberger and Hou, 2011	Consulting Report	Estimates long-term transmission needs and associated economic benefits in the U.S. and Canada.	$12 billion to $16 billion annual investment through 2030. Support 150,000 to 200,000 FTE jobs over 20 year period. Will indirectly support 130,000 to 150,000 full-time jobs over 20 years through renewable generation construction.
Labovitz School of Business and Economics, 2010	Academic Report	Estimate of the economic impact of constructing 5 transmission lines, costing a total of $2 billion dollar.	8,000 jobs in peak year of construction (direct, indirect and induced.)
Multiple Technologies			
Engel and Kammen, 2009	Academic/Industry Report	Quantitative analysis of job creation data for major renewable energy technologies.	Essentially, renewables create more jobs. Jobs/GWh numbers presented are taken from earlier works
Harker, 2010	Periodical Article	Provides a comparison of economic metrics for multiple generation technologies. Provides a table summarizing direct, permanent jobs for multiple generation sources	Max: Nuclear with 0.5083 jobs/MWe. Min: wind with 0.049 jobs/MWe.
Kammen et al., 2004	Academic Report	Normalizes numbers from multiple other studies to develop average jobs/GWh figures. Uses average jobs figures to evaluate 5 different energy scenarios.	Largest impact: 20% rps by 2020 (40% biomass, 55% wind and 5% solar) creates 188,018 total jobs. Smallest impact from natural gas intensive scnerio which created 83,987 jobs.

Loomis and Carter, 2011	Academic Report	Analyzes the potential employment impacts on other sources of electricity that could result from increasing wind generation in the state of Illinois. Uses JEDI model to estimate jobs from Nat Gas and Coal. Uses Loomis and Hinman, 2010 for wind numbers.	For 100 MW of effective capacity. Considers direct impacts only. Wind = 0.37 jobs per MW. Coal = 0.10 jobs/MW. Nat Gas = 0.05 jobs/MW
Singh and Fehrs, 2001	Consulting Report	Estimates the labor requirments for solar PV, Wind, Biomass Co-Firing and Coal.	35.5 job-year/MW for PV. 4.8 job-years/MW for wind. 3.8 to 21.8 job-years/MW for biomass co-firing.
Wei et al, 2010	Academic PRP	Normalizes numbers from multiple other studies to develop average jobs/GWh figures. Uses average jobs figures to evaluate different clean energy scenarios.	Study has a large table giving a summary of average job figures for multiple technologies. The excel sheet used for calculation is available online.
Yergin et al., 2012	Consulting Report	Discusses energy's role in the economy and the economic benefits from fossil fuel production and power generation and from renewable technology.	Oil and gas industry created nearly 150,000 jobs (direct, indirect and induced) between 2010 and 2011. Construction employment multipliers: 3.3 for PV, 2.0 for wind, 2.5 for NGCC. Operations multipliers: NA for PV, 2.0 for wind, 1.5 for NGCC and 2.8 for coal.
Program			
Apollo, 2004	Consulting Report	Looks at the impact of investing $300 billion of federal money over 10 years in T&D, renewables, energy efficiency and transportation.	Generate a total of 3.3 million jobs and 19,462,949 person-years of work.
Fulton et al, 2011	Consulting Report	Examines the economic impacts of an electric power forecast that calls for a scale up in natural gas and renewable energy over a 20 year period.	7.9 million cumulative net job-years of direct and indirect employment created.

Global Insight, 2008	Consulting Report	Looks at current and future economic impact of green technology and jobs under chosen scenarios.	4.2 million new green jobs added to the U.S. economy over a 30-year forecast period.
Heavner and Churchill, 2002	Consulting Report	Economic impact of installing 5,900 MW of renewable energy capacity in California.	28,000 year long construction jobs. 3,000 permanent OM Jobs.
Houser et al., 2010	Consulting Report	Assessment of the American Power Act	203,000 jobs above business as usual scenario. Jobs are lost in fossil fuels and as a result of higher energy and product prices.
Lantz and Tegen, 2011	National Laboratory Report	Estimates the jobs and economic activity resulting from the development of wind and natural gas generation capacity and the construction of new transmission lines necessary to facilitate capacity expansion in Wyoming.	4 HV lines, 9 GW of wind, 1.8 GW of natural gas. Average of 4,000-5,900 construction jobs per year for 10 years. 2,300 to 2,600 jobs during operations period.
EPRI, 2001	Consulting Report	EPRI study sponsored by CEC. Characterize the status and prospect of renewable energy resources in California and identify RDD opportunities.	Under a "favorable scenario" green power could supply 20% of California's demand and create over 18,000 jobs over a period of 11 years.
Pfeifenberger et al., 2010	Consulting Report	Analyzes the impact on jobs, earnings and economic output from two transmission investments and two levels of wind generation investment in the Southwest Power Pool. IMPLAN for transmission, JEDI for wind generation.	Transmission + 3,196 MW wind = 38,000 FTE-years. Transmission + 7,616 MW wind = 79,000 FTE-years.
Pollin et al, 2008	Academic Report	Outlines a green economic recovery program meant to strengthen the U.S. economy over a two year period (post-recession).	Spend $100 billion over two years on 6 green infrastructure areas. Would create 2 million jobs.

Pollin et al., 2009	Academic Report	Analyzes the job, income and economic growth that would result from the combined implementation of both the ARRA and the proposed American Clean Energy and Security Act.	$150 billion public/private investment over 10 years. Net increase of 1.7 million jobs. 2.5 million jobs gross. Fossil fuel counterfactual.
Pollin and Peltier, 2009	Academic Report	Examines the employment effect of federal spending on military, health care, education and clean energy. Compares each effect to an equivalent cut in taxes.	For $1 billion spent. Military = 11,600 jobs. Tax cuts for households = 14,800 jobs. Clean energy = 17,100 jobs. Health care = 19,600 jobs. Educational services = 29,100 jobs.
Rutovitz and Atherton, 2009	Consulting Report	Analysis of the two global energy scenarios defined by Greenpeace and the European Renewable Energy Council's Energy Revolution project. (One reference scenario and one revolution scenario.)	By 2030. 2.7 million more jobs than the reference scenario.
SEF alliance, 2009	Consulting Report	Examines the economic impact of government investments in green programs. Summarizes jobs numbers from multiple sources.	Green investment programs create 3-4 times as many jobs per dollar as tax cuts.
Shirley and Kammen, 2012	Academic Report	Economic impact from a scenario where energy efficiency and renewable energy initiatives account for a 60% reduction in fossil fuel fired electricity.	2,000 job-years by 2025.
Steinberg et al., 2012	National Laboratory Report	Estimate the direct and indirect jobs and economic impact of the 1603 Treasury grant program. Uses JEDI to estimate gross jobs for solar PV and large wind (greater than 1 MW)	13.5 GW of electric generating capacity. 52,000 to 75,000 direct and indirect CIM jobs per year. 43,000 to 66,000 indirect jobs per year in manufacturing (part of CIM total) and 5,100 to 5,500 direct and indirect operations jobs.

Sterzinger, 2006	Consulting Report	Discusses the results of the REPP job calculator and recommended policies for capturing economic benefit from renewable energy expansion in the state of Nevada.	Sample scenario reports 27,229 FTE for 1,572 MW of renewable capacity added over 10 years. (wind, solar PV, geothermal, biomass co-fire)
Stoddard et al., 2006	National Laboratory Report	Provides a technology assessment of CSP technologies and examines the economic impacts from the installation of parabolic trough CSP in California. Used RIMS II model. Two deployment scenarios.	100 MW capacity with 6 hours of storage. 94 OM jobs for PV. 56 OM jobs for NGCC. 13 OM jobs for NGSC. 3,990 job-years for CSP construction. 448 for NGCC construction and 327 for NGSC construction.
"Green Jobs"			
Muro et al., 2011	Consulting Report	Seeks to define and assess the number of clean energy jobs in the national economy and provides policy recommendations to support those jobs.	"Clean economy" employs 2.7 million workers.
Cray et al., 2011	Academic Report	Provides a critique of green job estimates and the pros and cons of different policies.	N/A
IRENA, 2011	Consulting Report	Jobs supported worldwide by renewable technologies. Potential future job creation and policy analysis. Job characterization. Contains employment estimates from several other reports.	3.5 million jobs supported in 2010.
Michaels and Murphy, 2009	Consulting Report	Discusses potential negatives of pro-green jobs policies. Critical examination of four different studies that claim benefits from programs that foster green job creation.	N/A

References

Abengoa Solar Inc. (2009). Application for Certification, Section 5.11. Mojave Solar LLC. 09-AFC-5. http://www.energy.ca.gov/sitingcases/abengoa/documents/applicant/afc/volume_01/5.11_Socioeconomics/5.11_Socioeconomics_final.pdf

Abt. (2009). *Assessing the Economic Impact of Dominion Virginia Power's Coal-Fired Power Plant in Wise County, Virginia.* Abt Associates Inc. http://www.abtassociates.com/reports/Economic_Analysis_of_Wise_County_Coal_Plant_1-22-09.pdf

Apollo. (2004). *The Apollo Jobs Report: Good Jobs and Energy Independence*. The Apollo Alliance. Washington, D.C. http://www.climateactionproject.com/docs/ApolloReport_022404_122748.pdf

AWEA. (2010). *Winds of Change: A Manufacturing Blueprint for the Wind Industry.* American Wind Energy Association, BlueGreen Alliance and United Steel Workers. http://www.awea.org/learnabout/publications/upload/BGA_Report_062510_FINAL.pdf

Bacon, R. and Kojima, M. (2011). *Issues in estimating the employment generated by energy sector activities*. The World Bank Sustainable Energy Department. Washington D.C. http://siteresources.worldbank.org/INTOGMC/Resources/Measuring_the_employment_impact_of_energy_sector.pdf

Ban-Weiss, G., Larsen, D., Li, S.X., Wlusz, D. (2004). *Job Creation Studies in California for VOTESOLAR.* University of California, Berkeley. http://www.votesolar.org/linked-docs/MSR_Job_Creation.pdf

Beacon Solar Energy Project. (2008). Application for Certification, Section 5.11. Beacon Solar LLC. 08-AFC-2 http://www.energy.ca.gov/sitingcases/beacon/documents/applicant/afc/5.11%20Socioeconomics.pdf

Bess, R., and Ambargis, R.O. (2011). *Input-Output Models for Impact Analysis: Suggestions for Practitioners Using RIMS II Multipliers*. Presentation given at the 50th Southern Regional Science Association Conference. March 23-27, New Orleans. http://www.bea.gov/papers/pdf/WP_IOMIA_RIMSII_020612.pdf

BIS. (2009). *Guidance for Using Additionality Benchmarks in Appraisal*. Department of Business Innovation and Skills. http://www.bis.gov.uk/files/file54063.pdf

Black Rock Geothermal Power Project Major Amendment. (2009*). Application for Certification, Section 5.11.* CE Obsidian Energy, LLC. 02-AFC-2. http://www.energy.ca.gov/sitingcases/saltonsea_amendment/documents/applicant/afc/5-11%20Socioeconomics.pdf

BLS. (2012). *The Employment Situation – August 2012*. Bureau of Labor Statistics. U.S. Department of Labor. USDL-12-1796. http://www.bls.gov/news.release/pdf/empsit.pdf

BLS website. (2012). *Industries at a Glance, Education and Health Services. Bureau of Labor Statistics*. U.S. Department of Labor. Accessed 3 October, 2012. http://www.bls.gov/iag/tgs/iag65.htm

Blythe Solar Power Project. (2009). *Application for Certification, Section 5.11*. Solar Millenium LLC and Chevron Energy Solutions. 09-AFC-06 http://www.energy.ca.gov/sitingcases/solar_millennium_blythe/documents/applicant/afc/Volume_I/5.11%20Socioeconomics.pdf

Breitschopf, B., Nathani, C., and Resch, G. (2011). *Review of Approaches for Employment Impact Assessment of Renewable Energy Deployment.* International Energy Agency – Renewable Energy Technology Deployment. The Netherlands. http://iea-retd.org/wp-content/uploads/2011/11/EMPLOY-task-1.pdf

Brown, J.P., Pender, J., Wiser, R., Lantz, E. and Hoen, B. (2012). Ex post analysis of economic impacts from wind power development in U.S. counties. *Energy Economics*, 34 (2012), 1734-1754.

Bubb, J., Carroll, D., D'Olier, R., Elwell, L., and Markel, A. (2005). *DOE NP2010 Nuclear Power Plant Construction Infrastructure Assessment*. MPR-2776. Department of Energy. Washington D.C. http://nuclear.energy.gov/np2010/reports/mpr2776Rev0102105.pdf

Burr, A.C., Majersik, C., Stellberg, S., and Garrett-Peltier, H. *Analysis of Job Creation and Energy Cost Savings: From Building Energy Rating and Disclosure Policy*. Institute for Market Transformation and Political Economy Research Institute. http://www.imt.org/resources/detail/analysis-of-job-creation-and-energy-cost-savings-from-building-energy-ratin

Bureau of Indian Affairs. (2004). *Wanapa Energy Center Final Environmental Impact Statement.* Bureau of Indian Affairs: Department of the Interior. Washington D.C. http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/EIS-0342-FEIS-2004.pdf

California Code of Regulations. (2012). Title 20. Public Utilities and Energy, Appendix B. CEC-140-2012-002. http://www.energy.ca.gov/2012publications/CEC-140-2012-002/CEC-140-2012-002.pdf

Campbell Hill Windpower Project. (2009). *Wyoming Industrial Development Information and Siting Act, Section 109 Permit Application*. Three Buttes Windpower, LLC. http://deq.state.wy.us/isd/downloads/Campbell_Hill_All_Combined_Final_010709.pdf

Carlsbad Energy Center Project. (2007*). Application for Certification, Section 5.10*. NRG Energy. 07-AFC-06. http://www.energy.ca.gov/sitingcases/carlsbad/documents/applicant/afc/CECP_Volume%201/CECP_005.10_Socioeconomics.pdf

CEE. (2008). *Green Jobs: A Review of Recent Studies*. Center for Energy Economics: The University of Texas at Austin. http://www.beg.utexas.edu/energyecon/documents/CEE_Green_Jobs_Review.pdf

Center for Business and Economic Research. (2008). *Projecting the Economic Impact of the Fayetteville Shale Play for 2008-2012.* Center for Business and Economic Research: University of Arkansas, Fayetteville.
http://groundwork.iogcc.org/sites/default/files/FayettevilleShaleEconomicImpactStudy2008.pdf

Contra Costa Generation Station. (2009). *Application for Certification, Section 5.10.* Contra Costa Generation Station, LLC.
http://www.energy.ca.gov/sitingcases/oakley/documents/applicant/afc/Volume%201/CCGS_5.10_Socioeconomics.pdf

CPV Vaca Station. (2008). *Certification for Application, Section 5.10.* COB Vacaville LLC. 08-AFC-11.
http://www.energy.ca.gov/sitingcases/vacastation/documents/applicant/afc/Volume_I/CPVVS_5.10_Socioeconomics.pdf

Cray, A., Nguyen, T., Pranka, C., Schildt, C., Scheu, J., and Rincon-Whitcomb, E. (2011). *Job Creation: A Review of Policies and Strategies*. Working Paper Series, Institute for Research on Labor and Employment: University of California, Berkeley. http://www.irle.berkeley.edu/workingpapers/105-11.pdf

Croucher, M. (2011). Capacity factors and solar job creation. *Energy Policy*, 39 (2011), 6914-6915.

Department of Commerce. (1997). *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)*. Bureau of Economic Analysis, Economics and Statistics Administration: U.S. Department of Commerce. Washington D.C.
http://www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf

Economic Development Research Group. (2009). *Economic Assessment of Proposed Power Facility in Brockton, MA.* Economic Development Research Group. Boston, MA.
http://brocktoncleanenergy.com.s68855.gridserver.com/cms/wp-content/uploads/090929-Economic-Assessment-_Final11.pdf

Engel, D., and Kammen, D.M. (2009). *Green Jobs and the Clean Energy Economy.* Copenhagen Climate Council Thought Leadership Series.
http://www.climatechange.ca.gov/eaac/documents/member_materials/Engel_and_Kammen_Green_Jobs_and_the_Clean_Energy_Economy.pdf

EPRI. (2001). *California Renewable Technology Market and Benefits Assessment.* Electric Power Research Institute. Palo Alto, CA. http://www.energy.ca.gov/2001publications/CEC-500-2001-005/CEC-500-2001-005.PDF

EPRI. (2008). *The Power to Reduce CO_2 Emissions: the Full Portfolio*. Electric Power Research Institute. Palo Alto. EPRI report 1018431.
http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname=ObjMgr&parentid=2&control=SetCommunity&CommunityID=404&RaiseDocID=000000000001018431&RaiseDocType=Abstract_id

Entingh, D.J. (1993). *Employment Impacts of Geothermal Electric Projects.* BNF Technologies INC. Alexandria, VA. http://www.osti.gov/bridge/servlets/purl/882445-eWdvFH/882445.pdf

Fulton, M., Sharples, S., Baker, J. and Delins, D.G. (2011). *Repowering America: Creating Jobs*. Deutsche Bank Climate Change Advisors. New York. http://www.banking-on-green.com/docs/DB_Repowering_America_Creating_Jobs.pdf

Garen, J., Jepsen, C. and Saunoris, J. (2011). *The Relationship between Electricity Prices and Electricity Demand, Economic Growth, and Employment*. Center for Business and Economic Research: University of Kentucky. http://cber.uky.edu/Downloads/CBER_Electricty_Economics_Employment_Oct2011.pdf

Genesis Solar Energy Project. (2009). *Application for Certification, Section 5.8*. Genesis Solar LLC. 09-AFC-8.
http://www.energy.ca.gov/sitingcases/genesis_solar/documents/applicant/afc/volume_1/5.8%20Socioeconomics/5.8_Socioeconomics.pdf

Glenn Rock Wind Energy Project and Rolling Hills Wind Energy Project. (2007). *Wyoming Industrial Development Information and Siting Act, Section 109 Permit Application.* PacifiCorp Energy. http://deq.state.wy.us/isd/downloads/Glenrock%20ISA%20Final_11-25-07.pdf

Global Insight. (2008). *U.S. Metro Economies: Current and Potential Green Jobs in the U.S. Economy.* Global Insight. Lexington, MA. http://www.usmayors.org/pressreleases/uploads/greenjobsreport.pdf

Global Labor Institute. (2011). *Pipe Dreams? Jobs Gained, Jobs Lost by the Construction of Keystone XL.* Global Labor Institute: Cornell. New York.
http://www.ilr.cornell.edu/globallaborinstitute/research/upload/GLI_keystoneXL_Reportpdf.pdf

Solar Generation 6. (2011). *Solar Generation 6: Solar Photovoltaic Electricity Empowering the World.* Greenpeace and the European Photovoltaic Industry Association.
http://www.greenpeace.org/international/Global/international/publications/climate/2011/Final%20SolarGeneration%20VI%20full%20report%20lr.pdf

Grover, S. (2007). *Energy, Economic, and Environmental Benefits of the Solar America Initiative*. National Renewable Energy Laboratory. NREL/SR-640-41998. http://www.nrel.gov/docs/fy07osti/41998.pdf

Hance, C.N. (2005). *Geothermal Industry Employment: Survey Results and Analysis.* Geothermal Energy Association. Washington D.C. http://www.geo-energy.org/reports/Geothermal%20Industry%20Employment%20-%20Survey%20Results%20and%20Analysis%20September%202005.pdf

Harker, D., and Hirschboek, P.H. (2010). *Green Job Realities: Quantifying the economic benefits of generation alternative.* Public Utilities Fortnightly. http://www.viadalvento.org/wp-content/uploads/2010/08/05012010_GreenJobRealities.pdf

Heavner, B., and Churchill, S. (2002). *Renewables Work: Job Growth from Renewable Energy Development in California.* CALPIRG Charitable Trust. http://www.policyarchive.org/handle/10207/bitstreams/5556.pdf

Houser, T., Mohan, S., and Hoffman, I. (2010). *Assessing the American Power Act: The Economic, Employment, Energy Security and Environmental Impact of Senator Kerry and Senator Lieberman's Discussion Draft.* Number PB10-12. Peterson Institute for International Economics. Washington D.C. http://www.iie.com/publications/interstitial.cfm?ResearchID=1574

Huntington Beach Generating Station. (2012). *Application for Certification, Section 5.10*. AES Southland LLC. 2012-AFC-02. http://www.energy.ca.gov/sitingcases/huntington_beach_energy/documents/applicant/AFC/Volume%201/

IHS. (2009). *The Contributions of the Natural Gas Industry to the U.S. National and State Economies*. IHS Global Insight. Lexington, MA. http://www.anga.us/media/41062/ihs%20global%20insight%20anga%20u.s.%20economic%20impact%20study.pdf

IHS. (2012). *The Economic and Employment Contributions of Unconventional Gas Development in State Economies.* IHS Inc. Washington D.C. http://www.ihs.com/info/ecc/a/unconventional-gas-report-2012.aspx

IRENA. (2011). *Renewable Energy Jobs: Status, Prospects and Policies.* International Renewable Energy Agency. Abu Dhabi, UAE. http://www.irena.org/DocumentDownloads/Publications/RenewableEnergyJobs.pdf

Jerrett, R., Barocci, T.A., and Harrison, B. (1978). *Job Creation and the Economic Stimulus Package.* Alfred P. Sloan School of Business. Massachusetts Institute of Technology, Cambridge. http://dspace.mit.edu/bitstream/handle/1721.1/48289/jobcreationecono00jerr.pdf?sequence=1

Kammen, D.M., Kapadia, K. and Fripp, M. (2006). *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* Renewable and Appropriate Energy Laboratory. University of California, Berkeley. http://qualenergia.it/UserFiles/Files/Rn_Ge_23_Putting_Renewables_to_work_Berkeley_2006.pdf

KEMA. (2008). *The U.S. Smart Grid Revolution: KEMA's Perspectives for Job Creation.* KEMA Inc. http://www.smartgridnews.com/artman/uploads/1/KEMA_s_Perspectives_for_Job_Creation.pdf

Kenley, C.R., Klinger, R.D., Plowman, C.M., Soto, R., Turk, R.J., Baker, R.L., Close, S.A., McDonnell, V.L., Paul, S.W., Rabideau, L.R., Rao, S.S., and Reilly, B.P. (2004). *U.S. Job Creation Due to Nuclear Power Resurgence in the United States, Volumes 1 and 2.* INEEL/EXT-04-02384. Idaho National Engineering and Environmental Laboratory. Idaho Falls. http://www.ne.doe.gov/pdfFiles/200411_JobCreation_VI.pdf

Kenley, C.R., Klinger, R.D., Plowman, C.M., Soto, R., Turk, R.J., Baker, R.L., Close, S.A., McDonnell, V.L., Paul, S.W., Rabideau, L.R., Rao, S.S., and Reilly, B.P. (2009). Job creation due to nuclear power resurgence in the United States. *Energy Policy*, 37 (2009), 4894-4900.

Kings River Conservation District Community Power Project. (2007). *Application for Certification, Section 8-13*. Kings River Conservation District. 07-AFC-07. http://www.energy.ca.gov/sitingcases/communitypower/documents/applicant/afc/AFC_VOLUME_1/8.13-Socioeconomics.pdf

Knudson, W.A. (2011). *The Economic Impact of Replacing Coal with Natural Gas for Electricity Production.* The Strategic Marketing Institute: Michigan State University, East Lansing. http://archive.lib.msu.edu/eres/open/naturalgaseconomicimpactstudy.pdf

Koson, M., Grover, S., Josephson, A., Dickerson, C., Takanishi, W., and Cole, J. (2012). *Beyond the Payback Period: Measuring the Economic Impacts of Energy Efficiency Programs.* 2012 ACEEE Summer Study on Energy Efficiency in Buildings, August 12-17. Pacific Grove, CA. http://www.aceee.org/files/proceedings/2012/data/papers/0193-000180.pdf

Labovitz School of Business and Economics. (2005). *The Economic Impact of Constructing and Operating An Integrated Gasification Combined-Cycle Power-Generation Facility on the Iron Range*. Labovitz School of Business and Economics, Bureau of Business and Economic Research: University of Minnesota, Duluth.
https://lsbe.d.umn.edu/departments/bber/projects/Mesaba%20One%20Excelsior/17oct2004FINAL.pdf

Labovitz School of Business and Economics. (2010). *The Economic Impact of Constructing Five Electric Power Lines in Minnesota, North Dakota, South Dakota and Wisconsin, 2010-2015.* Labovitz School of Business and Economics, Bureau of Business and Economic Research: University of Minnesota, Duluth. http://www.capx2020.com/Projects/pdf/capx_economic_impact_study_revised_11.24.2010.pdf

Laitner, J.A. and McKinney, V. (2008). *Positive Returns: State Energy Efficiency Analysis Can Inform U.S. Energy Policy Assessments.* American Council for an Energy-Efficient Economy, Report E084. Washington D.C. http://www.aceee.org/research-report/e084

Lantz, E. (2009). *Economic Development Benefits from Wind Power in Nebraska: A Report for the Nebraska Energy Office.* NREL/TP-500-44344. National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy09osti/44344.pdf

Lantz, E., and Tegen, S. (2011). *Jobs and Economic Development from New Transmission and Generation in Wyoming.* NREL/TP-6A20-50577. National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy11osti/50577.pdf

Leatherman, J. and Golden, B. (2010). *The Economic Impact of Building and Operating an 895 MW Coal-Based Power Plant in Finney County Kansas.* Department of Agricultural Economics. Kansas State University. Manhattan, KS.
http://www.americaspower.org/sites/all/themes/americaspower/images/pdf/sunflower.pdf

Levine, L. (2010). *Job Loss and Infrastructure Job Creation During the Recession*. Congressional Research Service. Washington D.C. R40080. http://assets.opencrs.com/rpts/R40080_20100719.pdf

Lodi Energy Center. (2008). *Application for Certification, Section 5.10.* September, 2008. Northern California Power Agency. 2008-AFC-10. http://www.energy.ca.gov/sitingcases/lodi/documents/applicant/afc/Volume_I/LEC_5.10_Socioeconomics.pdf

Loomis, D. and Carter, J. (2011). *Wind Development Provides the Most Jobs of the Various Generation Sources in Illinois.* Center for Renewable Energy, Illinois State University. Normal, IL. http://renewableenergy.illinoisstate.edu/wind/publications/1102%20WorkingPaperWindDevProvidesMostJobs030211.pdf

Loomis, D., Hayden, J., and Noll, S. (2012). *Economic Impact: Wind Energy Development in Illinois.* Center for Renewable Energy. Illinois State University. http://renewableenergy.illinoisstate.edu/wind/publications/2012EconomicImpactReportForWeb.pdf

Makower, J., and Pernick, R. (2002). *Bringing Solar to Scale: A Proposal to Enhance California's Energy, Environmental and Economic Security.* Clean Edge Inc. Oakland, CA. http://www.cleanedge.com/reports/bringing-solar-to-scale

Michaels, R. and Murphy, R. (2009). *Green Jobs Fact or Fiction? An Assessment of the Literature*. Institute for Energy Research. Washington D.C. http://www.instituteforenergyresearch.org/green-jobs-fact-or-fiction/

Milligan, M. and Porter, K. (2005). *Determining the Capacity Value of Wind: A Survey of Methods and Implementation.* May, 2005. National Renewable Energy Laboratory. Golden, CO. NREL/CP-500-38062. http://www.nrel.gov/docs/fy05osti/38062.pdf

Muro, M., Rothwell, J. and Saha, D. (2011). *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. Brookings Institution Metropolitan Policy Program. Washington D.C. http://www.brookings.edu/~/media/Series/resources/0713_clean_economy.pdf

NETL/MIS. (2009). *Literature Review of Employment Impact Studies of Power Generation Technologies.* National Energy Technology Laboratory. DOE/NETL-2009/1381. http://www.netl.doe.gov/energy-analyses/pubs/Employment_Lit_Review_091409.pdf

NCEP. (2009). *Task Force on America's Future Energy Jobs.* National Commission on Energy Policy: Bipartisan Policy Center. Washington D.C. http://bipartisanpolicy.org/sites/default/files/NCEP%20Task%20Force%20on%20America%27s%20Future%20Energy%20Jobs%20-%20Final%20Report.pdf

NPC. (2011). *Macroeconomic Impacts of the Domestic Oil and Gas Industry*. Macroeconomic Subgroup of the National Petroleum Council. Washington D.C. http://www.npc.org/Prudent_Development-Topic_Papers/5-1_Macroeconomic_Impacts_of%20Oil_and_Gas_Industry_Paper.pdf

NEI. (2004). *Economic Benefits of the Duke Power-Operated Nuclear Power Plants.* Nuclear Energy Institute. Washington D.C. www.nei.org/filefolder/**economic_benefits_duke**power.pdf

NEI. (2011). *Nuclear Energy's Economic Benefits-Current and Future.* Nuclear Energy Institute. Washington D.C. http://www.nei.org/resourcesandstats/documentlibrary/newplants/whitepaper/jobs/

Oxford Economics. (2008). *Economic, Employment and Environmental Benefits of Renewed U.S. Investment in Nuclear Energy.* Oxford Economics. http://www.nuclearcompetitiveness.org/images/Oxford_State_Benefits.pdf

Palen Solar Power Project. (2009*). Application for Certification, Section 5.11.* August, 2009. Solar Millenium LLC and Chevron Energy Solutions. 09-AFC-7. http://www.energy.ca.gov/sitingcases/solar_millennium_palen/documents/applicant/afc/5.11%20Socioeconomics.pdf

Paul, A., Palmer, K., Ruth, M. Hobbs, B.F., Irani, D., Michael, J., Chen, Y., Ross, K. and Myers, E. (2010). The role of energy efficiency spending in Maryland's implementation of the Regional Greenhouse Gas Initiative. *Energy Policy,* 38(2010), 6820-6829.

Peterson, S., Widner, L. and Nelson, J.R. (2004). *Estimated Impacts of Proposed Idaho Geothermal Energy Projects.* Department of Agricultural Economics and Rural Sociology: University of Idaho. http://www.energy.idaho.gov/informationresources/d/geo_impact_sm.pdf

Pfeifenberger, J., Chang, J., Hou, D., and Madjarov, K. (2010). *Job and Economic Benefits of Transmission and Wind Generation Investments in the SPP Region*. The Brattle Group. http://www.brattle.com/_documents/uploadlibrary/upload859.pdf

Pfeifenberger, J.P. and Hou, D. (2011). *Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada.* The Brattle Group. http://www.wiresgroup.com/images/Brattle-WIRES_Jobs_Study_May2011.pdf

Pioneer Wind Park I and Pioneer Wind Park II. (2011). *Wyoming Industrial Development Information and Siting Act, Section 109 Permit Application*. Wasatch Wind. http://deq.state.wy.us/isd/downloads/Permit%20Application%20Wasatch.pdf

Pollin, R., Garrett-Peltier, H., Heintz, J. and Scharber, H. (2008). *Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy.* Political Economy Research Institute: University of Massachusetts, Amherst. http://www.americanprogress.org/wp-content/uploads/issues/2008/09/pdf/green_recovery.pdf

Pollin, R. and Garrett-Peltier, H. (2009). *The U.S. Employment Effects of Military and Domestic Spending Priorities: An Updated Analysis*. Political Economy Research Institute: University of Massachusetts, Amherst. http://www.peri.umass.edu/fileadmin/pdf/published_study/spending_priorities_PERI.pdf

Pollin, R., Heintz, J. and Garrett-Peltier, H. (2009). *The Economic Benefits of Investing in Clean Energy. June, 2009. Political Economy Research Institute*. Political Economy Research Institute: University of Massachusetts Amherst. http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/economic_benefits/economic_benefits.PDF

PWC. (2011). *The Economic Impacts of the Oil and Natural Gas Industry on the U.S. Economy in 2009: Employment, Labor, Income and Value Added.* Price Waterhouse Coopers. http://www.api.org/newsroom/upload/industry_economic_contributions_report.pdf

Ramey, V.A. (2012). *Government Spending and Private Activity*. University of California, San Diego. http://econ.ucsd.edu/~vramey/research/NBER_Fiscal.pdf

REMI. (2012). Product Brochure: *What does REMI say?* Regional Economic Models, Inc. Amherst. http://www.remi.com/products

Reategui, S. and Hendrickson, S. (2011). *Economic Development Impact of 1,000 MW of Wind Energy in Texas*. NREL/TP-6A20-50400. National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy11osti/50400.pdf

Reategui, S. and Tegen, S. (2008). *Economic Development Impacts of Colorado's First 1000 Megawatts of Wind Energy*. NREL/CP-500-43505. National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy08osti/43505.pdf

Roland-Holst, D. (2008). *Energy efficiency, innovation and job creation in California.* Department of Agricultural and Resource Economics: University of California, Berkeley. http://are.berkeley.edu/~dwrh/CERES_Web/Docs/UCB%20Energy%20Innovation%20and%20Job%20Creation%2010-20-08.pdf

Rothwell, J. (2012). *Education, Job Openings, and Unemployment in Metropolitan America.* Metropolitan Policy Project: Brookings. http://www.brookings.edu/~/media/research/files/papers/2012/8/29%20education%20gap%20rothwell/29%20education%20gap%20rothwell.pdf

Rutovitz, J. and Atherton, A. (2009). *Energy Sector Jobs to 2030: A Global Analysis*. Institute for Sustainable Futures. University of Technology, Sydney. https://secured.greenpeace.org/international/Global/international/planet-2/binaries/2009/9/energy-sector-jobs-to-2030.pdf

Rutovitz, J. and Usher, J. (2010). *Methodology for Calculating Energy Sector Jobs*. Prepared for Greenpeace International by the Institute for Sustainable Futures: University of Technology, Sydney. http://www.isf.uts.edu.au/publications/rutovitzusher2010jobsmethodology.pdf

Schell, L.S. (2009). *Value Proposition of Large-Scale Solar Power Technologies in California.* Center for Energy Efficiency and Renewable Technologies. Sacramento, CA. http://www.ceert.org/PDFs/reports/LSSPValueProposition-0509.pdf

Schwer, R.K. and Riddel, M. (2004). *The Potential Economic Impact of Constructing and Operating Solar Power Generation Facilities in Nevada*. NREL/SR-550-35037. National Renewable Energy Laboratory. Golden, CO. http://www.nrel.gov/csp/pdfs/35037.pdf

Scott, M.J., Roop, J.M., Schultz, R.W., Anderson, D.M. and Cort, K.A. (2008). The impact of DOE building technology energy efficiency programs on U.S. employment, income and investment. *Energy Economics*, 30 (2008) 2283-2301.

SEF Alliance. (2009). *Why Clean Energy Public Investment Makes Economic Sense.* Sustainable Energy Finance Initiative Public Finance Alliance. Switzerland. http://www.sefi.unep.org/fileadmin/media/sefalliance/docs/specialised_research/Advance_Draft_economic_impact_01.pdf

Shirley, R. and Kammen, D. (2012). *Estimating the Potential Impact of Renewable Energy on the Caribbean Job Sector*. Renewable and Appropriate Energy Laboratory and Energy and Resources Group: University of California, Berkeley. http://rael.berkeley.edu/sites/default/files/RAEL%20Green%20Jobs%20Report_%20Shirley%20and%20Kammen_May2012.pdf

Singh, V. and Fehrs, J. (2001). *The Work that Goes into Renewable Energy*. Renewable Energy Policy Project. Research Report No. 13. Washington D.C. http://www.repp.org/articles/static/1/binaries/LABOR_FINAL_REV.pdf

Snead, M.C. and Barta, S.B. (2008). *The Economic Impact of Oil and Gas Production and Drilling on the Oklahoma Economy.* Center for Applied Economic Research: Oklahoma State University. http://www.oerb.com/Portals/0/docs/State%20Oil%20Gas%20Impact%20Draft%2020080916.pdf

Slattery, M.C., Lantz, E., and Johnson, B.L. (2011). State and local economic impacts from wind energy projects: Texas case study. *Energy Policy*, 39 (2011) 7930-7940.

Steingberg, D., Porro, G., and Goldberg, M. (2012). *Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the §1603 Treasury Grant Program*. National Renewable Energy Laboratory. NREL/TP-6A20-52739. http://www.nrel.gov/docs/fy12osti/52739.pdf

Sterzinger, G. (2006). *Jobs and Renewable Energy Project*. Renewable Energy Policy Project. Washington D.C. http://www.osti.gov/bridge/servlets/purl/899887-T9Q65H/899887.pdf

Stoddard, L., Abiecunas, J. and O'Connell R. (2006). *Economic, Energy and Environmental Benefits of Concentrating Solar Power in California.* NREL/SR-550-39291. National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy06osti/39291.pdf

Swenson, D. (2002). *An Introduction to Economic Impact Assessment*. Department of Economics: Iowa State University. http://www2.econ.iastate.edu/classes/crp274/swenson/URP290/Readings/IOtext.pdf

The Perryman Group. (2008). *The Impact of Exelon's Proposed Construction and Operation of a Nuclear Power Facility on Business Activity in Victoria County and Texas*. The Perryman Group. Waco, TX. http://www.nuclearenergyfortexans.org/pdfs/exelon_impact_072508.pdf

The Perryman Group. (2010). *The Anticipated Impact of Construction and Operations Associated with the Proposed Development of Units 3 and 4 of the South Texas Project (STP) Nuclear Generation Facility on Business Activity in Texas and the Matagorda County Area.* The Perryman Group. Waco, TX. http://www.nuclearinnovation.com/pdf/STP%20Economic%20Impact%200110.pdf

Top of the World Wind Power Project. (2009). *Wyoming Industrial Development Information and Siting Act, Section 109 Permit Application.* Top of the World Wind Energy LLC. http://deq.state.wy.us/isd/downloads/ToWorld%20Application%209-21-09.pdf

Toquop Energy Facility. (2003). *Toquop Energy Facility Final Environmental Impact Statement.* Bureau of Land Management. Washington D.C. http://www.blm.gov/pgdata/etc/medialib/blm/nv/field_offices/ely_field_office/energy_projects/toquop_energy/toquop_2003_feis.Par.58360.File.dat/18%20-%20FEIS%202003%20Toquop%20Energy%20Project%20-%20Appendix%20F.pdf

TXP, Inc. (2008). *The Potential Economic and Tax Revenue Impact of the Tenaska Trailblazer Energy Center.* TXP, Inc. Austin. http://www.tenaskatrailblazer.com/pdfs/TenaskaTrailblazerEconImpact-Nov08.pdf

UNM (2004). *The Economic Impact of Concentrating Solar Power in New Mexico, Draft Report.* Bureau of Business and Economic Research: University of New Mexico. http://www.emnrd.state.nm.us/ecmd/multimedia/documents/UNM-BBER-CSP-Final-11-04.pdf

Weber, J.G. (2012). The effects of a natural gas boom on employment and income in Colorado, Texas and Wyoming. *Energy Economics*, Article in Press.

Wei, M., Patadia, S. and Kammen, D. (2010). Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US? *Energy Policy*, 38(2010), 919-931. http://rael.berkeley.edu/sites/default/files/WeiPatadiaKammen_CleanEnergyJobs_EPolicy2010.pdf

WGA. (2006). *Geothermal Task Force Report.* Western Governors' Association: Clean and Diversified Energy Initiative. www.westgov.org/component/joomdoc/doc.../95-**geothermal**

Yusuf, F., Playstead, K. and Gray, D. (2009). *Economic Analysis for the Teanaway Solar Reserve Kittitas County, Washington*. CH2MHILL. http://teanawaysolarreserve.com/wp-content/uploads/2010/05/Teanaway_Economic_Impact_Analysis_10_07_09.pdf

Yergin, D., Gross, S., Bachman, D., Larson, J., Lyman, T., Meyer, N. and Randolph, J. (2012). *Energy for Economic Growth: Energy Vision Update 2012*. World Economic Forum. http://reports.weforum.org/energy-for-economic-growth-energy-vision-update-2012/

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