



Bureau of Economic Geology, Jackson School of Geosciences
The University of Texas at Austin

Green Jobs: A Review of Recent Studies

**Center for Energy Economics
Bureau of Economic Geology
The University of Texas at Austin**

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Green Jobs: A Review of Recent Studies

Executive Summary

The purpose of this paper is to review four recent studies on green jobs. Estimating economic impact, including creation of jobs, of any major investment scheme is difficult as multiplier effects can change over time and unintended consequences are often ignored. With green jobs, there are further complications such as their definition and assumed labor intensities. Comparing these four studies, our objective is to shed light on how these complications are handled, how realistic the job creation estimates are, and what may be done to improve future studies.

Four studies are reviewed:

1- *Job Opportunities for the Green Economy: A State-by-State Picture of Occupations That Gain From Green Investments*, Robert Pollin & Jeannette Wicks-Lim, Political Economy Research Institute (PERI), University of Massachusetts, Amherst, June 2008

2- *Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy*, Robert Pollin, Heidi Garrett-Peltier, James Heintz, and Helen Scharber, Department of Economics and Political Economy Research Institute (PERI), University of Massachusetts-Amherst, and Kit Batten and Bracken Hendricks, Project Managers, Center for American Progress (CAP), September 2008

3- *U.S. Metro Economies: Current and Potential Green Jobs in the U.S. Economy*, prepared, Global Insight (GI) for The United States Conference of Mayors and the Mayors Climate Protection Center, October 2008

4- *Harvesting California's Renewable Energy Resources: A Green Jobs Business Plan*, Peter Asmus, Center for Energy Efficiency and Renewable Technologies (CEERT), Sacramento, California, August 15, 2008

Common Issues across Studies

The first study by the Political Economy Research Institute (PERI) is an effort to identify what kinds of jobs would be required for a green economy. In the second study by the Center for American Progress (CAP) and PERI, the researchers estimate the number of green jobs (as defined in the first study) that would be created in response to a \$100 billion stimulus over two years. The third study by Global Insight (GI) estimates potential job creation over a 30-year period under an aggressive scenario of increasing shares of green technologies. The final study by Center for Energy Efficiency and Renewable Technologies (CEERT) brings together estimates from several other reports rather than carrying out its own modeling exercise. Despite these different approaches, some common issues and inconsistencies are identified. Detailed comments are provided in the main body where excerpts from each study are discussed in detail.

- 1- Definition of “green” jobs is not clear in some studies; differs between studies; and is very inclusive in some cases.
- 2- The studies depend on very aggressive growth assumptions for renewable power, far above official government forecasts. For example, according to Annual Energy Outlook 2008 by the Energy Information Administration, renewable energy generation (including conventional hydro) will grow at an average rate of 2% per year and reach 12% of the total generation capacity by 2030 from 9% in 2008. The Global Insight study, for example, assumes renewable generation excluding conventional hydro (currently about 3% of the sector) to increase its share to 27% by 2028.
- 3- Jobs created are not always separated between construction jobs, which are temporary, and operation jobs, which are long-term.
- 4- Jobs may not be “new” in that already employed people will be doing “green” work.
- 5- There is no mention in any of the studies of how much it would cost both in terms of capital investment and, more importantly, end-user prices of electricity and transportation fuels.
 - a. The CAP/PERI analysis assumes an incentive package scenario of \$100 billion over two years.
 - b. Some of the studies referred to in the CEERT study also have similar scenarios (for example, \$300 billion over 10 years in Apollo Alliance scenario).
- 6- There is no analysis of job destruction due to:
 - a. Increased cost of energy (as renewables generate more expensive electricity) to businesses and households (less consumption)
 - b. renewables jobs replacing some traditional industry jobs
- 7- There is no comparison of economic impacts of similar investment in other segments of the economy (energy or non-energy).
- 8- There is no consideration of challenges such as lack of transmission (cost and ability to site), technical limitations of integrating large amounts of intermittent sources such as wind into the grid (lack of storage, asynchronous nature of wind generation and daily loads, frequency mismatch, etc.), and NIMBY attitude for even renewable facilities.
- 9- Investment requirements and time frame assumptions vary widely between the studies. Resulting job creation estimates also differ significantly (see table below).

Investment scenarios of different studies

Studies	New renewables	Investment	Jobs created	Time period
CAP/PERI		\$100 billion	2 million	2 years
GI*	~750 GW	>\$1.5 trillion	1.2 million	30 years
CEERT (Environment California)**	20% RPS by 2017		200,000 (CA only)	15 years
CEERT (Apollo Alliance)**		\$500 billion	5 million	10 years
CEERT (WWF)**			1.3 million	2001-2020

* Our estimate based on the GI scenario of increasing power generation from renewables (excluding conventional hydro) from 3% in 2008 to 40% by 2038. Note that we are not including the GI scenarios for transportation fuels and efficiency investments.

** CEERT study focuses on job creation in California. The range of estimates for green job creation in California is reported as 16,000 to 430,000 by 2020 (p. 9). In this table, we provided, when available, national estimates from the same studies to compare with estimates from other studies.

The summary of investment scenarios in the table above captures nicely fundamental issues with these studies. There is a high level of uncertainty surrounding the jobs estimates of these studies, partly because they use different definitions of a green job. But the estimates differ significantly also because the studies use different models to estimate job creation (usually, input-output models) and different investment scenarios. Also, there is no effort to balance the potential positive impacts with potential negative impacts of job destruction and higher energy costs. In a sense, these studies are cost-benefit analyses without any cost considerations. Detailed evaluation of each study is provided next.

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Specific Comments on Individual Studies

Background

Energy efficiency and alternative energy technologies are important components of addressing energy security and environmental challenges. Without doubt, they will play an increasingly larger role in future energy policies. In addition to established technologies such as wind, newer technologies such as biofuels based on different feedstocks, advances in solar PV and thermal, and electricity storage are in various stages of research and development. Differing technologies offer a varying array of benefits and trade-offs including cost structures, reliability of supply, and lower emissions. These are appropriate criteria to consider when evaluating energy policy options.

Often, however, creating jobs is also offered as a benefit associated with investment in these energy technologies. This is an economically problematic argument as job creation is in direct conflict with the overall goal of increasing productive efficiency and hence lowering cost of production. Alternative technologies may in part be more expensive than established technologies due to lack of economies of scale. Some of this cost disadvantage may be justified based on environmental and diversification benefits, but if they are also more labor-intensive and will likely remain so, their cost disadvantage may remain permanent.

Focusing on job creation may in fact undermine the expansion of alternative technologies. About 28 states have some form of renewables portfolio standards (RPS). In many of these states, creating local jobs is a goal that shapes the RPS program. States naturally favor the resources with which they are endowed or those they think would create the most jobs. As such, credits for renewables generation built in one state often cannot be used in other states. If one state has more potential for development and its own RPS mandates are already met, there will be little incentive to build new generation since the excess credits would not be valid in other states. It is also often the case that states with RPS programs that do not allow out-of-state credits end up with more expensive technologies and hence higher electricity prices. This focus on local jobs and economic development is a handicap for the efforts to create a regional, or even a national, market for RPS programs that could facilitate more investment in areas where the most cost-effective resources could be harnessed.

Specific Study Comments

Job Opportunities for the Green Economy: A State-by-State Picture of Occupations That Gain From Green Investments, Robert Pollin & Jeannette Wicks-Lim, Political Economy Research Institute (PERI), University of Massachusetts, Amherst, June 2008

This study is simply trying to demonstrate what kind of jobs will be needed for a green economy.

- The definition of a green job seems quite inclusive and not always clearly framed.
 - For example, on page 4: “Train operators who currently deliver furniture may one day deliver wind turbine component parts, meaning that their work will be contributing to a green economy that solves global warming and builds healthier communities.” It is not clear whether the train operator will be considered only a part-time green job if they continue to deliver furniture along with wind turbine components.
- It does not appear that the authors consider job destruction in sectors that will decline due to a switch to green sectors, or job losses in the overall economy due to higher energy prices associated with alternative technologies.
- An implicit assumption seems to be that there is an unlimited supply of skilled labor that will be ready to fill green job openings.
- Finally it is not clear why the authors selected the 12 states they analyze. It is possible that this selection is due to data availability.

Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy, Robert Pollin, Heidi Garrett-Peltier, James Heintz, and Helen Scharber, Department of Economics and Political Economy Research Institute (PERI), University of Massachusetts-Amherst, and Kit Batten and Bracken Hendricks, Project Managers, Center for American Progress (CAP), September 2008

This report analyses the effects of a \$100 billion stimulus package (\$50 billion in tax credits, \$46 billion in direct government spending, and \$4 billion in loan guarantees) over two years. The scenario envisions that this amount would be met by revenues generated from the auction of CO₂ emission permits under a cap-and-trade scheme, though up-front costs would be met by deficit spending. The study estimates that 2 million new jobs would be created with this stimulus. The job categories identified in the PERI study are used.

There are quite a few sweeping statements in this study that are not backed by evidence or analysis:

- Page 2: “It will also strengthen career ladders by providing pathways for workers to move up from lower-paying to higher-paying green jobs that can be

created on a geographically equitable basis throughout all regions of the country."

- Why would green jobs be higher paying? If there is such an expectation, wouldn't there be an over-supply of say green electricians, which would put downward pressure on wages?
- Also, given that most states are structuring their RPS programs to favor local economic development, how can geographical equity be established? Is geographical equity desirable? Shouldn't regions with cost advantages be preferred?
- Page 2: "Employment in construction fell to 7.2 million in July 2008, down from 8 million in July 2006. A green economic recovery program would replace, at least, those 800,000 lost construction jobs over the next two years, and could result in renewed investment in the housing sector that is at the root of the current economic slump." There is already an oversupply of housing; it is not likely that there will be large scale investment in new housing. Any likely investment in energy efficiency improvements (for example, adding insulation, switching to more efficient appliances and light bulbs) would not be enough to replace lost construction jobs.
- Page 2: "...because of increased U.S. investment in renewable energy and energy efficiency, then the price of oil would also fall." This statement is misleading. The price of oil may still increase despite large investment in the U.S. on alternatives; global factors such as rapidly increasing demand in China, India and elsewhere, and the lack of sufficient upstream investment will dictate the price of oil.
- Page 3: "Lowering energy costs for educational buildings eventually means more funds for teachers, books, and scholarships. Retrofitting hospitals over time releases money for better patient care." These expectations assume that energy costs will decline while evidence suggests that the cost of alternative energy will be higher than that from conventional sources.
- Page 4: "A green economic recovery program is needed to bring our nation's economy back to its full capacity."
 - It is an open question whether the green recovery program will help the economy. If the end result is higher cost energy for the U.S. economy, then the answer is probably no. Also, there are many ways to "stimulate" the economy, and what is lacking in all of these studies is a realistic comparison of stimulus packages to determine the most effective option.
 - Also, "full capacity", which is not a common term for economists, is not defined.
- Page 7: "Lower public transportation fares." In addition to large new investment in mass transit, the study calls for a reduction of fares. But, it does not appear that fare reductions are covered by the \$100 billion stimulus package. As a result, the mass transit companies would not be able to recover their investment from ridership and would have to go back to the government

for more support. Also, if the ridership does not rise because people start telecommuting more or alternative fueled vehicles become more prevalent, or both, transit companies would need further support.

- Page 11: “Domestic content.” Imported renewable technology or parts of it, or renewable fuels (such as Brazilian ethanol) can be cheaper than domestically produced alternatives. Why should American consumers pay more for domestically produced alternatives? An implicit assumption seems to be that trade barriers should be erected or protected (such as the existing ethanol import tariff) in order to ensure domestic job creation. Historically such protectionist trade policies ended up lowering the standard of living of both the country instituting such policies and potential exporters.
- Page 12: “Of course, beyond construction, we are still left, as of July 2008, with 8 million additional unemployed workers in other sectors of the economy. There is thus little chance that we will face serious labor shortages through creating 2 million more jobs overall.”
 - This is a simplistic statement. The construction sector may have additional labor to meet the new demand but when it comes to skilled professions, supply may not be that elastic.
 - Also, 8 million additional unemployed cannot be offered seriously as the labor pool. The “full employment” (or, structural) rate of unemployment is about 4% and hence there will always be some people not working.
- Page 14: footnotes 11 and 12 contain unrealistic assumptions and inaccurate comparisons:
 - ft11 - releasing oil from SPR could have short-term impact on price, which will probably be transitory, but 5% reduction in oil demand due to green energy will not happen as quickly.
 - ft12 - assuming supply will remain the same is unrealistic (not the least because of OPEC cuts). Also, “market behavior in short-term supports this” is not a sufficient argument since green energy will not reduce oil demand significantly in the short-term.
- Page 15: The authors claim that despite spending \$100 billion over two years, the creation of 2 million new jobs will help the government “restore fiscal balance.” But there are no calculations or evidence provided on how the fiscal balance will be restored, especially considering the fact that deficit spending is proposed to cover up front program costs. The only explanation in the study is the revenues from auctioning CO₂ permits under a cap-and-trade system. The study provides a range of revenue estimates from \$75 to \$200 billion. But no references or underlying support for the estimates are provided; nor are the CO₂ price assumptions or time frames known. An estimate of \$750 billion over 10 years is provided from another CAP study but again no details about CO₂ price or time frame. Finally, although the study claims that this revenue stream is not speculative, there is no cap-and-trade program in the U.S.. The Senate proposals the study refers to have not passed; and the details of a future cap-

and-trade design are not known. The experience in Europe over the last several years has shown that CO₂ prices can be very volatile and low.

- Finally it is not clear why the authors selected the 34 states they analyze. It is possible that this selection is due to limited data availability.

U.S. Metro Economies: Current and Potential Green Jobs in the U.S. Economy, prepared, Global Insight (GI) for The United States Conference of Mayors and the Mayors Climate Protection Center, October 2008

This study by Global Insight, focusing on major metro areas in the U.S., provides a current count of green jobs and forecasts future green jobs under certain scenarios.

- The study makes some generalizations that are not backed up by any evidence nor qualified as “possible” or “likely”. For example, from page 2: “The economic advantages of the Green Economy include the macroeconomic benefits of investment in new technologies, greater productivity, improvements in the US balance of trade, and increased real disposable income across the nation. They also include the microeconomic benefits of lower costs of doing business and reduced household energy expenditures. These advantages are manifested in job growth, income growth, and of course, a cleaner environment.”
 - There is a lack of evidence for making the claim for greater productivity, especially given the likely outcome that “green” energy sectors would likely be more labor intensive than conventional energy sectors.
 - Furthermore, an increase in real disposable income would require lower cost energy or higher wages, or both.
 - For cost of doing business and household energy expenditures to decline, higher efficiency or lower energy costs or both would be required as a result of the proposed policy.
 - Alternative energy has historically been more expensive than conventional sources and increased efficiency is difficult to square with increased labor intensity associated with “green” energy sectors, and requires upfront investment.
- The definition of green jobs is very inclusive. The study counts as green jobs nuclear industry jobs, agricultural jobs supplying corn and soy to ethanol plants and government jobs in environmental administration (p. 5). The largest category, however, is in the “engineering, legal, research & consulting” category (419,000 out of a total of 751,000, or 56%). Given that there are also categories for renewable generation, manufacturing, construction & installation, it is likely that the majority of the jobs in the largest category are not directly associated with the generation of a single kWh of “green” power or a single Btu of “green” fuel.

- The study describes the large potential for wind and solar (p. 7). However, there are very real constraints faced by these technologies such as lack of transmission capacity, difficulty of siting and building these facilities (high cost as well as NIMBY opposition to transmission facilities), technical challenges associated with reliably incorporating a lot of wind into grids, high cost of solar (orders of magnitude, unfortunately), etc.
- Hydro and biomass are counted as green alternatives. But, there is opposition to hydro facilities, especially larger dams, due to their negative impact on the ecology. Collection and combustion of biomass is not free of emissions (p. 8-9).
- The study contains inconsistencies regarding green and conventional construction projects. For example, the study says “Research has shown that both green and conventional construction projects are being bid and worked on by similar contractors, implying that green construction work does not require specialized workers” (p. 10).
 - The research they are referring to is the PERI study reviewed above, which has not “shown” but rather predicted that the same people will do the green jobs in most cases.
 - There is also a contradiction with the following sentence from the same paragraph: “Some firms are not fully aware of some green construction techniques or the wide variety of modern materials that can be used in a given renovation project.” It may be the same workers but they will have to be trained and specialized before they can do at least some of the green jobs.
- The study has a fundamental weakness in its definition of a green job. This is evidenced in the footnote on page 11. It says “We acknowledge there is debate over whether corn-based ethanol and soy-based biodiesel should be considered Green Jobs due to high energy and water usage in the production of crops. We consider them as alternative fuels here because of their ability to reduce reliance on fossil fuels.” It appears that the focus of the study should have been on “alternative” jobs as well as on “green” jobs.
- The study depends on some very aggressive growth assumptions for renewable power, far above official government forecasts. For example, according to the Annual Energy Outlook 2008 by the Energy Information Administration, renewable energy generation (including conventional hydro) will grow at an average rate of 2% per year and reach 12% of the total generation capacity by 2030 from 9% in 2008. But on page 12, the GI scenario is for renewable generation excluding conventional hydro (currently about 3% of the sector) to increase its share to 27% by 2028.
- The study’s fundamental weakness with its green job definition is compounded by its assumption that green manufacturing can establish and support a viable domestic industry. This remains an open question. For example on page 13: “The technology of wind electricity is relatively new, but the manufacturing base for its production is very similar to past products. Every state in the country has firms and a labor force with experience making products similar to the blades,

gearboxes, brakes, hubs, cooling fans, couplings, drives, cases, bearings, generators, towers and sensors that make up a wind tower. These jobs fall into the familiar durable manufacturing sectors of plastics and rubber, primary metals, fabricated metal products, machinery, computer and electronic products, and electrical equipment." Are these sufficient to establish a viable domestic industry for manufacturing alternative technology components? Could they compete with imports from established producers?

- The study depends on some very aggressive assumptions for efficiency. On page 14 for example: "We assume a reduction of energy consumption by the current stock of residential and commercial structures by 35% over the next three decades. Other research has established that such a reduction is technically feasible." This assumption does not seem realistic given the expected growth in population and economic activity, and the fact that we are using more and more electric appliances. For example, the reference case of the AEO 2008 by the EIA predicts an annualized increase of 0.8% in residential and 1.4% for commercial energy consumption between 2006 and 2030 (despite an overall assumption of 1.7% decline per year in energy intensity). Even under best technology case (consumers investing in most efficient technologies regardless of cost) residential energy consumption is expected to rise but will be 22% less than the reference case in 2030. There are no references to other research on technical feasibility in the GI report; even if these technologies are technologically feasible, they present no cost estimates.

Harvesting California's Renewable Energy Resources: A Green Jobs Business Plan, By Peter Asmus, Center for Energy Efficiency and Renewable Technologies (CEERT), Sacramento, California, August 15, 2008

This study focuses on California and reports on economic impacts of the state receiving one third of its electricity from renewable sources based on several other studies, without carrying out a modeling effort of its own. It is similar to the CAP/PERI study in that it is produced in order to promote a particular investment strategy. In terms of its language and the way it is written, it is more confrontational, challenging the California Energy Commission (CEC) and the California Public Utilities Commission (CPUC) for their failed policies and tariff regulations that ties the price of renewables generation to natural gas prices. Essentially, the study criticizes CPUC for its efforts to protect consumers against higher energy prices. Given that CA is nowhere near its 20% in 2010 renewables goal, achieving 33% by 2020 appears very difficult. The study does not provide any cost estimate for how much it will take to reach the 33% goal.

There are many generalizations or blanket statements that are not backed by data or recent experience in California. Only a few are listed below.

- Page 6: "Some of the biggest and most innovative energy and engineering companies in the world are willing to make massive investments in the development of California's renewable energy industry – if we only let them." There is no evidence offered to support this statement.

- Page 9: "California is blessed with the most diverse renewable energy assets in the U.S., but has failed to aggressively maximize these assets over the past two decades. As a result, California squandered a golden opportunity to stabilize today's electricity rates at a time when fossil fuel prices have reached record highs. An even greater economic hit to the state is the jobs lost due to lack of progress in building and maintaining new renewable energy projects..." It is not clear that California would have been able to stabilize today's electricity rates even if they invested in more renewables than the state already did; there is no evidence or data provided to support this position. The cost of new transmission lines seems to be totally ignored although elsewhere in the study, the need for new transmission lines to connect new renewables generation is recognized. There are no jobs 'lost' due to lack of progress as the authors claim; jobs that did not exist cannot be lost.
- Page 14: "Since this report looked at a 20 percent RPS, simple extrapolations imply that a 33 percent RPS could create over 330,000 construction / manufacturing jobs in California developing renewable technologies to export overseas. These figures do not include CSP, so potential jobs under this maximize exports scenario could surpass 350,000 and even approach 400,000." Using Environment California 2003 estimates based on a 20% RPS scenario, the study offers just simple guesses as to how many new jobs would be created under its 33% RPS scenario. There is no empirical analysis to back these estimates.