An Exploration of Green Job Policies, Theoretical Underpinnings, Measurement Approaches, and Job Growth Expectations

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Overview

There is widespread consensus in the U.S. that looming limits to global energy supplies and continuous pressure to produce more goods and services while preserving scarce natural resources will lead to growing demand for technologies and production practices that reduce our dependence on fossil fuels and promote greater efficiencies in our society.

The colloquial practice for both fossil-based energy-reducing or other environmentally beneficial actions is to label the activities "green." Green industries, therefore, produce green products or services, and in so doing require green labor. A clear and concise definition of what constitutes green industrial activity or a green job is, however, far from determined. Indeed, arriving at statutorily-defined or rule-defined conclusions still seems somewhat far in the distance, perhaps not unlike the long process the USDA needed to set and implement organic crop and animal production standards.

The U.S. Bureau of Labor Statistics concedes there currently is "no widely accepted standard definition of 'green jobs.'" Nonetheless, they assume those jobs are linked to "preserving or restoring the environment" (1). Others tend to allocate those jobs to industrial establishments resulting in the production, distribution, or consumption of energy sources that are considered "clean" (2); (3). Those "cleaner" industrial activities result in energy uses that have fewer environmentally harmful consequences. A more succinct designation has been deployed by the U.S. Department of Commerce in that it considers green products or services to be those that conserve energy and other natural resources and those that reduce pollution (4).

Whatever the definitional scope, there are currently twin public policy focuses regarding this type of industrial activity. The first relates directly to the implied value of the activity; namely, the ability to conserve energy and other natural resources as well as reduce pollution. The second focus, however, is the job producing value of the activities. While most people agree that the environmentally beneficial goals of policy developments are laudable and essential, the job creation goals are likely foremost in most policymakers' minds given nearly three years of widespread economic decline or stagnation. Not surprisingly, all states have green job initiatives, the U.S. Department of Commerce and the Bureau of Labor Statistics are formally engaged in detailed evaluations of green industries and jobs, the USDA has initiated green research efforts, and the Obama Administration has made green jobs a centerpiece of its justification for and promotion of the benefits of the American Recovery and Reinvestment Act of 2009.

This begs consideration, therefore, of the near term value and the longer term value of green industrial development. In the short run, owing to the nature of recessions in that traditional production and service capacity are constrained until economically sustainable growth signals are sent to firms irrespective of recent policy initiatives, the vast preponderance of recovery-related job growth will in fact be in traditional goods and service producing industries. Over the longer run, we have conflicting expectations for green job growth. In the manufacturing sectors, industrial activity that contributes strongly to green outputs tends to be capital intensive and therefore lean on job requirements per million dollars of industrial output. More labor intensive opportunities may exist in service-oriented activities such as renovating businesses and homes to reduce their energy use, research and design to further environmental and energy reduction goals, and implementation and administration of socially and environmentally beneficial public programs.

Long run green job development will be determined by combinations of state, national, and even international policies coupled with global market forces. Carbon production limits will eventually alter production costs, which in turn will create job opportunities as commodity substitutes and remedial

production strategies are implemented. Projected higher transportation fuel costs will stimulate innovation in seeking greater transportation systems efficiencies, the adoption of advanced biofuels, and greater exploitation of cleaner fuel resources such as natural gas, nuclear energy, and other liquid fuel alternatives that accomplish policy objectives.

This study explores the policy antecedents, theoretical foundations, and the many approaches to measuring green jobs in the U.S. It also contains brief descriptions of national and state initiatives to quantify green jobs currently in the economy, as well as their potential growth. The research preliminarily evaluates the likelihood of green job growth in non-metropolitan areas. Finally, this study identifies areas of research and investigation that need to be completed to more fully inform green job policy development and programming.

Section 1. Evolution of the "Green Economy" Movement

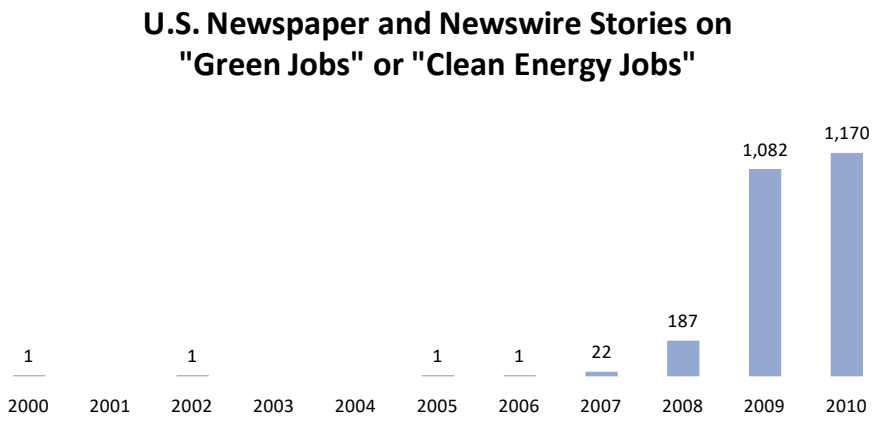
The green economy movement can be traced back at least as far as the 1970s and has been associated over time with a wide assortment of environmental, social, economic, and political goals. According to its various proponents, the "greening" of our economy will improve national energy security, address global climate change, stimulate rural development, revitalize urban neighborhoods, revive the domestic manufacturing sector, and provide poor and disadvantaged workers with pathways out of poverty. Of late, however, the diverse environmental, social, and economic goals of a green economy have been overshadowed by its purported job creation potential. Policy-makers have promised a coming green economy that will create millions of jobs that are safe from outsourcing to other countries. Today's usage of the term "green economy" refers to an impending reorganization of industrial activity to achieve environmental sustainability. Current green economy rhetoric implies that this transformation is inevitable, linear, and reasonably predictable. In reality, the transition to a green economy will be influenced by both policy and market forces, which may work to thwart or delay expected changes. There may be substantial opposition to specific policies that would lay the groundwork for further growth of green jobs. For example, some groups oppose setting a national industrial policy on the basis that it picks winners and losers by virtue of their "green" potential versus other, more market driven criteria. Other groups oppose massive investments in public infrastructure and transportation systems in a time of growing concern over all manner public spending and public debt. Still others will likely oppose new environmental regulation of industry to include policies such as cap and trade for carbon emissions irrespective of promised environmental or social gains.

Despite potentially strong opposition to individual green policy components, there has been little vocal criticism of green jobs or the green economy in general. As of this writing, the terms have yet to attract significant negative connotations among policymakers and the citizenry. It could perhaps be the case that definitional vagueness helps to shield the wide array of green job and green economy initiatives from critical scrutiny. The following sections examine the evolution of these terms and their underlying policy foundations.

Linking Jobs With Green

Widespread use of the term "green jobs" is a relatively modern phenomenon, though the nation has to varying degrees embraced environmental action and activism for the past four decades since the passage of the Environmental Protection Act and its many sub-provisions in 1970. Figure 1 shows the number of U.S. newspaper and newswire stories that contained at least three references to the terms "green jobs" or "clean energy" jobs just in the last decade.

Figure 1



The recent surge in popularity of "green jobs" rhetoric is problematical for two reasons. First, by virtue of its exponential growth, it is highly suggestive of an economic development fad, which may work to create disdain among academic researchers and discourage serious research on the topic. Second, it creates the impression that the job-creating potential of environmental policies has only just been recognized. In fact, jobs and the environment have been linked in the public consciousness for many decades in both positive and negative ways.

A growing ecological movement during the 1960s and 1970s led to a series of regulations on industrial activities to limit their environmental impacts. During that era, references to the economic impacts of such regulation were likely to portray a tradeoff between the environment and jobs. For example, a 1976 article in The Economist magazine reported that ".[t]he environmental lobby … received a major setback during the economic recession when pleas for more jobs and more energy became more persuasive than those for protection of the countryside" (5).

Well into the 1980s, business and industry leaders lobbied for rollbacks to environmental and worker safety protections implemented during the 1970s, claiming that over-regulation had resulted in productivity and job losses and had undermined U.S. competitiveness abroad. A 1988 study by the National Center for Policy Analysis claimed that regulatory burdens explained nearly one third of the decline in U.S. manufacturing productivity during the 1970s and slowed the rate of job creation (6).

Countering arguments that environmental regulations were costing jobs, the environmental lobby began to emphasize the job-creation benefits of environmental regulation. Reports appeared of a growing demand for specialized workers to assist companies in meeting federal environmental regulations such as the Clean Air, Clean Water, and Superfund Acts. These claims generally focused on specific industries or occupations. A 1986 New York Times article referred to a growing "environmental management industry" resulting from stricter federal oversight of toxic chemicals and wastes from industrial processes (7). These regulations helped drive demand for graduates with degrees in chemistry, health sciences, geology, and hydrology as well as less-skilled workers involved in cleanup operations at hazardous waste sites.

The 1990s saw the word *green* increasingly paired with words such as *economy*, *jobs*, and *occupations*. An early reference to a broad "green economy" appeared in a 1990 piece in the Washington Post by Jeremy Rifkin. Rifkin argued that global environmental threats such as climate change, ozone depletion, acid rain, and deforestation represented a growing threat to national security that warranted a major shift in U.S. spending away from defense and toward the environment. Notably, Rifkin did not predict, or even mention, potential job-creation outcomes from that shift (8).

The term "green-collar jobs" was in use by 1994. A newswire report in that year claimed there were nearly 3 million workers in green-collar jobs, primarily in fields related to industries' responses to environmental regulations. High growth areas included technical fields such as environmental engineering, toxicology, industrial hygiene and risk management (9). In 1995, the California Department of Conservation published "Good, Green Jobs," a book that promoted a balance between environmental responsibility and economic development. The book highlighted jobs created through companies' recycling, pollution prevention and cleanup, waste reduction, and energy efficiency initiatives (10).

The term "green-collar jobs" took a rural development turn in a 1999 Northwest Environment Watch book titled "Green-Collar Jobs" that described efforts by rural communities in the Pacific Northwest to transform their economic base from extractive industries to sustainable forestry and ecosystem restoration (11). In this case, the greening of their economy was viewed as a solution to job losses in the timber industry.

A list of "green occupations" highlighted in an Earth Day 2000 speech by U.S. Labor Secretary Alexis Herman still had a decidedly environmental sciences flavor. The list included biological scientists, chemical engineers, civil engineering technicians, environmental engineers, environmental technicians, hazardous materials removal workers, park rangers, soil conservationists, urban planners and wastewater treatment plant operators (12).

The meaning of "green-collar jobs" broadened when it was linked to opportunities for poor and disadvantaged workers. Raquel Pinderhughes, of the Department of Urban Studies and Planning at San Francisco State University, defined "green-collar" jobs as blue-collar work force opportunities created by firms and organizations with a strong environmental and social consciousness. This notion of green jobs has also been promoted by such organization as the Apollo Alliance, the Ella Baker Center, and Green for All (11).The green economy came to be increasingly associated with energy and climate change issues during the 2000s, although green job claims were still being used rather narrowly to advance the causes of various interest groups. In 2001, for example, the World Wildlife Fund argued against drilling in the Arctic National Wildlife Refuge by claiming that the jobs created from development of alternative energy sources would exceed the number of jobs created by drilling. The group published a study claiming 1.3 million new jobs by 2020 from energy efficiency policies and development of renewable energy resources. The biofuels, wind, and other alternative energy industries explicitly exploited the job-creation potential of their interests as they lobbied for production tax credits and renewable energy portfolio standards that would directly benefit their industries.

The popular appeal of a more broadly-defined concept of green jobs as economic development strategy was evident to political candidates in the 2004 elections. The Pew Center on the States noted that several presidential candidates promoted the job-creating potential of clean energy jobs (12). By the 2008 elections, green jobs were a prominent theme in national as well as state-level campaigns.

The popularity of an economy-wide notion of green jobs was cemented after massive job losses from recession beginning in 2008. The promise of green jobs came to be viewed as a potent palliative to offset recession-induced job losses, especially those in traditional extractive and manufacturing industries. By 2010, the job-creating promise of the green economy movement has all but upstaged its original environmental benefits foundations. The development of alternative energy sources and other green policies are now being promoted as economic development strategies with inevitable and positive outcomes, particularly at the state level.

Green Jobs Policy Foundations

The gradual evolution of the green jobs movement has occurred against a backdrop of geo-political and economic events and federal and state policy responses to those events. Some of the underlying policy foundations for current as well as future green jobs are highlighted below.

Federal Influences

Many of the "green" jobs in today's economy owe their existence to federal policy initiatives in four key areas: environmental policy, energy policy, green government initiatives, and labor policy. Several executive and legislative bodies are active in policy development related to the green economy. They include the Environmental Protection Agency; the Department of Energy; the Department of Labor; the Department of Agriculture; the U.S. Senate Committee on Environment & Public Works - Subcommittee on Green Jobs and the New Economy; and the U.S. House of Representatives Energy and Commerce Committee – Subcommittee on Energy and Environment.

Environmental Policy

The goals of environmental policy include conserving natural resources, limiting human exposure to hazardous substances, and providing mechanisms to reclaim contaminated resources and regions.

Environmental policy changes are frequently motivated by environmental disasters. A growing public awareness of environmental issues, as evidenced by the 1970 Earth Day demonstrations nationwide, led to the creation of the Environmental Protection Agency and a series of environmental regulations throughout the 1970s. Acid rain issues and a depleting ozone layer led to restrictions on coal burning power plants and chlorofluorocarbon products like refrigerants and common aerosols. Global climate destabilization emerged as a new environmental policy challenge during the 1990s; however, efforts to address carbon and other greenhouse gas emissions through domestic policy have been significantly unsuccessful thus far in the U.S.

Key elements of federal environmental policy include the Clean Air Act, Clean Water Act, the Superfund Act, and their subsequent amendments. These Acts set limits on point and non-point emissions from industrial and other sources.

Energy Policy

Energy policy goals include increasing energy security by reducing dependence on imported and/or non-renewable energy sources, either through development of alternative energy sources or improved energy efficiency.

Shifts in the direction of energy policy are often driven by energy prices and geo-political events. For example, interest in developing domestically-produced alternative energy sources rose after the oil embargoes of the 1970s (13). Interest in alternative energy sources such as biomass and wind energy systems again received heightened attention in the early part of this decade in response to energy

security concerns related to our relationships with foreign suppliers. This heightened concern coincided with wars in Iraq and Afghanistan, diplomatic tensions with Iran, political instability in other oil producing areas like Nigeria and Venezuela, and disruptions to our own oil production and refining systems caused by hurricanes Katrina and Rita in 2005.

Some energy policies have promoted the development of alternative energy sources. Such policies have employed the use of tax credits and other incentives as well as federal and state mandates for production and consumption of alternative energy sources. Examples include production tax credits for wind energy and blending requirements for ethanol.

Other energy policies set minimum efficiency standards for buildings, automobiles, and other products. For example, the Energy Star program identifies products in six broad categories that meet standards for consumption of electricity.

More recent federal actions such Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 both provided incentives to accelerate research and development into renewable energy, to mandate the production and consumption of biofuels and advanced biofuels, amended automobile mileage objectives, and created training programs for energy efficiency and renewable energy workers. These acts provided a wide array of market enhancing and policy driven incentives to develop, manufacture, and deploy energy reducing technologies and services.

Both acts were boosted in part by the American Recovery and Reinvestment Act of 2009, which contained several economic stimulus related provisions. ARRA provided $45 billion for several green-oriented objectives. Much of the funding was dedicated to energy conservation programs and weatherization projects for homes, public institutions, and firms. Another large block of spending was directed at smart grid technology and deployment to facilitate, for example, extracting wind energy from highly yielding yet remote regions. Important fractions of the spending were dedicated to fossil fuel R & D and separately to renewable energy activities, programs, construction, and research. Programs to develop green jobs via targeted training and education programming amounted to $1.1 billion.

"Green Government" Initiatives

Green government initiatives may have environmental, energy-use, and job creation goals. These often serve two purposes: energy efficiency mandates to reduce the costs of government coupled with procurement programs to help create markets for targeted products and services. Some are included within energy bills, and others are issued via executive orders.

The buying power of the federal and state governments can help create markets for desired types of products and services. In addition, these programs have a "lead by example" quality that may encourage more widespread adoption of products and practices by the public.

Nationally, the National Energy Conservation Policy Act (NECPA) and the Energy Policy Act (EPACT) have established a wide array of energy and resource conservation mandates and guidelines. Among them include goals to reduce energy use intensity, meter public buildings, establish guidelines for the procurement and use of energy consuming products and systems, develop federal building performance standards, establish goals for federal renewable energy use, and to reduce water consumption.

Within agencies, there may be much greater types of specificity regarding departmental goals and preferences. For example, a procurement program developed by the U.S. Department of Agriculture specifies preferences for the following types of products (14)

- Recycled content
- Energy-efficient products
- Bio-based products
- Environmentally preferable products – "products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, or disposal of the products or services"
- Green electronics (Electronic Product Environmental Assessment Tool (EPEAT) Products, EPA), which all must be Energy Star products
- Water efficient (WaterSense products, EPA)
- Non-Ozone depleting (Significant New Alternative Policy (SNAP) products, EPA)
- Alternative fuel vehicles and alternative fuels

Labor Initiatives

Labor policy goals include promoting the welfare of workers and advancing their opportunities for profitable employment and ensuring an adequately trained workforce to meet the demands of a changing economy. Jobs associated with a transition to a green economy cover a wide spectrum in terms of educational requirements, pay, and job safety.

Key labor initiatives directly affecting the workforce with environmental components or subcomponents include the creation of the Occupational Health and Safety Administration of 1970; the Green Jobs Act of 2007; and the American Recovery and Reinvestment Act of 2008.

State Policies and Mandates

States have been active in setting policies to speed the transition to a green economy. Many of these are motivated by economic development concerns as states jockey for position in attracting alternative energy producers and suppliers. Others are motivated by regional competitive production or resource advantages. As examples,

- As of December 2009, 32 states had mandatory renewable or alternative energy portfolio standards (15).
- 38 states provide incentives for the production and use of ethanol. Twelve of those 38 have developed their own Renewable Fuels Standard (16).
- 15 states have energy efficiency standards for appliances that exceed federal standards (17).
- 24 states require LEED or equivalent green building rating standards for new state buildings (18).
- States vary in the stringency of their residential and commercial building energy codes. Such codes generally specify requirements relating to heating and cooling loss from the building shell and windows and minimum efficiencies for heating and cooling equipment. Typical standards used include the International Energy Conservation Code (IECC) produced by the International Code Council, and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (19).

Other National and International Organizations

Several governmental consortiums and non-governmental organizations have been investigating the job growth potential and other social and economic implications of a transition to a greener economy. The research and lobbying efforts of these organizations may factor into policy development at the local, national, and international levels. Such organizations include:

- OECD The Organization for Economic Cooperation and Development recently noted several "OECD countries are hoping green industry will be an antidote to unemployment." They are active in both researching and coordinating policy related discussions that will facilitate dialogue across borders. Most importantly, they note, green job growth will be driven most significantly not by recovery-related fiscal policy, but by coordinated carbon reduction policies.

- UNEP The United Nations Environmental Program. In their recent report, "Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World," UNEP notes that worldwide investment patterns are changing as nations begin to cope with climate change issues. These changes are creating work opportunities as well as work losses. They note four dynamics:

  (1) new jobs will be created in manufacturing and in services that must address and maintain pollution controlling devices;
  (2) some employment will be substituted as economies shift to lower levels of fossil fuel dependence;
  (3) some jobs will simply be eliminated as there will be no demand for them; and
  (4) many jobs will transform to be able to accommodate new energy and conservation standards.

  They also are mindful that there are an array of critical drivers to create the conditions and the reality of green job generation, to include carbon markets, direct subsidies and tax credits, international assistance to poor nations, and mandates.

- OPEC The Organization of Petroleum Exporting Countries. OPEC exerts a tremendous influence over the supply and price of large fractions of the world's oil via production quotas among its members. The organization is sophisticated and has a very well researched understanding of world energy markets and inter-country behavior. It is well-researched on issues affecting supply, demand, and price, and it knows that instability in oil prices can lead to rapid adoptions of alternative energy systems or conservation initiatives, which in turn can have an impact on demand. While OPEC can ultimately exert strong economic power via supply manipulation, there are limits economically and politically to their power to influence environmental legislation and energy conservation activities.

- International Climate Change Initiatives. Beginning with Kyoto in 1997, as of 2009, 187 nations have ratified its major protocols. Chief among them, the signing nations commit themselves to reducing major greenhouse gas emissions. These activities were moved into the present at the 15th Conference of the Parties (COP 15) to the United Nations Framework on Climate Change and the 5th Meeting of the Parties (COP/MOP 5) to the Kyoto Protocol in December, 2009, where a successor to Kyoto was to be produced. The US, China, India, Brazil and South Africa drafted an accord that acknowledged that climate change is one of the greatest current challenges and that action needs to be taken to limit further warming of the climate.

- Organized Labor and Major Business and Industrial Trade Groups. On the polarizing issue of global climate change, job impact claims have been used to both thwart and support efforts to limit carbon emissions. There are generally tensions driven by dominant trade groups and labor groups as they fight to maintain their competitive positions or protect existing jobs. For example, negative job impact arguments helped to block U.S. participation in the Kyoto Protocol toward the end of the Clinton administration, and which were maintained through the G.W. Bush administration. In that instance, the AFL-CIO claimed that the treaty would result in millions of lost U.S. manufacturing jobs. Just 10 years later, the AFL-CIO has endorsed efforts to address climate change because of the opportunities it represents for the manufacturing sector.

  Alternatively, the National Association of Manufacturers, while advocating for emissions inventory along with greenhouse gas reduction reporting system, is adamant that climate change legislation that does not include global participation would ultimately impose undue competitive burdens and cost jobs in the U.S. Without mandatory global participation, they argue, no deal.

  The U.S. Chamber of Commerce, a very powerful national organization, also promotes both public and private investment in clean technologies and alternative energy sources and initiatives to improve energy efficiency. It, however, adopts an “all of the above” energy policy which includes aggressive development of U.S. energy sources to include expanded oil exploration and clean coal demonstrations.

Section 2. Green Jobs Measurement

While general agreement may indeed exist considering a broad array of green economy goals, despite the absence of a well defined conceptual framework for evaluation in the social sciences, it is nonetheless important for federal, state, and local governments to align their initiatives around defensible agreed-upon definitions of green activities for the purposes of economic and environmental policy planning as well as program funding. Lacking such an alignment, there is the potential of definitional anarchy as each state, agency, or special interest seeks to define green activities in manners that protect their regional economic or institutional prerogatives.

Definition and Categorization

Examining some of the diverse goals and expectations for the green economy helps to explain some of the difficulty in defining a green job. Broadly, a green job might produce a good or service that achieves any of the following laudable outcomes:

- Environmental protection – Examples might include environmentally beneficial industrial process changes, and lessening solid waste and potential exposure to hazardous wastes through integrated waste management, remediation, re-use, and recycling activities

- Climate change mitigation – Here the objective would be reduced domestically-caused carbon dioxide and other environmentally deleterious emissions

- Energy security – By replacing petrochemical imports with domestically-produced and environmentally sustainable energy sources, we reduce our economic vulnerability to unstable or unfriendly foreign energy suppliers

- Energy and natural resource conservation – Lower consumption of energy, water, and other natural resources through improvements to the efficiency of buildings, products, distribution, and other transportation systems allows us to get more private and public goods with fewer natural resource inputs

Green jobs and green economic activity may also further secondary regional and national objectives such areas as:

- Social – In many areas of the U.S. there is the need to create opportunities for upward mobility for the poor by providing safe jobs that pay a living wage and providing education and retraining to disadvantaged workers; and revitalizing urban neighborhoods by retrofitting and improving homes and buildings, which will lower energy costs for low-income residents and provide job opportunities in those neighborhoods.

- Economic – Among these would include rejuvenating portions of the domestic manufacturing sector by replacing jobs lost from out-sourcing or overall global competition, developing new markets for producers of agricultural commodities, and assisting in stabilizing rural areas.

However desirable those outcomes, it is generally the case that “green” initiatives in and of themselves do not presuppose *a priori* either poverty reduction or serious economic revitalization as their core objectives.

Baseline Estimates

To date, there have been many and quite varied approaches to isolating what constitute a green job. Among these, four standard green job characterizations stand out. Jobs may be green by virtue of the product made, the process employed, the industry in and of itself, or the occupational characteristics of the job-holder.

Green Product Approach

Green products and services are identified as meeting or substantially contributing to agreed-upon environmental and conservation objectives, and then estimates are derived for the number of jobs involved in the production or delivery of those products and services to intermediate or final users. For the product selection, many studies use lists of green products identified by federal procurement programs. Hybrid or electric automobiles, triple-pane windows, insulation products, and energy monitoring and management systems would all be considered green products.

In so doing, these studies tend to rely on the federal government's official list of products or industries to determine what constitutes a green product. Those categories include

- Energy Star products
- Federal Energy Management Program (FEMP) products (U.S. Department of Energy)
- Environmentally Preferable products (EPA)
- OEPNU Biobased products (U.S. Department of Agriculture)
- Energy Star qualified homes
- Leadership in Energy and Environmental Design (LEED) certification

The strength of this approach is that it identifies tangible and commonly agreed-up products or activities. A weakness of the approach is that it relies on census of industry data which are collected in 5 year cycles making trend analysis and short term, research based policy adjustments infeasible. Additionally, detailed industrial summaries are not available to non-governmental researchers. Another weakness is that it fails to capture green activities that are not directly associated with the production of a particular product or service, such as energy conservation within a firm.

Green Process Approach

There is a wide range of industrial activity that involves active waste management, treatment, inputs re-use, and systems of recycling. These activities would be firm specific, and they might involve the activities of energy use monitoring and efficiency maximizations, establishing waste management and inputs re-use protocols, or devising systems to reduce natural resource inputs.

There have been multitudes of environmental and occupational protection rules implemented over the years, and businesses have incrementally adopted standard and processes that reduce air and water emissions and solid wastes. Incremental energy spikes have also induced industrial efficiency measures ranging from retrofits to airline wings or over-the-road tractor trailers, to waste water, solvent, or other industrial oils re-use activities.

Green processes are ongoing and have been a significant component of modern manufacturing and other industrial processes since the origins of both the Environmental Protection Agency and the Occupational Safety and Health Administration in 1970. Accordingly, establishing meaningful and area-specific baselines for green jobs using a process-based approach would be problematic and involve

expert and on-site evaluation. The use of secondary data sources for such determinations would not be possible.

Green Industry Approach

A green industry approach identifies specific industries that have a high likelihood of, or high fraction of firms, producing green products or services or engaging in green production processes. For example, because many electronic appliance manufacturers produce Energy Star-qualified products, the appliance manufacturing industry might be characterized as a green industry under this approach. The same might be the case for a plant that manufactured electricity generators which may be used in wind turbines.

The strength of this approach is that a wide variety of employment, firm, and other data are organized at the industrial level of detail. This makes modeling potential green scenarios much easier. In addition, the data provide a range of dimensions for evaluation considering the range of environmentally desirable products or services as well as the jobs required to produce them.

The weakness of the approach is that it is highly likely that the number of green jobs is over-described because the industrial classification schemes are not detailed enough to distinguish green products and services from similar, non-green products and services or otherwise apportion the productivity that is generating green products distinct from non-green products.

Green Occupation Approach

Knowing how green industries are staffed is another important piece of policy planning information. Although jobs identified using a green industry approach may produce occupational counts associated with green production or services, those jobs, in and of themselves, may not be green occupations.

A green occupation evaluation begins by identifying specific jobs related to the environment, energy production or conservation, etc. Examples might include environmental engineers, architects, biologists, agronomists, hydrologists, and resource recovery or reuse specialists to name just a few.

The strength of a green occupation approach is that it is less likely to over-describe green jobs because it is based on the work that people actually do rather than the type of firm in which they are employed. The weakness of this approach is that it will undercount the support jobs that may be necessary to sustain green production activities.

Integrated Approaches

Limits to the either the industry or occupational approaches prevent the full use of information for policy planning purposes. These limits involve the timeliness of data collection, the detail to which evaluators have access to secondary data, and the overall reliability of green job or occupation definitions. To overcome these limits, many green jobs measurement initiatives have adopted an integrated approach that combines elements of two or more approaches. In addition, many utilize a combination of survey data and secondary data to address serious limitations in current availability of data, especially those supplied by federal sources. Examples of these studies include several state-level initiatives described in greater detail in Section 3.

The strength of these integrated approaches is that they allow for the establishment of state-level baselines in the absence of either concrete definitional foundations or federally-distributed secondary data. The weakness of state-level research efforts is that they significantly profile and promote regional

industrial prominence in the measured categories without informing a broader understanding of regional or national relationships, and the position the particular state might play over time.

Growth Projections

The potential growth of green jobs is an important selling point for green policies. In addition, green jobs growth projections have an important workforce development component. If indeed there is an emerging green economy that will place specific demands for particular industrial products and services as well as particular types of occupations, business, government, and education planners need to know what those occupations are. Not all emerging green jobs will require newly trained individuals. Some jobs will fundamentally be similar to earlier characterizations but will require either an enhancement in skills or in knowledge.

Basic Approaches

Green jobs projections are typically obtained by first estimating future demand for a particular green product or service in terms of industrial output, and then applying the change in output demand to an existing labor-to-output ratio. This is the approach employed for studies that examine the potential job needs from expanded use of alternative energy sources such as wind, solar, and biofuels. These efforts typically run the risk of failing to account for potential advances in technology or economies of scale, but basic projections are relatively straight-forward and methodologically sound.

Where the relationships between a green job and a green product or service are less clear, we must rely on indirect projection methods and sources. An initiative funded by the U.S. Department of Labor Employment and Training Administration provides a basic framework for characterizing potential drivers for green job growth. This framework includes additional sources of job growth from increased skill and knowledge demands placed on existing occupations, and the emergence of entirely new occupations to satisfy the needs in emerging areas of importance.

Estimating Offsetting Job Losses

In projecting the potential new jobs from a green economy, especially as those jobs are implied to be linked to net new economic activity, it is important to consider the likely job losses that will result in other areas of the economy. For example:

- The use of bio-based inputs for consumer goods such as carpet, paint, candles, or even motor vehicle fuels displaces other petroleum-based inputs. The employment impacts of the increased adoption of bio-based products should include offsets, to the degree that they can be described, from reduced demand for the petroleum-based products they displace.

- Absent overall changes in consumer demand, the manufacture and sale of energy-efficient consumer goods such as Energy Star appliances displaces demand for their less energy-efficient counterparts. In this case, designating jobs associated with the more energy-efficient products is simply and significantly a relabeling of existing manufacturing jobs.

- Increments to clean energy production will produce jobs in industries generating capital goods and providing utility services. Those gains will come at the expense of traditional energy suppliers, to include indirect impacts on coal and natural gas mining.

Some researchers have acknowledged the tradeoffs involved in a shift to a green economy. As examples, Pollin and Baker (33) claim that enhanced investment in "… clean energy development is a

powerful source of job creation in the U.S. relative to major alternative spending targets, including the military and fossil fuel industries (p. 18)." In this case offsets in funding priorities are implicitly acknowledged. And Weinstien, et al, (34) remind us that "a larger green energy sector comes at the expense of employment in the fossil fuels industry (p ii)."

Still, few projection studies have attempted to estimate offsetting job losses in traditional industries associated with increased adoption of green products or technologies. This is due, at least in part, to the difficulty in modeling inter-industrial transactions and behaviors during a period of industrial uncertainty, as would be the case in a policy-driven green transformation of the economy.

Another reason for the absence of information about offsetting job losses may be related to the sources used for many green jobs projections. Many studies have relied on figures provided by industry trade groups such as the American Wind Energy Association and the Renewable Fuels Association. These groups, which lobby for policies favorable to their industries, have little incentive to estimate or publicize the negative or job-offsetting impacts of their own growth on other industries.

Labor organizations are somewhat unique among special interest groups in attempting to quantify potential job losses that will accompany a greener economy. Several labor organizations, both domestic and international, are trying to ensure that green government policies acknowledge and address these potential job losses. Such organizations include the Blue-Green Alliance, a national partnership between labor unions and environmental organizations, and the Green Jobs Initiative, an international partnership between the United Nations Environment Programme, the International Labour Organization, the International Organisation of Employees, and the International Trade Union Confederation (35).

Studies sponsored or conducted by Federal agencies are more likely to attempt to quantify both positive and negative economic impacts associated with a greener economy; however, not all of them do. For example, a recent Department of Energy wind study failed to estimate the number of displaced jobs associated with a 20 percent wind energy scenario. Though that estimation absence is acknowledged, it is not possible for readers to understand what in fact might constitute net job gains (17).

Another limitation of many government-initiated studies is that they generally focus on specific bills or initiatives rather than the green economy as a whole. In addition, such studies usually measure changes in total output or GDP and are less frequently translated into numbers of jobs. An exception was a recent report by the Congressional Budget Office report that estimated potential job impacts of a cap and trade system for regulating carbon emissions (36).

Other Challenges to Projecting Green Job Growth

Beyond the definitional issues of which products, industries, or occupations are to be considered "green," and uncertainty about the future labor needs of green industries, there are several other important considerations when describing potential growth in green jobs. First is consideration of the validity of sources and methodologies underlying many green jobs claims. In addition, owing to the demonstrated cyclical nature of green job initiatives, possible short-term and long-term policy shifts that might change incentives for investment in the green economy need mentioning.

Validity of Underlying Assumptions

- To date, nearly all green job growth efforts have focused on identifying direct jobs associated with a particular industrial activity or process. In time, it is likely that policy makers will demand economic impact summaries that anticipate indirect job growth and induced economic activity associated with particular types of green industrial activities. Recent policy advocacy evidence suggests that there is a high likelihood that both government agency and interest groups will seek to maximize the public's perception of potential job gains. As notorious examples, corn based ethanol and bio-diesel developments in the Midwest have frequently significantly overstated net regional job gains due to both the misapplication and misinterpretation of economic multipliers.

- Attributing characteristics of demonstration-scale projects to commercial scale operations is another issue that must be addressed. There are anticipated technological innovations and deployments that are expected to yield future environmental benefits. The feasibility, ultimate configuration, and the scope of these technologies may be mis-anticipated and result in errors in both job projections by type and by region. An example here might include cellulosic ethanol. The EISA calls for 100 million gallons for 2010, with production roughly doubling annually through 2014, and maintaining an annual rate of growth of 120 percent through 2022. To date, there is no commercially viable configurations producing that much cellulosic ethanol, which raises therefore serious questions about growth estimates that may be factoring in that type of fuel production.

- Adding up multiple-year job impacts – The wind industry has been fighting for a permanent wind energy production tax credit. Like nearly all green policy advocates, it uses jobs to advance its argument. To promote job claims, analysts combine research-based technical specifications with input-output economic models of state or regional economies to anticipate before and after effects or to attempt to provide policy makers with estimates of the annual job or income value of a particular type of change over a period of time. These projection exercises are designed to produce results that make sense primarily on an annual basis, or as a comparison of a future level of activity against a current baseline. For example, if the deployment of new wind generation capacity supported 1,000 construction jobs in year one and 2,000 jobs in year two by installing twice the capacity as was installed the year previous, we would say that an average of 1,500 construction related jobs were sustained annually over the two year period. It would be incorrect to sum the two years to claim that 3,000 jobs were added to the economy. As an example of this type of jobs over-statement, a recent Department of Energy-sponsored wind study looks to have carefully measured potential jobs from a 20 percent wind scenario by 2030, but then adds up the annual job impacts, which double counts by adding previous installations to the amounts added in successive years to achieve a cumulative number of jobs for a 24-year period (37). Many readers might easily mistake this inappropriate jobs summary as the number of new jobs that were estimated to still exist at the end of the projection period.

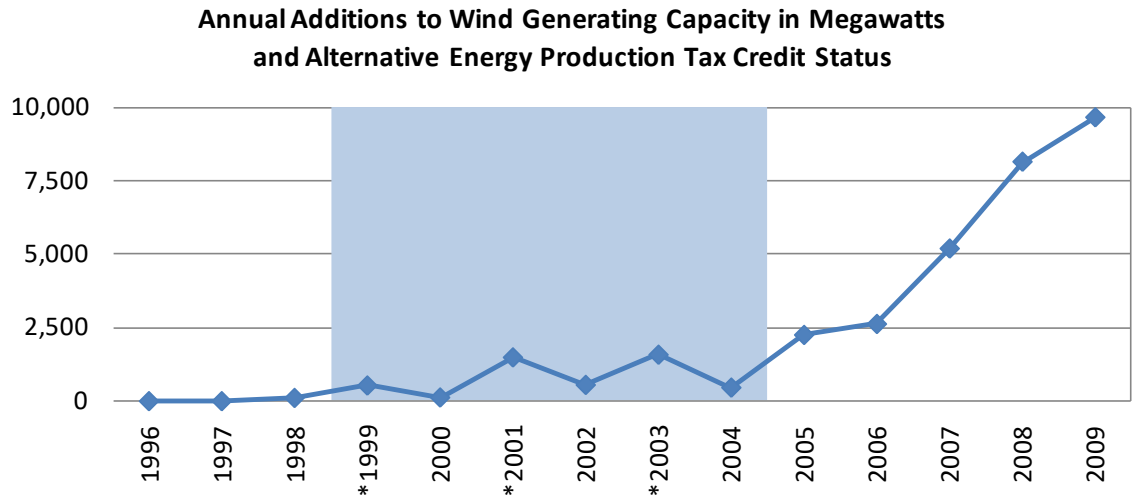
Effects of Policy Changes

Any projections for growth in green jobs must be viewed within the context of likely policy developments. History has demonstrated that short-term policies and longer-term policy direction can influence investment in green technologies, capital, and education and occupational programming.

Short-term policy decisions and uncertainty may impact the growth of a green economy. A well-cited example is the pattern of investment in new wind-generating capacity in relation to the expiration of the alternative energy production tax credit. Wind energy is widely viewed as a major potential source of green jobs growth in the United States, with growth demanding specialized manufactured inputs as well as utility workers and trained repair workers.

Figure 2 below illustrates annual additions to wind-generating capacity in the United States. The data come from the Electric Power Annual 2009, of the U.S. Energy Information Administration. The production tax credit was allowed to expire for a short time in 1999, 2001, and 2003, but was eventually extended each time. The credit was most recently extended in the American Recovery and Reinvestment Act and is set to expire in 2012. The period of uncertainty over the tax credits extends from 1999 through 2004, and is shaded in the chart. Investments dropped notably in the years following the expiration of the tax credits. Periods of uncertainty like that can have a chilling impact on investment decisions and work to thwart policy goals. A similar argument can be made regarding biodiesel production and investment in the U.S. where production tax credits have lapsed, and there has been no national legislative action attending to the issue.

Figure 2

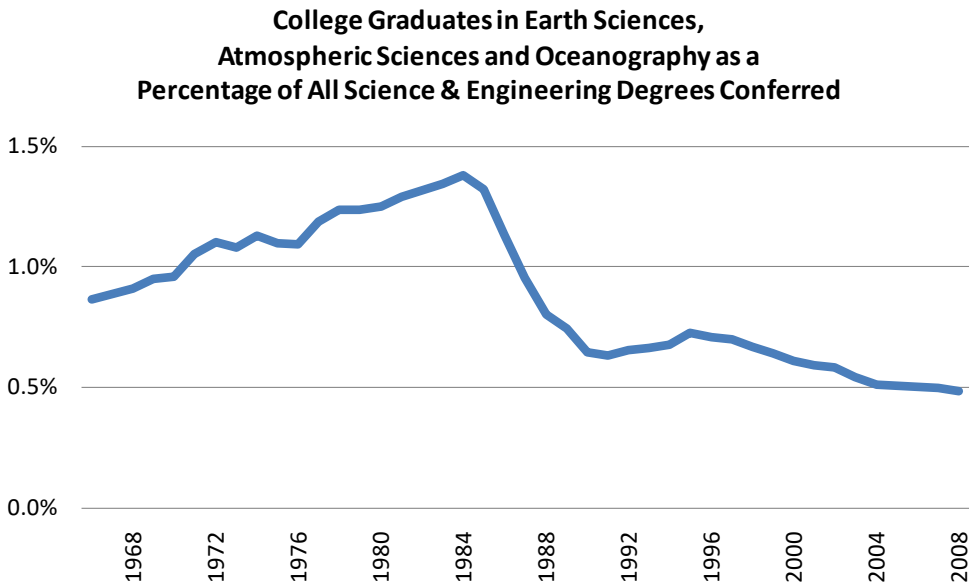


* Production tax credits expired at the end of years marked

Longer-term policy direction also influences investment decisions relating to the green economy. An illustration may be found by looking at the number of earth science graduates as a fraction of all science and engineering graduates in U.S. colleges and universities during the last four decades, illustrated in Figure 3 below. This information is from the National Center for Education Statistics (NCES) of the National Science Foundation. Degrees in these fields grew in popularity during the 1970s, a period of heightened environmental policy activity; however, even at their peak in 1984, they accounted for only 1.4 percent of science and engineering graduates. Education decisions will tend to lag occupational opportunity announcements, which might explain a continued rise in these degrees through 1984, well into the presidency of Ronald Reagan where many federal environmental initiatives were shelved, eliminated, or otherwise curtailed. The number of degrees conferred recently is low. Despite the recent and growing attention on global climate change, degrees conferred in these fields accounted for less

than ½ of one percent of all science and engineering degrees in 2008 -- the lowest fraction in more than four decades.

Figure 3



As this example illustrates, any projected growth in green jobs must be evaluated within the context of both the current and future policy environment. In the near term, green job development will be driven significantly by federal policy development.

The most pertinent contemporary direct and indirect policy boost in industrial production and service shifts towards cleaner energy usage and resource conservation would come from the passage of energy conservation incentives and carbon production limits in the U.S. Congress. Those incentives and limits, as currently exemplified in the Waxman-Markey legislation has only passed in the U.S. House of Representatives. It required that 20 percent of retail electricity demand come from renewable sources or efficiency savings, enabled research into increased domestic energy production, and provided for a cap and trade mechanism with a goal of reducing greenhouse gas emissions in the U. S. to 85 percent of 2005 levels by 2050. That bill has stalled in the U.S. Senate, and will likely not be addressed in the 2011 fiscal year. Accordingly, as regards to U.S. policy, current indications suggest standards and initiatives that are somewhat less robust than the Waxman-Markey bill would have demanded.

Section 3. Review of Selected Green Jobs Measurement Initiatives

There have been several organizational, state, and federal efforts to quantify the number of jobs in the states and the U.S. in total that would in one way or other count as green labor. Those research efforts have relied on secondary administrative data, proprietary data sets, and survey data. The findings vary widely. Following is a selected evaluation of the research, findings, or initiatives.

Current and Potential Green Jobs in the U.S. Economy. Global Insight

Global Insight issued this study for the United States Conference of Mayors and the Mayors Climate Protection Center (3). They expansively described green jobs as

> … any activity that generates electricity using renewable or nuclear fuels, agriculture jobs supplying corn or soy for transportation fuel, manufacturing jobs producing goods used in renewable power generation, equipment dealers and wholesalers specializing in renewable energy or energy-efficiency products, construction and installation of energy and pollution management systems, government administration of environmental programs, and supporting jobs in the engineering, legal, research and consulting fields (p. 5).

Their findings, as with the case of the Pew study described next, rely on the National Establishment Time Series (NETS) data set, which allows for analysis and aggregations beginning with business establishments and their basic economic characteristics. The focus of the research is to identify both national level green job potential as well as prospects for metropolitan areas, to include existing and 2038 forecast green jobs by metropolitan city.

Table 1 displays their national findings. The highly technical category of engineering, legal, research and consulting accounted for 56 percent of green jobs, with renewable power generation trailing far behind at 17 percent. Of all green jobs, as many as 85 percent were found in metropolitan economies, and the remaining are in non-metro areas. In fact, they note that the nation's top 10 metropolitan areas accounted for nearly a quarter of all green jobs as they define them.

Table 1

Global Insight: Green Jobs, 2006

Global Insight	2006	Percent of Total
Total Green Jobs	751,052	100.0%
Renewable Power Generation	127,246	16.9%
Ag and Forestry	57,546	7.7%
Construction & Systems Installation	8,741	1.2%
Manufacturing	60,699	8.1%
Equipment Dealers & Wholesalers	6,205	0.8%
Engineering, Legal, R&D, & Consulting	418,715	55.8%
Government Administration	71,900	9.6%

Figure 4 provides the Global Insight green jobs forecast. From a base of three quarters of a million in 2006, their growth scenarios anticipated 3.3 million green jobs in 2018. To achieve that growth, compounded annual growth from 2006 would 13.1 percent. Thereafter, the growth rate slows to 2.5 percent annually through 2028 where 4.2 million jobs are forecast, and 1.6 percent per year through

2038 topping out at 4.97 million jobs. By their measure, we are currently in the highest green jobs boom period.

Figure 4

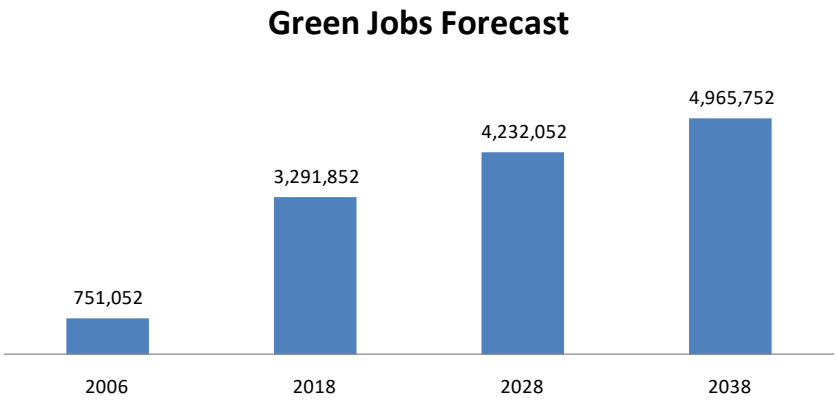


Table 2 displays the forecasted jobs by broad category. These categories do not align cleanly with those provided in Table 1, making it difficult to track all categories of expected growth. Readers will notice the forecast pegs the job demands for residential and commercial retrofitting at a fixed level through the estimate period. Strong growth is evident for renewable power generation and the engineering, legal, research and consulting group as well. This forecast, likely driven by the EISA renewable fuels mandates and expectations for robust advanced biofuels growth, also anticipates 1.2 million new jobs in the production of renewable transportation fuels, though growth in that category slows over the remaining two periods. Relatively sharp growth, however, is expected in renewable power generation over the final two decades of the estimate. Where that category is expected to supply 16 percent of all new green jobs in 2018, by 2038 they will explain just under 30 percent. Based on these estimates, the authors concluded that perhaps "10 percent of new job growth over the next 30 years" will be in green jobs.

Table 2

Forecast New Job Growth Levels by Category

	2018	2028	2038
Renewable Power Generation	407,200	802,000	1,236,800
Residential & Commercial Retrofitting	81,000	81,000	81,000
Renewable Transportation Fuels	1,205,700	1,437,700	1,492,000
Engineering, Legal, R&D, & Consulting	846,900	1,160,300	1,404,900

The renewable transportation fuels job growth expectations warrant brief comment as an illustration of why the Global Insight forecast is likely to be overly optimistic. In 2008, using County Business Patterns data, there were roughly 65,000 jobs in U.S. petroleum refineries, a very large fraction of whom would be producing motor vehicle fuels, and slightly fewer than 8,000 jobs producing ethyl alcohol, which is

also a motor vehicle fuel. Counting just factory production and not distribution, only 73,000 U.S. jobs produced 3.3 billion barrels of finished motor gasoline in 2008, which included all blended ethanol, for an average fuel productivity per job at the factory of nearly 1.9 million gallons per worker (which is very close to the production average for a 100 million gallons per year ethanol plant). The Global Insight methodology likely anticipates widespread and rapid exploitation of advanced biofuels feedstocks. However, to date, there are no commercially viable operations of that kind in the U.S. In addition, existing research does not suggest future biofuels mandates will generate that level of job creation.

For example, recently completed research for the state of New York on the possibility of cellulosic production from a wide range of feedstock sources estimated that if the state could produce 354 million gallons of cellulosic ethanol a year, it would require 275 jobs at the refineries, and would stimulate 3,341 jobs statewide after considering all direct and indirect boosts in regional productivity (38). Softwood and grass biomass farming and harvesting coupled with a very high number of new transportation jobs to move biomass would explain most of the job impacts, while less than a 10th would be at the biofuels factories.

The advanced biofuels cellulosic ethanol mandate for 2018 according to EISA is 7 billion gallons. Using the New York state study data to conservatively project total direct and indirect national job growth required to produce those fuels nationally suggests that 66,065 jobs in ethanol refineries, feedstock production, transportation, and all other support industries would satisfy that mandate. Getting, therefore, from that research-based estimate to a forecast offered by the Global Insight study which is more than 18 times greater is very difficult to reconcile.

The Clean Energy Economy. The Pew Charitable Trusts

The Pew Charitable Trusts uses the term “clean” jobs, and their research relied on a proprietary nationwide data set to identify the performance of clean industrial jobs between 1998 and 2007 (2). Their report identified 770,385 clean jobs in the U.S. in 2007, a boost of 64,258 jobs or 9.1 percent compared to their 1998 estimate using the same data base.

Table 3 displays their summary. Their classifications differ markedly from those listed above in the Global Insight report, though their job totals are identical. Nearly two-thirds of clean jobs were in conservation and pollution mitigation in 2007. Clean energy jobs include those that “create, distribute, and store clean, renewable energy (p. 17).” That sector made up nearly 12 percent of the jobs. Energy efficiency jobs, many of which are energy-related white collar technical and management positions, account for about 10 percent. The remaining 14 percent are distributed across environmentally friendly production, like corn ethanol and biodiesel, and training and support jobs that educate workers in these fields.

Table 3

Pew: Clean Jobs Distributions, 2007

	1998	Percent of Total	2007	Percent of Total	Change 1998 to 2006	Percentage Change
Total	706,127	100.0%	770,385	100%	64,258	9.1%
Conservation and Pollution Mitigation	486,708	68.9%	501,521	65.1%	14,813	3.0%
Clean Energy	72,624	10.3%	89,365	11.6%	16,741	23.0%
Energy Efficiency	61,996	8.8%	73,187	9.5%	11,190	18.0%
Environmentally Friendly Production	32,278	4.6%	53,927	7.0%	21,649	67.0%
Training and Support	52,522	7.4%	52,386	6.8%	(135)	-0.3%

According to their method of assessment, the biggest boost in employment was in environmentally friendly production, which grew by 67 percent. This should not be surprising given the short-term boom in ethanol and biodiesel output last decade. Clean energy jobs, grew by nearly a quarter, and energy efficiency jobs grew by just under a fifth. Training and support jobs posted minor reductions, and the largest single category, conservation and pollution mitigation, posted just 3 percent growth.

There is an assertion in the Pew research regarding clean job growth compared to national job growth that does not align with the evidence, however. Using their data source, the National Establishment Time Series Database (NETS), Pew researchers concluded clean jobs grew by 9.1 percent over the measurement period, but that the nation's total job growth was only 3.7 percent. While this statement may be true in light of the data set that was analyzed, it is not a true statement to assert green job growth was nearly 2.5 percent greater than all jobs in the U.S. By all standard official measures, total national job growth over this period was significantly greater than Pew's clean job gains. Using BEA annual values, total U.S. jobs between 1998 and 2007 grew by 13.5 percent, nonfarm jobs grew by 14.1 percent, and the wage and salary component of all jobs grew by 8.8 percent, just a shade less than the clean job growth assertion. The NETS –based analysis by the researchers and the reported official statistics produced by the Bureau of Economic Analysis are significantly at odds and raise serious questions about the generalizability of the NETS data to the national economy and Pew's conclusion that clean job growth outpaced total job growth in the U.S. in the period of measure.

Measuring the Green Economy. U.S. Department of Commerce

Having conducted a wide-ranging review of the aforementioned green job estimate efforts and others, the U.S. Department of Commerce produced a separate and much more comprehensive accounting of green jobs in the U.S. Their designation begins with the production of green commodities or services, which are those that conserve energy and other natural resources and those that reduce pollution (4). The Commerce study has access to the millions of industrial surveys that are accumulated and analyzed as part of the quinquennial economic census effort. In so doing, they identified 497 product or service codes, using a narrow definition of what constituted green economic activity, and 732 codes considering a more expansive definition. Using shipments and receipts data for the firms, they then allocated industrial jobs in those narrow industrial classifications roughly in proportion to sales. Their data are based on 2007 survey collections.

Table 4 provides their findings. They distinguish between a restricted definition of green jobs and a broad characterization. As an example, modern biofuels production, which is dominated by corn

ethanol systems, was excluded from the narrow definition but included in the broader group. Under the narrow view, there were 1.8 million jobs, and under the broader view there were 2.4 million U.S. green jobs. Extremely few green jobs were located in the agriculture sector, and over 76 percent were in services. While not presented in the table above, as measured by jobs, the narrow grouping accounted for 1.5 percent total U.S. jobs and the broad group 2.0 percent. In terms of the incidence of green jobs by broad category, about twice those rates were reported for the construction sector, but in agriculture, green jobs were a mere .3 percent of the agriculture categorical total.

Table 4

Commerce: Green Economy Jobs by Sector, 2007

	Narrow Definition	Broad Definition
	in thousands	
Agriculture	4	4
Construction (building and services)	224	304
Manufacturing	197	241
Services	1,396	1,833
Total	1,821	2,382

Commerce's estimates are 2.5 to 3 times higher than either the Pew or the Global Insight conclusions. As they are based on a tangible products or services that unambiguously conserve natural resources or lower pollution to some degree, they may suffer less from definitional ambiguity. They are also based on objective, product-based evaluations as opposed to subjective determinations of green activities. In addition, their research was quite mindful that firms produce mixes of goods, and care was taken to apportion sales and jobs to the appropriate clean product or service.

The Commerce results allow for a much more steady foundation from which to gauge future green job growth. The method and the process suffer some, however, as they are pegged at five-year intervals which may be inconvenient for policy development. In addition, while national findings are useful, there are likely significant regional variances in green job activity by size and type. Knowing those variances will further assist policy development. Regional summaries are planned for later release.

U.S. Department of Labor

Two ongoing green jobs measurement initiatives by the U.S. Department of Labor will significantly help inform green jobs research and policy development by characterizing the occupational as well as the industrial content of the green economy. Both initiatives will result in the continuous collection and publication of data related to green jobs as opposed to one-time studies.

Bureau of Labor Statistics

The U.S. Bureau of Labor Statistics (BLS) has a wealth of continuously-collected survey data that allows for cross-tabulations of industrial and occupational classifications at various levels of geographic detail. The BLS is adapting some of its industrial and occupational data programs in order to collect additional information specifically related to green jobs.

In defining and identifying green jobs, the BLS is deploying an integrated approach that looks both at industrial outcomes, i.e., the products and services generated by firms, and the processes by which industries engage in production, regardless of whether the products they produce are green or not. The data allow the identification of jobs by type by industry, to include the prevailing wages paid in those jobs.

The BLS published its final definition of green jobs in the fall of 2010 for the purposes of conducting its survey. Their goal was to produce a green jobs definition that was both objective and measurable. Accordingly, they will look both at the North American Industrial Classification System (NAICS) and the U.S. Standard Occupational Classification (SOC), and by doing so that will allow them to obtain employment, wages, and other pertinent data pertaining to the green job holders or the green industries. Their resulting Green Goods and Services (GGS) survey will identify first whether firms are producing green commodities or services as well as the number of jobs involved in that production.

The BLS's initial screening identified 333 industries (at the six-digit level) within which either green goods are services may be found. This group will, accordingly, constitute the population of firms from which the GGS survey is drawn. The survey results will be supplemented by using the Occupational Employment Statistics survey (OES) instrument, which will allow for estimations of staffing patterns, employment, and wages in firms reporting green jobs and services and those that are not. This will allow for analytic contrasts within industrial groups as well as across green classifications relating to job quality and qualifications.

The BLS has a very straightforward determination of green jobs. There are either

- Jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources, or
- Jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources.

The purpose of the GGS survey is to transform these definitions into quantified industrial and occupational outputs in order to establish a reliable green jobs and services baseline. Upon completion and review of the survey results, BLS believes its findings should help to inform federal and state policy on green job opportunities and occupational needs, and it should also assist regional policy planners in evaluating the prospects of green jobs by types by particular area of the country or by level of urbanization.

The BLS research, which is intended to produce useful results by 2012, will provide the most comprehensive industrial and occupational baseline for identifying green industrial activity, whether a product, service, or process and the jobs that staff those industries. While the BLS initiative will certainly produce the most exhaustive evaluation of green jobs in the U.S. by virtue of goods or service production or actual environmentally friendly activity, final definitions of constituent green jobs by magnitude, industry, or occupational activity for policy purposes to be applied to other governmental agencies, like the Department of Commerce or USDA, as examples, will likely be refined subsequent to the release of the GGS survey results.

Employment and Training Administration (O*NET)

The O*NET Resource Center is an occupational information network sponsored by the U.S. Department of Labor/Employment and Training Administration through a grant to the North Carolina Employment Security Commission. As part of its charge to identify new and emerging occupations, O*NET

researchers have developed information products for evaluating the education, training, and other characteristics of green jobs.

The O*NET green jobs taxonomy identifies three types of green jobs: those based on the need for new skills and knowledge within existing occupations, those that will be based on increased demand, and those that are new and emerging. The O*NET taxonomy identifies 64 existing occupations that are expected to see increased demand from existing occupational types due to the greening of the economy. Another 60 occupations are expected to change in terms of the skills or knowledge required to do the job. Another 45 new occupations are expected to emerge, either as completely new occupations or as offshoots of existing occupations.

The "increased demand" occupations currently account for 10 percent of all occupational employment in the United States. The "skills change" occupations account for 9 percent. By definition, the new or emerging occupations are small. Nonetheless, according to the O*NET taxonomy, almost 20 percent of the U.S occupational structure is employed in an occupation that has a higher probability of being impacted by the greening of the economy in some way than all remaining professions.

Further research into their findings shows that not all of the green occupations are created equal. The increased demand occupations tend to have lower-than-average wages compared to the current all-occupation average. The skills-affected occupations tend to pay higher-than-average wages. The green occupations also differ in their near-term growth projections. By applying recent employment projections by the U.S. Bureau of Labor Statistics to the green-impacted occupations identified in the O*NET taxonomy, a preliminary expectation of near-term occupational growth can be estimated. During the next 10 years,

- green demand occupations are projected to grow by 6.7 percent
- green skill occupations are projected to grow by 8.4 percent
- the weighted average for all green-impacted occupations is 7.5 percent.

The projected growth rate for all U.S. occupations from 2008 to 2018 is 10.1 percent, however, which is noticeably higher than the overall green job growth average using this basic measurement rubric. Absent new cues from the economy or policy initiatives, green jobs are currently projected to lag the overall rate of occupational growth by the O*NET measures.

State-Level Initiatives

States have been active in green jobs measurement with many studies initiated through state legislative mandates. Other states' initiatives were spurred by the State Labor Market Improvement Grant Program in the American Recovery and Reinvestment Act of 2009. That program awarded grants to thirty states' workforce development agencies in order to, among other goals, develop methods for estimating industrial and occupational employment impacts of green technology adoption.

The state of Washington was the first to complete a comprehensive, state-level assessment of green jobs. The Washington study served as a template for similar efforts in Michigan and Missouri. While their methods varied slightly, all three states adopted a similar two-stage approach to identifying their total employment in green industries and the composition of their green industrial portfolio. In the first stage, the states selected a set of industries that were likely to be engaged in selected green business activities. In the second stage, the states surveyed firms within the green industries to enumerate and characterize their green jobs.

State of Washington

The 2009 Washington State Green Economy Jobs report was completed for the Washington State Employment Security Department (39). Washington State conducted green jobs measurement studies in both 2008 and 2009. Their 2009 study expanded the scope of the 2008 study by including a broader selection of private sector industries plus adding the public sector. The Washington approach has been emulated and refined by other states.

- Washington defined the green economy as containing industries and business engaged in four core areas of activity: increasing energy efficiency, producing renewable energy, preventing and reducing environmental pollution, and providing mitigation or cleanup of environmental pollution.
- Green jobs were defined as those promoting environmental protection and clean energy activities. Only jobs directly engaged in those activities were considered green. Indirect or support jobs were not included in the definition of green jobs.
- The study began with identification of 101 6-digit NAICS industries where concentrations of green jobs were expected based on earlier research. An additional 95 industries were added to the pool using a random sample survey of firms in all other industries to identify firms with one or more green jobs.
- A mail survey was sent to a sample of 21,664 firms within the 196 selected industries. A total of 13,457 firms participated in the mail survey for a participation rate of 70 percent.
- The study estimated that green jobs account for 3.3 percent of the workforce that is covered by unemployment insurance in Washington.

State of Michigan

The Michigan Green Jobs Report 2009: Occupations & Employment in the New Green Economy, was completed for the Michigan Department of Energy, Labor & Economic Growth in 2009 (40). This study included an employer survey, secondary data analysis, and focus groups to collect both quantitative and qualitative information about the state's green jobs.

- Michigan defined the green economy as comprising industries that provide green products or services in five core business areas: Agriculture and natural resource conservation, clean transportation and fuels, increased energy efficiency, pollution prevention or environmental cleanup, and renewable energy production.
- Green jobs were defined as those involved in generating or supporting a firm's green-related products and services. Direct green jobs are those actively engaged in generating the green product or service. Support jobs are those created by the portion of the firm's revenues from green production.
- The study included firms in 691 different 6-digit NAICS codes.
- A total of 13,132 firms were surveyed by mail and 6,434 firms participated for a response rate of 49 percent.
- The study estimated that green jobs accounted for 3 percent of the state's total private sector employment. Direct green jobs accounted for 89 percent of green jobs identified.

State of Missouri

The Missouri Green Jobs Report by the Missouri Economic Research and Information Center was completed for the Division of Workforce Development in the Missouri Department of Economic Development in 2009 (41). A notable aspect of this study is that it addresses the likelihood of job displacement in other industries related to the growth of the green economy.

- Missouri's green economy definition comprises industries that provide green products or services in six broad sectors: Energy, Manufacturing, Building, Farming, Salvage/Remediation, and Government. Firms were identified as green based on their output, not their processes (i.e. a product-based approach).
- Green jobs were defined in terms of occupations, to include both primary and support occupations involved in generating a firm's green products or services.
- The study screened for firms that produce green products or services within 117 previously-defined green industries defined at the 6-digit NAICS level.
- An employer survey was conducted by telephone. The sample size for the survey was 3,880 firms, and 2,537 telephone interviews were completed for a response rate of 71.2 percent.
- The study estimated that green jobs accounted for 4.8 percent of the state's total employment. Primary green jobs accounted for 22 percent of green jobs identified.

Despite the similarity of approach, and similarity in ranges of green jobs percentages, there are still notable differences among the three studies. For example, the Washington study began with four green-economy core areas, the Michigan study had five core areas, and the Missouri study had six that aligned more closely with industrial sectors than the other two states. Researchers for the Washington study evaluated the survey responses to exclude any jobs that they considered to be "indirect," that is, all support jobs were excluded. The Michigan and Missouri survey instruments both allowed respondents themselves to distinguish between direct green jobs and supporting jobs related to their green production activities; however, the Michigan study results found only 11 percent of its green jobs characterized as indirect, or "support" jobs, while 78 percent of jobs identified in the Missouri study were characterized as support jobs.

Green Jobs: Toward Decent Work in a Sustainable, Low-Carbon World. Green Jobs Initiative

This report is a product of the Green Jobs Initiative, a joint effort by international development and labor organizations to promote awareness of a range of social and economic issues related to sustainable environmental policy. Participants in the Green Jobs Initiative include the United Nations Environment Programme, the International Labour Organization, the International Organization of Employers, International Trade Union Confederation (35).

The report provides an in-depth exploration of both conceptual and practical measurement issues related to the green jobs of the present and the future. Because it is multi-national in scope, the report also allows for an assessment of U.S. green jobs development potential from a competitive standpoint. In addition, it introduces a qualitative evaluation of green jobs that is missing from many other green jobs assessments.

Positing that not all jobs are equally green, the report utilizes a "shades of green" approach to evaluate the potential environmental benefits contributed by various green industries, production practices, and policies. For example, it ranks mass transit more highly green than automobiles, regardless of their fuel efficiency.

With a particular emphasis on the likelihood of winners and losers in the transition to a greener economy, this report is more somber in tone than the other reports evaluated above. It predicts that the greening of the economy, as with other major economic transitions of the past, will have both positive and negative social and economic consequences. It pays particular attention to the quality of green jobs in terms of career opportunities, pay, safety, and general working conditions. Many

industries typically associated with green jobs, such as biofuels feedstock production and recycling, are evaluated less positively on the job decency scale.

The employment estimates used in this report are drawn primarily from previously-published studies; however, the authors include critical evaluation of the job values when they believe them to be too high or too low. Green jobs estimates are provided by country or world region for several key sectors including energy supply; buildings/construction; transportation; basic industries such as aluminum, steel, and cement; food and agriculture; and forestry.

Section 4. Rural Development Opportunities and Constraints – A Preliminary Evaluation

The prospects for rural job growth from green products and green services appear to be muted. In addition, when comparing national estimates with some of the state evaluations, the size of green employment or the prospects for growth appear to be somewhat contradictory.

While the Department of Commerce identifies very few agricultural activities as being green (less than .3 percent of all agriculture jobs), the State of Washington's largest single group of green workers is in agriculture (39); Missouri considers small, organic heirloom crop farms as intrinsically green with great expansion potential (41); and research on opportunities in the Mid-South-Mississippi Delta region is focused on the potential for biomass development for transportation fuels (42). Michigan, another state with an energetic green jobs initiative has zeroed-in on jobs that support the production of energy reducing transportation goods, like hybrid and electric automobiles (40). Nearly 30 percent of their green jobs are engineers, production workers, machinists, and assemblers; however, the industry group with the highest fraction of green jobs is agriculture at 22 percent.

Neither the Pew findings nor the Commerce Department's research provide conclusions about green job growth potential in non-metropolitan areas. The Global Insight research provides high detail for metropolitan areas, but does not provide state-level non-metropolitan conclusions. While green job growth will be a factor nationally, the evidence suggests that the vast majority of existing green jobs and future green jobs will be either in or spatially proximate to dense metropolitan areas. Much of metropolitan U.S. is besieged with stubbornly high unemployment rates with objectively high demand for new job growth. In contrast, large swaths of non-metropolitan regions, especially in the Plains and the Midwest suffer from historically stagnant job performance and persistent outmigration.

While several states have investigated their green industries and green occupations, those efforts in many instances appear to be significantly preoccupied with green job scoring rather than strategic inputs into broad-based economic development opportunities at the regional, state, or substate levels. In fact, methods of evaluation employed by the states of Washington, Michigan, and Missouri, as examples, imply green job potential for rural areas based agricultural production and agricultural product value added activities in the main, which over time have persistently produced more and more output with fewer and fewer workers.

The booms in biofuels development and wind farms to date are considered by many as evidence of rural area green job growth potential at first blush. Now that both industries are well-established in sections of the Plains and Midwest, however, job growth reveals itself to be positive but not nearly sufficient to offset overall declines in non-metropolitan area manufacturing. Total jobs in Iowa's corn ethanol industry, for example, were fewer than 1,600 by the end of 2009, which is roughly half of the size of the vaunted Newton, Iowa, Maytag manufacturing facility at its peak, and which closed in 2007. Similarly, the nation's direct wind energy employment (at the generation facilities) in 2008 was likely fewer than 3,000 jobs. There has been growth in wind-related manufacturing jobs, many of those jobs, like base and blade manufacturing, are expected to migrate to be very close to wind energy development areas due to their bulk and other transportation issues. Higher value manufacturing of nacelle assembly systems has slowly evolved in the Midwest, as have some gears, generators, and other essential components. Nonetheless, the majority of the highest value wind energy manufactured goods are significantly of foreign origin.

To isolate metropolitan and non-metropolitan green industry growth potential, national and metropolitan establishment data from County Business Patterns for 2008 were analyzed. Using 6-digit NAICS classifications, 240 non-agricultural industries were identified as having the potential to produce green commodities or services, as suggested by the Department of Labor's broad green industry characterizations. These industries run the spectrum from firms that produce and process forest, grain or other biomass inputs, other green product manufacturing to include durable goods, service and installation, residential construction and repair, research and development, architecture and engineering, transportation, and direct energy generation. No farms are included in this assessment, nor does it include establishments without employees. Government operations are not included as well. The green industrial categories were dichotomized into those potentially making a green product as distinguished from those potentially providing a green service.

Table 5 displays the results of this investigation. While these firms are broadly defined and only have *the potential* of generating green products or services in many instances, 17.4 percent of the nation's establishments may fit into either the green production or service category. We also see that over 70 percent of those types of establishments nationally are green services. For green production, we see a slightly lower share in the metropolitan areas than the national norm, and a much higher fraction in the nonmetropolitan areas, suggesting a potential for green manufacturing and other green product development that exceeds the national average by 2.5 percentage points. Accordingly, however, its share of green service establishments, at 9.2 percent of the total is much less than its metropolitan counterpart at 12.8 percent.

These findings must be put into perspective given the previous job distribution discussions. In all cases the bulk of clean or green jobs were located in service activities, not in production activities, which favors metropolitan establishment and by extension metropolitan job growth opportunities. However, if policy evolves to demand much more green products and manufactured goods, the potential for comparatively stronger growth may align well with non-metropolitan production potentials.

Table 5

Distribution of Green Production and Service Potential, 2008, by Metropolitan and Non-Metropolitan Areas

	National	Metro	Non metro
Green Production	4.8%	4.6%	7.3%
Green Service	12.6%	12.8%	9.2%
Other	82.6%	82.5%	83.5%
Total	100.0%	100.0%	100.0%

Table 6 provides an alternative characterization of the results. Non-metropolitan areas accounted for 6.2 percent, of establishments, 9.4 percent of green production, and 4.5 percent of green service establishments. While the production specialization potentials are evident in non metropolitan areas, it is also clear that from 90.6 to 95.5 percent of green product or service establishments are nonetheless located in metropolitan regions, the nonmetropolitan competitive advantage notwithstanding.

Table 6

Distribution of Green Production and Service Potential, 2008

	National	Metro	Non metro
Green Production	100.0%	90.6%	9.4%
Green Service	100.0%	95.5%	4.5%
Other	100.0%	93.8%	6.2%
Total	100.0%	93.8%	6.2%

Table 7 displays the non-metro green industry specializations as calculated using a green industry potential location quotient from this same data base, which is simply the percent of green industries in an industrial category as a function of all green industries divided by the national percentage for the same industry. As is immediately evident, non-metro specializations are in manufacturing, agricultural services, or forestry related activities. Except for agricultural services (soil preparation and post harvest custom work) and ethanol manufacturing, all of the categories have suffered persistent establishment and employment declines over the past decade. In general, too, all of the categories are equipment and capital intensive operations with high output to job ratios.

Green job growth prospects in non-metropolitan areas are much higher in agricultural, forestry, and manufacturing related fields. Nationally, between 2001 and 2008, the nation's nonmetropolitan regions enjoyed total job growth of 7.1 percent. The nation grew by 9.8 percent, however. In explaining why nonmetropolitan areas did not grow at the national rate using a shift-share evaluation, the net of the entire deficit is explained by concentrations of industries in nonmetropolitan areas that are slow growing and a comparative paucity of fast growing firms. Nearly all of the green growth industrial categories, where nonmetro areas demonstrated competitive advantages, have been declining. None of the evidence analyzed suggests that nonmetropolitan green job growth will materially reverse those patterns of change.

Table 7

Top 20 Non Metropolitan Green Industry Specializations

	Green Industry Potential Location Quotient
Ethyl alcohol manufacturing	7.4
Logging	7.3
Pulp mills	6.0
Soil preparation, planting, and cultivating	5.9
Timber tract operations	5.5
Newsprint mills	5.4
Household refrigerator and home freezer mfg.	5.3
Support activities for forestry	5.2
Softwood veneer and plywood manufacturing	5.1
Reconstituted wood product manufacturing	5.1
Crop harvesting, primarily by machine	4.9
Wood preservation	4.6
Other postharvest crop activities	4.6
Newspaper publishers	4.5
Household laundry equipment mfg.	4.5
Forest nursery and gathering forest products	4.3
Manufactured home, mobile home mfg	4.3
Prefabricated wood building mfg	4.2
Hydroelectric power generation	4.0
Hardwood veneer and plywood manufacturing	3.9

There are many categories of green job growth that can have an impact on rural well-being. The extent to which advanced biofuels are derived from rural feedstocks and the extent to which rural areas are able to produce manufactured goods that yield green outcomes will determine in part the success of green job development in non-metropolitan areas of the U.S. It is important to remember, however, that the foregoing analysis indicates that rural areas are likely to be comparatively disadvantaged in terms of the vast majority of green job creation as those jobs will accrue disproportionately to metropolitan regions.

At a preliminary level, then, this suggests that states might need to be mindful of the limits to green job growth and develop state and substate programming that capitalizes on rural area green job development strengths with full acknowledgement of those areas' comparative disadvantages.

Section 5. Theoretical Conceptualizations of Green Jobs

Although there has been a proliferation of studies on green jobs, very few of these have been in peer-reviewed academic journals. In fact, studies on defining green jobs or the green economy are almost non-existent in academic journals in economics, public policy, and sociology. An extensive review of top journals in these fields over that last five years found only a small number of articles that addressed any aspect of the green economy at all. Of those few articles that do address some aspect of the green economy, most offer no formal or precise definition of what constitutes a green job or green industry. Most articles on this topic assume that readers already know how the green economy is defined, without providing any reference to secondary sources or any conceptual justification.

This lack of a formal definition of the green economy is a serious gap in the academic literature. Scientific inquiry is limited without proper conceptualization, which is necessary to properly operationalize concepts for hypotheses construction and empirical analysis. There is a need to specify this abstract concept of the "green economy" to make it more conceptually precise and grounded in relevant social science theory. Without this necessary conceptual grounding, any empirical analysis of the green economy will likely lack validity and reliability. In terms of validity, not having precise definitions of the concept of the green economy makes it impossible to assess whether empirical measures used to analyze the green economy actually measure what they are supposed to measure. In terms of reliability, not having a precise definition of the green economy makes replication of empirical results problematic if different measures are selected. Therefore, the purpose of this section is to review current theory and empirical research in the social sciences to derive a framework for conceptualizing the green economy.

Ecological Economics

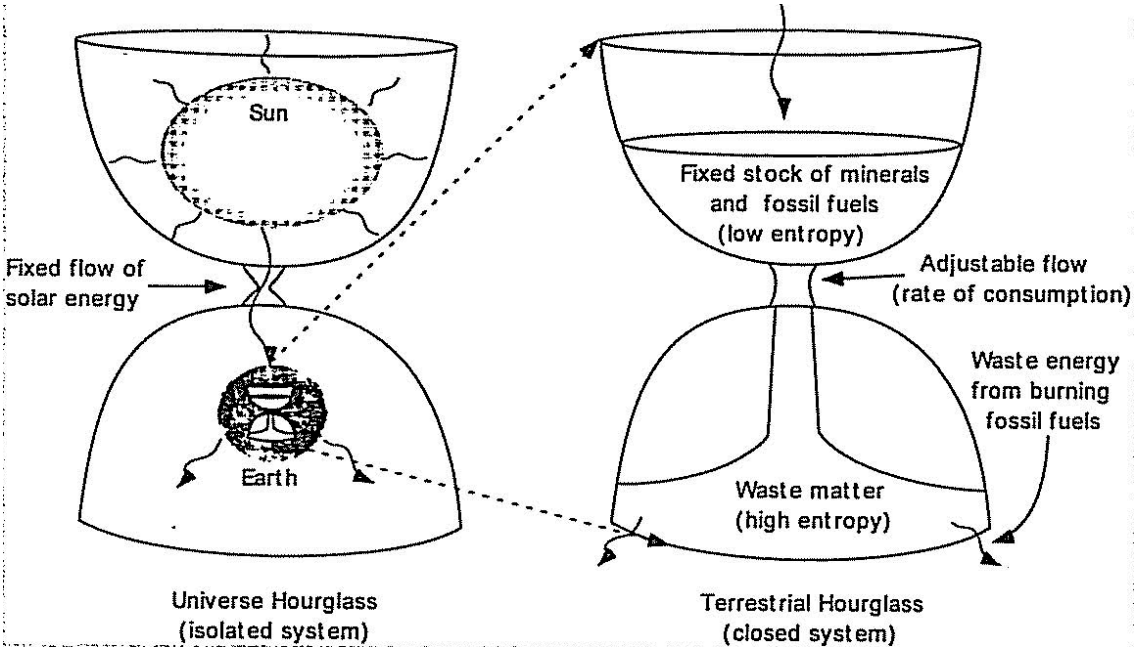
In the past two decades a new branch of economics has been developed that merges traditional neoclassical economic concepts with ecological concepts (43). The relatively new field is called ecological economics, which views the economy as a subsystem of the global ecosystem that is sustained by flows of resources into the economy and back out as waste (20). Ecological economics views the global ecosystem as a closed system and thus subject to the laws of thermodynamics where although matter and energy cannot be created or destroyed, the quality of matter and energy can change from organized to disorganized as measured by entropy. However, some economists argue that this merger of economics and ecology is not a new idea, rather what is new is its application to public policy issues (44). In other words, what has changed is the field has shifted from abstract theory to pragmatic policy support, which coincided with the rise on environmental issues and movements starting in the 1970s.

For example, ecological economics views the ecosystem-economy relationship as an hourglass (20). At the top there exists a large pool of abiotic and biotic resources that have low entropy, meaning organized matter and energy that can be put to useful purposes . The economic system is where the hourglass narrows, and the width of this narrowing represents the rate of resource use in the economy. The bottom of the hourglass is where the economy outputs waste in the form of high entropy matter and energy. This is termed throughput by ecological economics, where raw materials flow from the global ecosystem into the economy and back out as waste. In this model of the economy, energy and matter are finite and simply flow from one end of the hourglass to the other. So in an economy with abundant resources and little waste, the sands of the hourglass (representing matter and energy) are mostly concentrated at the top of the hourglass (representing resources) and very few are concentrated at the bottom (representing wastes). Ecological economics posits that the economy is quickly heading to an unsustainable situation, where the economy is consuming resources at a high rate (wide opening

between the two areas of the hourglass) leaving only a small amount of resources (less sand at the top of the hourglass) and a large amount of waste (more sand at the bottom of the hourglass).

Figure 5

Entropy or Throughput Hourglass



Ecological economics differs from traditional neoclassical economics in that it calls for the end of economic growth and advocates for the start of economic development (Daley and Farley 2004). In the neoclassical model, human welfare can be satisfied by expanded growth, or the quantitative increase in the size of the economy. The neoclassical model assumes that growth has no costs or constraints. However, ecological economics takes issue on this point and argues that growth does have a cost and does have constraints. They argue that the ecosystem has finite resources, and thus growth is constrained by biophysical laws. Rather than growth, ecological economics argues human welfare can be satisfied by expanded development, or the increase in the quality of the goods and services provided by the use of finite resources (21).

Thus, an ecological economy can be defined as a system that maximizes low entropy resources and minimizes high entropy wastes in allocating resources to achieve human welfare through development. However, there is no consensus within the discipline of economics as to the status of the ecological economics paradigm; and currently the mainstream neoclassical economics paradigm is dominant in North America, but less so in Europe (22).

The two main substantive critiques of ecological economics centers on the definition of growth and the viewing of waste as a resource (23). First, some economists have critiqued the ecological approach for conceptualized growth purely in terms of physical increases of goods, rather than including increases in

non-tangible services or monetary growth. Mainstream economists argue that growth in non-tangibles would not necessarily consume more resources and generate more waste. However, ecological economists argue that any non-tangible services growth is likely driven by or causes additional physical growth in goods. For example, while information may be a non-material product, it does consume material resources in the form of energy and computers (and in some cases printing) to produce and use the information.

Second, many economists argue that waste is simply a resource that has yet to find a purpose in the market, so there is the potential to convert waste into a resource for additional uses in the economy. However, ecological economists argue that physical laws cannot be amended, and the laws of thermodynamics show that matter and energy always move from a state of low entropy (organized and higher quality) to high entropy (disorganized and lower quality). So waste can never be fully reused and will eventually reach a point where it cannot be accessed by humans without considerable expenditure of additional energy. For example, there is a great deal of energy in the form of heat in the oceans, but that heat is so dissipated that it is not sufficient to run a ship.

Another related school of thought linking the ecosystem and the economy is sustainability economics, whose paradigm of understanding the economy is very similar to the ecological economics paradigm (24); (25). Sustainability economics is defined as the efficient and non-wasteful use of scare resources to achieve the goals of human welfare. However, sustainability economics differs from ecological economics in four key ways. First, sustainability economics seeks to satisfy human needs and wants that are socially desirable rather than economically efficient. Second, it seeks to satisfy justice between humans of the present and humans of future generations. Third, it seeks to satisfy justice between humans and the ecosystem. Fourth, its orientation is towards the long-term and assumes an uncertain future dominated by risk.

Sustainability economics also defines the green economy as one that reduces the negative impact on the environment relative to the status quo (26). This strand of research has identified the key components of the green economy that include environmental sustainability, renewable and alternative energies, energy efficiencies, intensive agriculture, alternative transportation technologies, conservation of abiotic and biotic resources, recycling and reuse, reducing greenhouse gas emissions, and reducing pollution. The sustainability economics literature is the only one known to have attempted a more precise conceptual definition of the green economy.

Environmental Sociology

The beginning of environmental sociology has its roots in the social movements of the 1960s and 1970s. It challenges the dominant Human Exceptionalism Paradigm (HEP) in mainstream sociology that places humans at the center of the social and biophysical world (27). Traditional sociology and the HEP views humans as unique among animals owing to culture and genetics, that social and cultural factors are major determinants of human affairs while the biophysical environment is largely irrelevant, and that technological and social progress can continue indefinitely and are ultimate solutions to social problems. The HEP has many of the same domain assumptions as the neoclassical economics paradigm.

However, environmental sociology takes traditional social theory and methods from the HEP and moves it to a New Ecological Paradigm (NEP), which explicitly incorporates the ecosystem into society. The NEP is the foundation for environmental sociology and assumes that while humans are unique in the animal kingdom, they remain one of many species that is independently involved in the global ecosystem. NEP assumes that human affairs are influenced not only by social and cultural factors, but are also influenced

by the biophysical environment and changes in the global ecosystem. NEP also assumes that human affairs are dependent upon a finite biophysical environment that places constraints on technological and social progress; while human technology can extend use of the environment it cannot alter biophysical laws.

Environmental sociology conceptualizes the ecosystem as serving three distinct functions in human society, including the economy (28). First, the ecosystem provides human society with the built environment that generally includes urban spaces and material objects. Specifically, the built environment encompasses housing, factories, vehicles, transportation systems, tools, machinery, and the like. Second, the ecosystem provides human society with a supply depot of resources that are necessary for living. This would generally include the abiotic and biotic resources needed to sustain human life and produce the built environment as discussed above. Third, the ecosystem provides human society with a waste repository used to store and recycle wastes generated by human activities. This can also be thought of as a sink for absorbing the waste products of modern industrial society. Environmental sociology recognizes that some wastes can be reused by the ecosystem (e.g. biodegradable wastes), while others cannot and therefore must be stored.

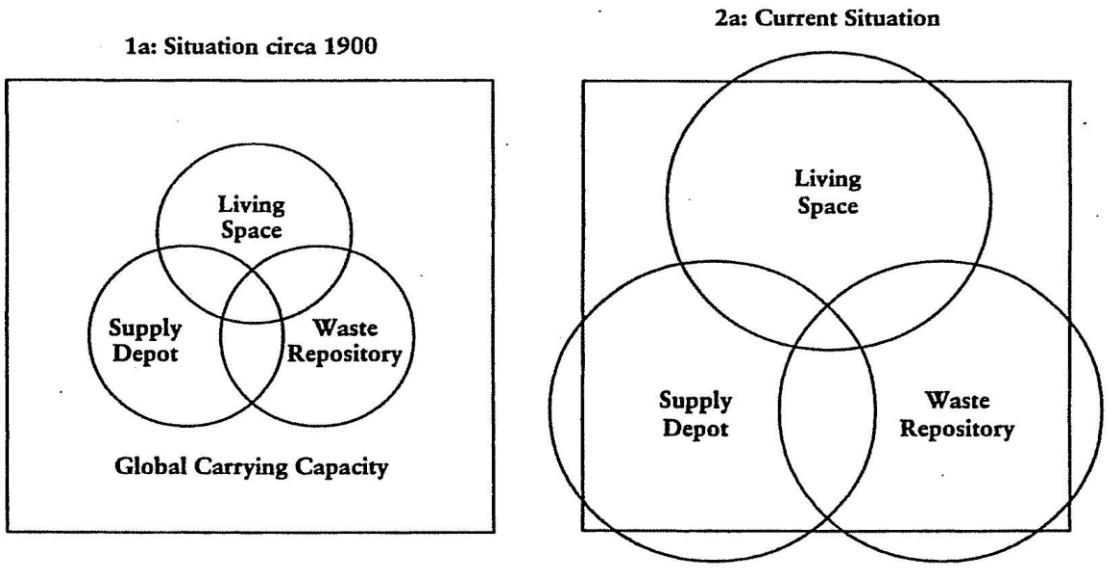
Within this model these three factors are not mutually exclusive and may overlap. The global ecosystem or a local environment has the potential to serve all three functions to some degree. However, the three factors also compete against each other in both the global and local ecosystems, and therefore may only serve one function. For example, using a local ecosystem as a waste repository tends to make it less suitable for use as a supply depot or living space in the built environment. In another example, building a housing tract on former farmland reduces the local ecosystems potential for food production.

Environmental sociology uses this model to illustrate concepts of sustainability. The field argues that modern industrial society is not sustainable as it has increased in size and made competing demands on the ecosystem, coming close to exceeding the global carrying capacity of the planet. Environmental sociologists argue that over the past century growth in human population and activities has generated more competition and conflict between the functions of built environment, supply depot, and waste repository. Also, environmental sociologists argue that total human demand for each of these three factors may soon exceed the long-term carrying capacity of both local and global ecosystems. Advocates of sustainability seek to minimize how the built environment, supply depot, and waste repository consume the ecosystem .

Thus, environmental sociology is the study of not only the relationships between humans and their environments, but also the many ways in which these relationships are influenced by social and culture processes. In addition, much of environmental sociology theory and research focuses on issues of justice and equity, arguing that green jobs ought to be secure, well compensated, and environmentally friendly (29); (30).

Figure 6

Competing Functions of the Environment



In terms of empirical research in environmental sociology, there is a large body of work focusing on the human causes and implications of global environmental change, which specializes in three main areas (31). The first area is climate change caused by human activities that have increased the amount of greenhouse gases responsible for regulating the earth's climate. The results suggest that this has resulted in changes in moisture dispersion, rising sea levels, volatile weather patterns, and changes in ocean currents. The second area is loss of biodiversity caused by human activities such as habitat destruction, introduction of exotic species, and pollution. The research claims this has caused a reduction in the genetic variation within species, reduced the number of species, and in some cases caused extinctions of species. The third area is the depletion of stratospheric ozone caused by industrial activities that increases the earth's exposure to ultra violet type B radiation. Although this research is at an early stage, current studies suggest that it may harm human health through increased cancers and other diseases, and also may be having a negative impact on the world's amphibian populations.

Lastly, environmental sociology also studies how environmental beliefs, attitudes, and motivations affect a person's behaviors and lifestyles (32). This body of work is called environmental concern, and measures the degree to which people are aware of problems regarding the environment and support efforts to solve them or indicate a willingness to contribute personally to their solution. This body research identifies environmental concerns in terms of topics (e.g. carbon dioxide levels), policy alternatives (e.g. cap-and-trade), personal beliefs (e.g. global stewardship), political beliefs (e.g. laissez-faire regulation), institutional and organizations actions (e.g. voting or memberships), and individual actions (e.g. consumption patterns).

Conceptual Framework for the Green Economy

As stated previously, there is scant research on the green economy in the social sciences, and the limited number of studies that do exist lack any formal definition on how to define the green economy –

which is a serious gap in the academic literature. There is a need to specify the abstract concept of the green economy to make it more conceptually precise and grounded in relevant social science theory. Doing so will permit more precise empirical and policy analysis. Based on the review of literature in ecological economics and environmental sociology, common themes from both are synthesized to present a framework of how to conceptualize and operationalize the green economy. The green economy can be defined along five main dimensions, as illustrated in , and under each are specific attributes of that dimension that are relevant to the green economy.

- The first dimension defines how inputs are used to produce goods and services, such as land, labor, and capital. A green industry or occupation is one that seeks to reduce the use of inputs overall, to make efficient use of inputs by increasing productivity per unit used, and seeks to find renewable alternatives for needed inputs.

- The second dimension defines how wastes are managed in the production of goods and services. Green industries or occupations seek to reduce the amount of wastes generated in the production process, they seek to reuse and recycle wastes without significant increases in inputs, and they seek to mitigate the impact of wastes in the ecosystem.

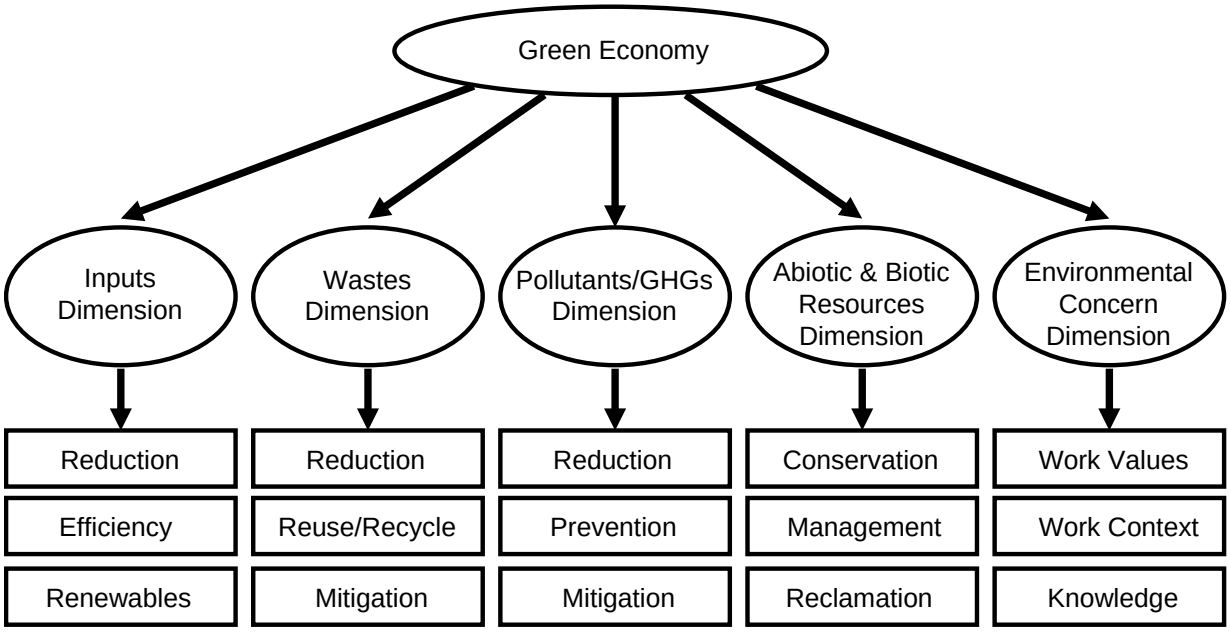
- The third dimension defines how pollutants and greenhouse gas (GHG) emissions are managed in the production of goods and services. Green industries and occupations are those taking active steps to reduce and prevent harmful emissions; and also includes those industries and occupations mitigating the negative impacts of such emissions.

- The fourth dimension defines how abiotic (fossil fuels, minerals, water, land, solar, etc.) and biotic (animals, plants, fungi, bacteria, other micro-organisms, etc.) resources are managed. Industries and occupations are considered green in that they are involved in the conservation and preservation of such resources, if they are involved in the managed use of abiotic and biotic resources, or are engaged in reclaiming those resources.

- The last dimension defines an individual's or organization's concern for the environment. Occupations and industries are green if environmental values are important to the satisfaction they derive from the work they are engaged in, if the physical and social context that influences their work is related to the environment, or if the types of knowledge and abilities required for their work in related to the environmental sciences.

Figure 7

Green Economy Conceptual Framework



The green economy conceptual framework can be used to develop empirical measures of each dimension and attribute, thus allowing one to measure the degree to which industries and occupations follow green practices and behaviors. Industries and occupations may have all of these attributes, while some may only have a few attributes. This permits one to rate the "greenness" of various industries and occupations. In addition, the conceptual framework attempts to provide a more precise and theoretically grounded definition of the green economy that is currently lacking in the literature. Providing such a framework is necessary to enhance the validity and reliability of empirical analyses of the green economy.

However, one major limitation of this model and similar ones proposed by ecological economics and environmental sociology is its complexity (45), (46). Drawing upon diverse disciplines like ecology, economics, and sociology results in conceptual models that look more additive that integrative. This results in disciplinary "silos" within a single model, with the conceptually weak linkages between them. More importantly, the conceptual complexity also hinders operationalization of the concepts. While the concepts may adequately reflect theory, the necessary data to actually measure the concepts may not be available. Existing data that may not adequately measure the concepts, resulting in measurement errors and less precise models. Generating new data is expensive and lack of a time series hinders model development. In short, it is this lack of adequate data that most hinders implementation of these types of conceptual models, including the one presented here.

Application of Conceptual Model

As stated previously, one current gap in the literature is the lack of any formal definition on how to define the green economy. We have presented a conceptual model, based on ecological economics and environmental sociology, that attempts to better define the green economy to make it more conceptually precise and grounded in relevant social science theory. One potential application of our conceptual model is that it can used to better identify green occupations. The vast majority of current work on the green economy takes industries as the units of analysis. These studies take a macroeconomic approach to understanding what industrial sectors produce green products and services. However, there is a need to better understand the green economy in terms of workforce development by examining green occupations. An occupational approach allows one to fully understand how the green economy is changing the nature of work and education.

To identify green occupations, dimensions and indicators presented in the conceptual model can be operationalized using detailed occupational data from O*NET, which is produced by the U.S. Department of Labor. O*NET provides detailed data for nearly one thousand different occupations in terms of needed knowledge and skills, occupational interests, work styles and values, work activities and tasks, and organizational contexts. These data are continually updated and have an established, albeit short, time series.

In our model, the conceptual dimensions of inputs, wastes, pollutants/GHGs, and resources can be operationalized using the nearly 20,000 job tasks detailed for all occupations. The environmental concern dimension can be operationalized using the over 50 work values and styles, nearly 100 broad knowledge domains and instructional programs, and nearly 200 work contexts. The conceptual model can be used to guide selection of these various tasks, knowledge areas, and work values so that they best align with our definitions of green practices. Once relevant data elements are selected that measure green dimensions, scales can be constructed to assess the degree to which an occupation is "green". Based on these values, green tasks and occupations can be identified for use in policy analysis.

For example, to operationalize pollution reduction under the wastes dimensions, one can utilize the job tasks data in O*NET. Searching the O*NET database for the keywords "pollution reduction" resulted in 28 related tasks. The scale measuring the degree of use is the percent of respondents saying that they perform that task more than once a week. The tasks are then grouped by occupation. Referring to Table X, we find that occupations most engaged in pollution reduction tasks are Compliance Officers, Environmental Engineering Technicians, Environmental Scientists and Specialists, and Environmental Science and Protection Technicians. Although all of these occupations have faster than average growth over the next decade (over 20%), only Compliance Officers have sizable numbers of openings (over 100,000). In terms of wages, Environmental Scientists and Specialists pay the most ($61,010) and Environmental Science and Protection Technicians pay the least ($40,790). All of these occupations generally require a Bachelor's degree, except Environmental Engineering Technicians that require a 2-year or vocational degree. Other occupations are also engaged in pollution reduction, but at a much lower degree. These include occupations like Fish and Game Wardens, Materials Engineers, and Commercial Divers.

Source: O*NET 15.0, U.S. Department of Labor

Table 8

Occupations and Tasks Associated with Pollution Reduction

Compliance Officers	
42.1	Analyze and implement state, federal or local requirements as necessary to maintain approved pretreatment, pollution prevention, and storm water runoff programs.
36.7	Inform individuals and groups of pollution control regulations and inspection findings, and explain how problems can be corrected.
25.5	Investigate complaints and suspected violations regarding illegal dumping, pollution, pesticides, product quality, or labeling laws.
23.3	Review and evaluate applications for registration of products containing dangerous materials, or for pollution control discharge permits.
10.4	Inform health professionals, property owners, and the public about harmful properties and related problems of water pollution and contaminated wastewater.
Environmental Engineering Technicians	
41.6	Conduct pollution surveys, collecting and analyzing samples such as air and ground water.
33.1	Work with customers to assess the environmental impact of proposed construction and to develop pollution prevention programs.
24.3	Perform statistical analysis and correction of air or water pollution data submitted by industry and other agencies.
Environmental Scientists and Specialists	
56.8	Collect, synthesize, analyze, manage, and report environmental data, such as pollution emission measurements, atmospheric monitoring measurements, meteorological a
35.4	Research sources of pollution to determine their effects on the environment and to develop theories or methods of pollution abatement or control.
28.5	Conduct applied research on environmental topics, such as waste control and treatment and pollution abatement methods.
24.6	Monitor effects of pollution and land degradation, and recommend means of prevention or control.
Environmental Science and Protection Technicians	
65.5	Collect samples of gases, soils, water, industrial wastewater, and asbestos products to conduct tests on pollutant levels and identify sources of pollution.
63.8	Calculate amount of pollutant in samples or compute air pollution or gas flow in industrial processes, using chemical and mathematical formulas.
31.3	Develop and implement programs for monitoring of environmental pollution and radiation.
Microbiologists	
85.7	Monitor and perform tests on water, food, and the environment to detect harmful microorganisms or to obtain information about sources of pollution, contamination, or in
Atmospheric and Space Scientists	
67.3	Research and analyze the impact of industrial projects and pollution on climate, air quality, and weather phenomena.
Cartographers and Photogrammetrists	
80.0	Provide advice on water quality and issues related to pollution management, river control, and ground and surface water resources.
22.0	Perform monitoring activities to ensure that ships comply with international regulations and standards for life saving equipment and pollution preventatives.
Ship Engineers	
75.9	Monitor the availability, use, and condition of lifesaving equipment and pollution preventatives, in order to ensure that international regulations are followed.
Biological Scientists	
48.7	Study aquatic plants and animals and environmental conditions affecting them such as radioactivity or pollution.
Mining and Geologic Engineers	
48.4	Devise solutions to problems of land reclamation and water and air pollution, such as methods of storing excavated soil and returning exhausted mine sites to natural state
Hydrologists	
38.5	Apply research findings to help minimize the environmental impacts of pollution, waterborne diseases, erosion, and sedimentation.
Fish and Game Wardens	
18.5	Collect and report information on populations or conditions of fish and wildlife in their habitats, availability of game food or cover, or suspected pollution.
3.5	Investigate crop, property, or habitat damage or destruction or instances of water pollution to determine causes and to advise property owners of preventive measures.
Materials Engineers	
20.4	Supervise production and testing processes in industrial settings, such as metal refining facilities, smelting or foundry operations, or nonmetallic materials production oper
Commercial Divers	
19.0	Remove rubbish and pollution from the sea.

In developing this conceptual model, we have followed the suggestions of Milon and Shogren (1995) who argue that any model should produce influential social indicators that provide technical and political knowledge (47). The above example shows how our conceptual model can provide this information. First, our model can address current issues related to the green economy using existing data from O*NET. This provides needed information on the current green economy. Second, it can address issues suggested by historical trends. By using historical occupational employment and 10-year projections data from BLS, one can estimate future trends in green jobs and the resulted demand for skills and education. Lastly, it can address issues suggested by either the continuation or change of current policies and economic conditions. Using the base occupational projections data, one can model different employment growth scenarios. We argue that our conceptual model does a fair job at addressing these criteria.

Section 6. Summary of Findings and Recommendations for Additional Research

There is little academic research that conceptualizes and operationalizes this notion of the green economy.

There are very few peer-reviewed studies defining green jobs or the green economy in academic journals in economics, public policy, and sociology. Of the small number of existing articles that do address some aspect of the green economy, most offer no formal or precise definition of what constitutes a green job or green industry. Most articles on this topic assume that readers already know how the green economy is defined, without providing either any reference to secondary sources or any conceptual justification.

A conceptual framework for defining the green economy can and should be developed based on existing social science theory.

Based on theory and research from ecological economics and environmental sociology, the green economy can be defined along five main dimensions:

(1) the reduction, efficient use, and renewable sources of *inputs* to produce goods and services;
(2) the reduction, reuse and recycling, and mitigation of *wastes* generated by the production of goods and services;
(3) the reduction, prevention, and mitigation of *pollutants and greenhouse gas emissions*;
(4) the conservation, management, and reclamation of *abiotic and biotic resources*; and
(5) the work values, work context, and work knowledge driving *environmental concern* that motivates the work for individuals, firms and organizations.

Regional research to assist state and local policy development is critically needed

There is broad-based supposition that green jobs growth potentials will have a uniform and stimulative impact across all regions of the U.S. Evidence suggests there will be substantial differences in green job formation in urban areas compared to rural areas. In time, there will also be substantial regional off-setting consequences as energy demands change and sources of energy transform. The net consequences of those shifts need to be investigated and incorporated into policy development and state and multi-state planning efforts.

Evaluations need to more rigorously investigate offsetting job losses

The emergence of an increasingly green economy will mean that there will be incrementally less demand for carbon producing inputs into energy production and other industrial activities. Energy efficiency standards will also involve the shifting of production away from non-green commodities. We have very little information about the number of jobs that will be replaced by green jobs. Few industry and trade groups even acknowledge, let alone try to quantify the job losses in traditional industries that will offset job gains in their own industries. Federal agencies have attempted to quantify economic impacts of specific energy policies, but they rarely translate those into job estimates.

Green job quality and characteristics need to be more fully explored

The quality of green jobs in terms of career opportunities, pay, safety, and general working conditions needs to be explored and described more fully. Many green jobs are low paying, repetitive, dangerous, and do not offer significant opportunities for career growth.

Reasonable green industry and occupational projections must be developed

Expectations for net new national job growth attributable to green production and service activities need to be evaluated carefully. Estimates of the potential growth in green jobs may be biased. Growth projections are based in large part on information supplied by industry and trade groups that are promoting their own interests.

If state and national policies continue to promote increased levels of green activity both as a component of economic development and as an element of regional and national energy security, those policies must be informed by reasonable assumptions about net job and economic growth in the green economy. Overly optimistic projections can result in the oversubsidization of green activities, which will have the effect of misallocating scarce public resources away from other potentially deserving public services.

Furthermore, many state and local leaders, in the absence of policy and definitional precision, may have highly inflated expectations about the economic development potential of green jobs and industries. Owing to prolonged economic stagnation and the need to boost regional fortunes, many are urgently adopting green industry development activities, especially as they may allow capitalizing on current federal incentives, and in the absence of reliable information, they may be implementing poorly-thought-out policies.

Federal agencies need to use mixes of survey, administrative, and evaluative data to more fully describe the green economy

Many baseline estimates of green jobs are likely inflated because they have been over-defined. Key federal agencies have defined green jobs at either the industry or occupational level, as opposed to the individual firm or job level. Such precision can only be achieved using surveys. We are several years away from obtaining reliable, national survey data. While individual states have administered their own surveys to identify baseline estimates for green jobs, we cannot generalize those results to other states, the nation, or over time.

Clear and understandable green industry, occupation, and outcome standards need to be developed and implemented at the federal level

The vast majority of green industry incentives and policy guidance comes from the federal government. It is imperative that all U.S. executive agencies, to include EPA, Commerce, Labor, Education, OMB, and the USDA adopt uniform industry, occupation, commodity, service, and outcome definitions in promoting green economic activity in the U.S.

Rural and regional development opportunities need to be carefully circumscribed

The rural development prospects for green job growth are mixed. Rural areas contain biomass feedstocks which will be increasingly relied upon to offset fossil fuel dependencies. The distribution of those feedstocks, however, is not uniform across rural areas. Furthermore, the technologies to convert those feedstocks into fuels and other uses are yet to be demonstrated at commercially successful scales. Both policy development and research activities should be focused on the efficient utilization of rural natural resources, human capital, and rural infrastructure in achieving national green policies.

The green economy appears to be fertile ground for unbiased, academic research to examine some of the regional consequences of green jobs growth and green jobs policies, to include an examination of rural opportunities, but going well beyond that dimension to include the integration of statewide and multi-state regional development opportunities as well as consequences.

Appendix A: Timeline of Key Policy Events Related to Green Jobs

1970. Earth Day demonstrations gave evidence to the growing strength of a modern environmental movement.

1970. The Environmental Protection Agency was created to consolidate oversight of federal air pollution, water, and other environmental programs under an independent agency

1970. The Clean Air Act marked a shift in federal policy to stricter controls of air emissions from industrial and other sources as opposed to just monitoring and measuring

1970. The National Environmental Policy Act (NEPA) created a Council on Environmental Quality (CEQ) to review Environmental Impact Statements required of all federal agencies planning projects with major environmental consequences.

1970. The Occupational Safety and Health Act created the Occupational Safety and Health Administration to reduce workplace injuries, illnesses and deaths.

1972. Amendments to the Federal Water Pollution Control Act strengthened Federal oversight of pollution discharge into the nation's navigable waters.

1978. The National Energy Conservation Policy Act (NECPA) provided underlying authority for Federal energy management goals and requirements.

1980. The Comprehensive Environmental Response Compensation and Liability Act, commonly referred to as the Superfund Act, was passed to reduce the likelihood of human exposure to toxic chemicals by establishing requirements for disposal, containment, and cleanup of hazardous chemical wastes.

1992. The Energy Policy Act called for energy-efficient product procurement. Its authority created the Federal Energy Management Program (FEMP), whose stated primary mission is to reduce the cost of federal government by advancing energy efficiency and water conservation, promoting the use of renewable energy, and managing utility costs.

1992. The 1992 Energy Policy Act ("EPAct") mandated that all states must review and consider adopting the national model energy standards for building codes.

1992. Production tax credits for alternative energy, including utility-scale wind energy and biofuels, were included in the Energy Policy Act.

1992. The Energy Star program was introduced by the U.S. EPA and U.S. Department of Energy.

1993. The Office of the Federal Environmental Executive was created by Executive Order. The office promotes sustainability and environmental stewardship throughout Federal government operations, focusing on the successful implementation of Executive orders and documenting the economic benefits of environmental performance standards.

1997. Senate Resolution 98, referred to as the Byrd-Hagel Resolution, effectively blocked participation by the United States in the Kyoto Protocol based partly on fears that it would drive U.S. jobs overseas.

1998. National Energy Conservation Act of 1998.

1999. The U.S. Department of Agriculture's Office of Energy Policy and New Uses (OEPNU) assumed responsibility for researching the economic potential of new uses for agricultural products.

2001. Executive Order 13221 relating to the use of Energy-Efficient Standby Power Devices was issued.

2004. The American Jobs Creation Act of 2004 authorized tax exempt bonds issued by state or local governments for qualified green building and sustainable design projects.

2005. The Energy Policy Act of 2005 established several new energy management goals for federal government. It called for procurement of energy-efficient products and required Federal buyers to purchase products that are ENERGY STAR® qualified or FEMP-designated for energy efficiency and low standby power; set targets for Federal agencies to source electricity from renewable energy; and established volume mandates for blending renewable fuels into transportation fuels

2005. The Energy Policy Act of 2005 specifies the most current model energy codes for residential and commercial buildings and requires that states certify that their codes meet or exceed that standard.

2007. The Energy Independence and Security Act expanded renewable fuels mandates.

2007. The Green Jobs Act amended the Workforce Investment Act as Title X of the Energy Independence and Security Act of 2007. The Green Jobs Act authorized spending for a pilot program to identify needed skills and develop training programs for industries that produce sustainable products and uses sustainable processes and materials. The pilot program was to have a special focus on creating "green pathways out of poverty."

2007. Executive Order 13423—Strengthening Federal Environmental, Energy, and Transportation Management was issued.

2008. Hilda Solis, a green jobs proponent and sponsor of the Green Jobs Act of 2007, was selected as U.S. Secretary of Labor.

2008 The American Recovery and Reinvestment Act of 2009 included funding for energy and green jobs training programs.

2009. Executive Order 13514—Federal Leadership in Environmental, Energy, and Economic Performance was issued.

2010. U.S. Bureau of Labor Statistics publishes its final definition of green jobs in the Federal Register for the purpose of conducting a national survey of green products, services, and occupational activities.

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