Jobs Created by the Green Economy in the USA

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Abstract

Green jobs are of intense interest in the USA but heretofore have not been rigorously estimated. While green jobs are desirable and are increasing rapidly, consistent time series estimates and forecasts of these jobs are not available. This has impeded research and policy development. We analyze the importance of green jobs and estimate the green jobs created by the USA economy 1970 – 2030 by industry, occupation, skill, and salaries. Here we show that: 1) jobs generated by the USA green economy have increased from 1% of total jobs in 1970 to 6% 2020, and are forecast to comprise 14% of jobs in 2030; 2) most persons in these jobs do not realize that they owe their livelihood to the green economy; 3) jobs generated by the green economy are at least 3 or 4 times larger than realized; 4) most green jobs are not attractive, well paid, or unionized; 5) advocates can be their own worst enemies by misrepresenting the reality of green jobs. The significance of green jobs is not appreciated and this has serious economic, environmental, and policy implications that must be remedied.

Keywords: green jobs, green jobs estimates, green jobs forecasts, green jobs significance, green jobs skills, USA green jobs

1. Significance of the Findings

Here we correct disinformation being disseminated by analysts and interest groups who are opposed to green jobs programs and who minimize their potential significance. However, our findings also upend much conventional wisdom being propagated by green jobs advocates. The findings derived here are relevant to many of the economic, environmental, and job issues currently being debated in the USA, including infrastructure spending,[1] climate mitigation policies in the wake of COP 26, [2] the Green New Deal,[3] and green jobs, employment, and training policies.

2. Size of the Green Economy

We find that the USA green economy and the jobs generated by it are much larger and more important than is generally realized, are growing rapidly, and will continue to increase rapidly in both absolute and percent terms.[4] The rapid growth of USA green jobs is not recognized. Over the five decades from 1970 to 2020, jobs generated by the green economy increased from less than 1 million and 1% of total USA jobs in 1970 to over 8 million jobs and 6% of total jobs by 2020 (Figure 1). By 2030, these jobs are forecast to total 24 million and comprise 14% of all jobs (Figures 2 and 3). Over the six decades 1970 - 2030, jobs generated by the USA green economy are forecast to increase nearly 16 times as rapidly as total jobs. These estimates are much larger than most currently available green jobs estimates. Thus, green initiatives can form an integral part of economic development strategy and innovative learning opportunities and solutions to the national/state/local jobs skills gap. This information is critical in garnering support for green initiatives: It emphasizes that USA green jobs are being seriously under-estimated and that the potential implications are serious.

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[1] https://www.whitehouse.gov/bipartisan-infrastructure-law/.

[2] See https://ukcop26.org/.

[3] See, for example, Roger H. Bezdek, "The USA New Green Deal Will Create Over 18 Million Jobs," *Journal of Environmental Science and Renewable Resources*, Vol. 2, No. 1 (June 2020); Jessica McDonald, "The Facts on the 'Green New Deal,'" https://www.factcheck.org/2019/02/the-facts-on-the-green-new-deal/.

[4] See Management Information Services, Inc., "Defining and Estimating the U.S. the Green Economy and Green Jobs, prepared for WorkingNation, January 2022; https://workingnation.com/the-green-economy-its-bigger-than-you-think-and-growing-rapidly/.
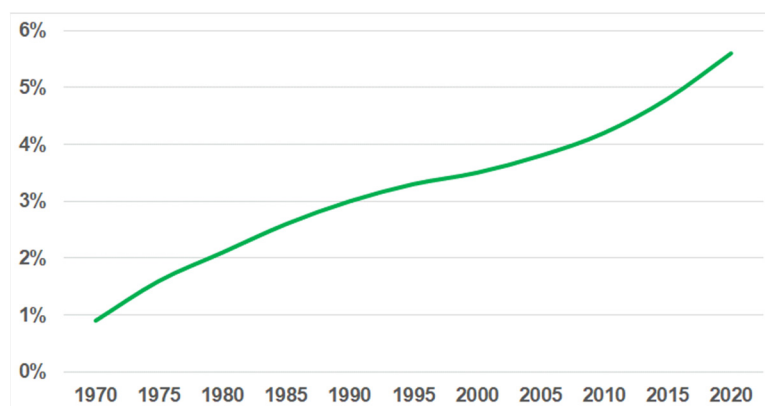
Figure 1. Jobs generated by the USA green economy as a percent of total jobs, 1970 – 2020
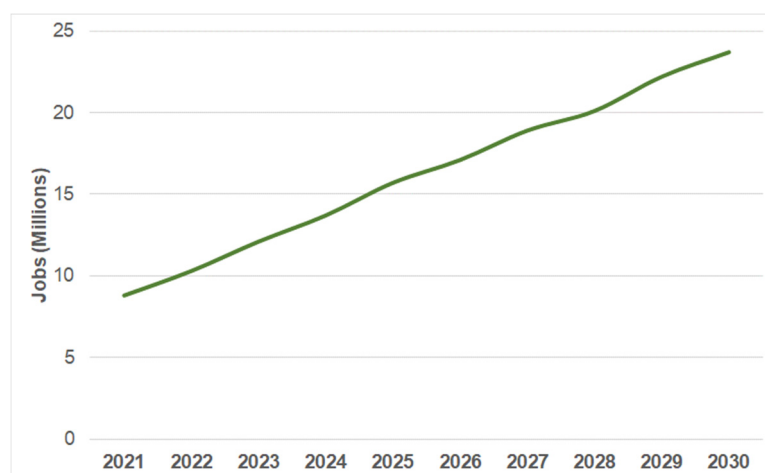
Source: BLS and MISI.

Figure 2. Jobs generated by the USA green economy forecast, 2021 - 2030

Source: BLS, EIA, and MISI.

We find that most jobs generated by the USA green economy are not "green" (Figure 4). Rather, the vast majority of jobs generated are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc., and most of the persons thus employed do not realize that they owe their livelihood to the green economy.

This information can inform companies, workers, and policymakers of the importance of green expenditures and the green economy in generating sales, jobs, tax revenues, and economic growth. Many workers are dependent on the green economy for their employment, although they have no way of recognizing this unless it is brought to their attention.[5] Many companies, whether they realize it or not, owe their profits – and in some cases their existence – to "green" expenditures. This will be a revelation to many analysts and represents a major contribution to the debate.

3. Defining a Green Job

There is no consistent definition of a "green job." It is impossible to develop such a definition, and numerous organizations and researchers have different green jobs definitions, many of which are inconsistent and

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[5] See Roger H. Bezdek, Robert M. Wendling and Paula DiPerna, "Environmental Protection, the Economy, and Jobs: National and Regional Analyses," *Journal of Environmental Management*, Vol. 86, No. 1 (January 2008), pp. 63-79.

contradictory. Green jobs is an amorphous and still-emerging concept and many green jobs do not easily fit into currently available occupational or industrial classification systems.[6]
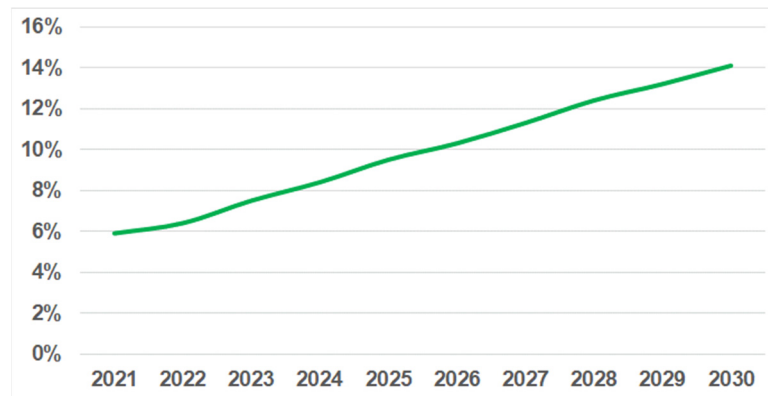
Figure 3. Jobs generated by the USA green economy as a percent of total jobs forecast, 2021 - 2030
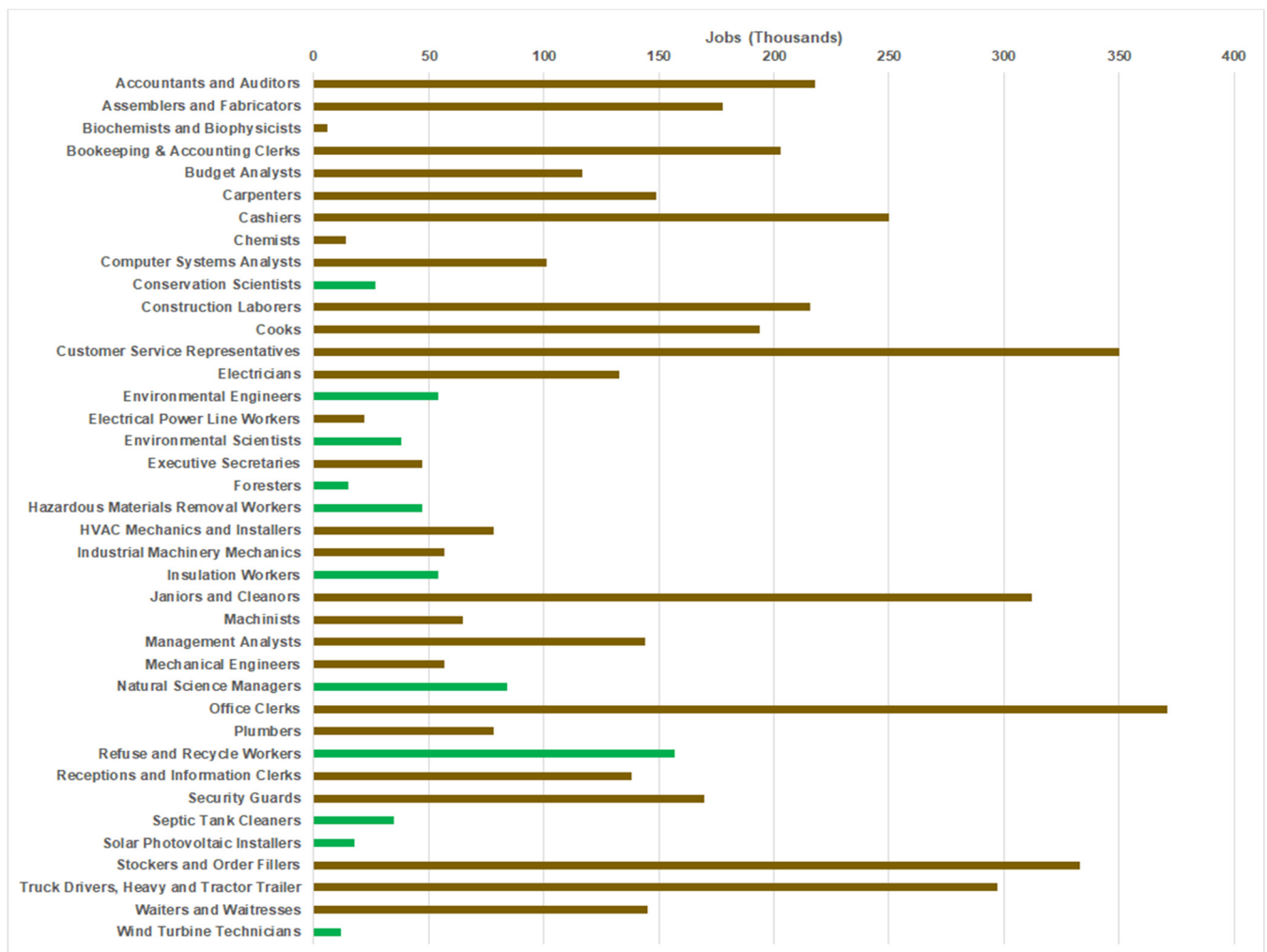
Source: BLS, EIA, and MISI.

Figure 4. Jobs generated by the USA green economy in 2030, by selected occupations

Source: BLS, EIA, and MISI.

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[6] See Management Information Services, Inc., "Defining and Estimating the U.S. the Green Economy and Green Jobs, prepared WorkingNation, January 2022; https://workingnation.com/the-green-economy-its-bigger-than-you-think-and-growing-rapidly/.

Accordingly, attempts have been made to define and estimate green jobs by means of occupational classifications, industry sectors, surveys, "transactional triangulation,"[7] etc. The occupational approach is inadequate because many green jobs are not specified in current occupational classifications. The industry approach is deficient because there are many green jobs that are not part of NAICS industries[8] classified as green, and limiting the scope to businesses that produce green products or services excludes green-related jobs at other firms. The major disadvantage of the survey approach is that interpretation of what constitutes a green job is often left to survey respondents. Approaches such as transactional triangulation are difficult to evaluate, impossible to replicate, and are not comparable to estimates in national statistical data bases.

Different estimates of USA green jobs are available from a variety of sources, and they vary widely depending on the green job definition, source of the estimate, and other factors. State green jobs estimates also differ markedly and illustrate the enormous range of green jobs estimates among states and even for the same state.

National estimates differ by a factor of 40, and even recent estimates differ by a factor of 10 (Figure 5), and state estimates also differ markedly. Heretofore, there has been no consistent time series database of green jobs estimates available at the national level or for any state, and this is a serious failing.
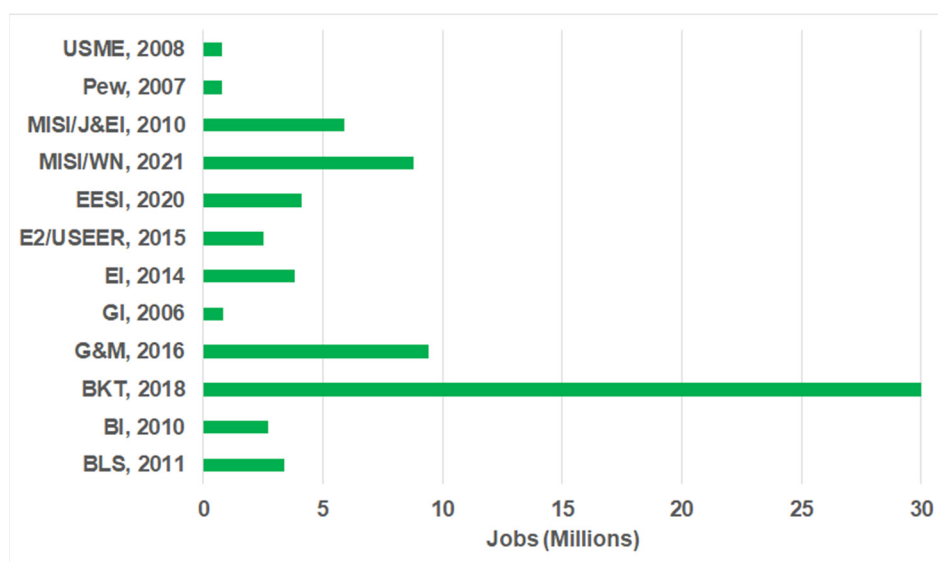

Figure 5. Examples of variations in USA green jobs estimates

Source: MISI.

Legend for Figure 5: BLS – U.S. Bureau of Labor Statistics; BI -- Brookings Institution; BKT -- Bowen, Kuralbayeva, & Tipoec; EESI -- Environmental and Energy Study Institute; E2: Environmental Entrepreneurs; EI -- Echotech Institute; G&M -- Georgeson and Maslin; GI -- Georgetown Institute; J&EI -- Jobs and Environment Initiative; MISI -- Management Information Services, Inc.; Pew -- Pew Charitable Trusts; USEER -- USA Energy Employment Report; USME -- USA Metro Economies; WN – Working Nation.

Our green job concept is not a unique green job definition based on industrial or occupational characteristics or on survey methods. Rather, we define green jobs as full time equivalent (FTE) jobs generated – directly, indirectly, or induced – by the activities of the green economy. This approach has several advantages: 1) It does not bog down into interminable debates over specific green job definitions; 2) it corresponds to interindustry job creation concepts that have been validated over the past half-century; 3) It provides a consistent time series national data base of estimates of jobs generated by the green economy; and 4) it is credible and produces neither the highest nor the lowest green jobs estimates.

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[7] Lucien Georgeson and Mark Maslin, "Estimating the Scale of the U.S. Green Economy Within the Global Context," https://doi.org/10.1057/s41599-019-0329-3; https://www.newscientist.com/article/2219927-us-green-economy-has-10-times-more-jobs-than-the-fossil-fuel-industry/.

[8] https://www.census.gov/naics/.

4. A Closer Look at the Green Economy

There is considerable debate over green jobs' salaries,[9] and here we resolve the contentious debate over the relative salaries of green jobs compared to non-green jobs. Since the vast majority of jobs generated by the green economy are standard "non-green" jobs, the average salaries for these jobs must – due to the law of large numbers – be close to the USA average. The green economy generates disproportionately more jobs in professional, scientific, and technical services occupations than the USA average – higher than the average of these occupations in the labor force. Nevertheless, there are far fewer workers in these occupations than in many of the other jobs generated by the green economy. Further, while many of the jobs generated pay higher than average salaries, many others do not (Figure 6).

For example, three types of the most numerous green jobs created – Refuse and Recycle Workers, Insulation Workers, and Septic Tank Cleaners – pay below average wages. Thus, at best, the average salary for the jobs generated by the green economy may be only slightly higher than the USA average – and the difference is likely in the statistical noise of the estimates. Thus, it is not valid to contend that the jobs generated by the green economy pay wages and salaries that are significantly higher – or lower -- than USA averages.[10]
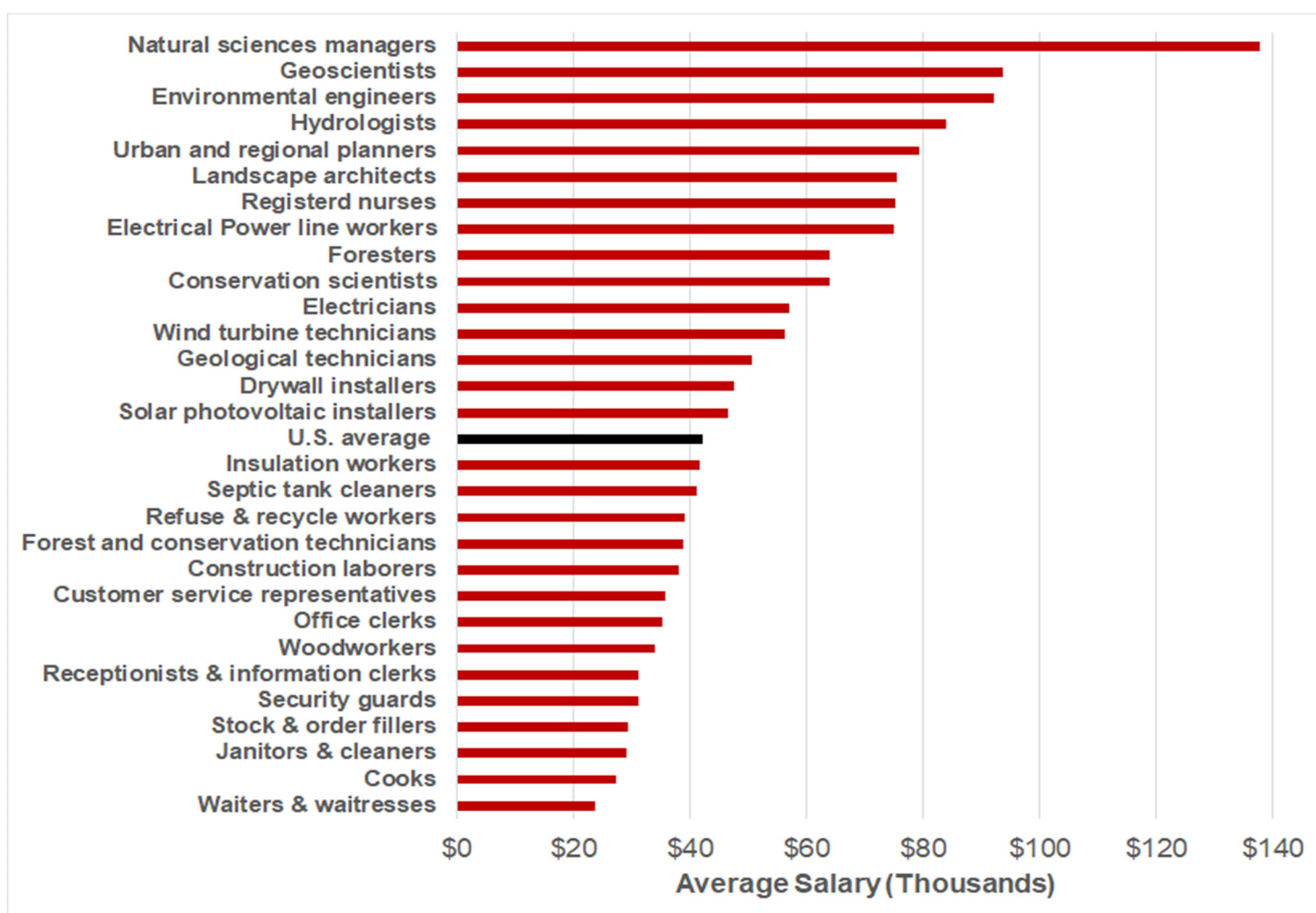
Figure 6. Average 2020 annual salaries of selected jobs generated by the green economy

Source: BLS, EIA, and MISI.

Most jobs in firms producing green products or services are not necessarily "green." For example, in a wind turbine

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[9] Kelsey Tamborrino, "The Wage Gap That Threatens Biden's Climate Plan, *Politico*, April 6, 2021.

[10] However, policy initiatives could be focused on increasing the salaries for green jobs and for greatly increasing the rate of unionization of green jobs.

manufacturing plant there are few if any classic green jobs. Rather, the job profile reflects that of a typical manufacturing facility with numerous jobs for Assemblers, Machinists, Machine Tool Operators, Engineers, Inspectors, Laborers, Clerks, etc. Nevertheless, these are green jobs due to the product being produced.

Green jobs advocates can be their own worst enemies. Organizations, advocates, and politicians have greatly tightened the criteria for defining green jobs and have, paradoxically, greatly reduced the number of jobs that can according to these criteria be legitimately defined as "green."[11] The more stringent the criteria – high pay, good benefits, quality jobs, union jobs, favorable working conditions, etc., the fewer the jobs that are defined as green. The reality is that the most jobs created by the green economy may not adhere to the stringent criteria. A very strict list of necessary criteria greatly reduces estimates of the number of green jobs. Utilization of these criteria seriously underestimates the size, importance, and rates of growth of USA green jobs. Since the jobs issue is critical, this will hinder efforts to address pressing environmental, climate, and energy issues and to expand the green economy.

Contrary to green jobs advocates' hype, many green jobs are not necessarily glamorous, exciting, or desirable. Thus, forecast job openings for occupations such as Recycle Worker, Hazardous Materials Removal Worker, and Septic Tank Cleaner greatly exceed those for occupations generally promoted, such as Wind Turbine Technician, Solar Photovoltaic Installer, and Environmental Engineer. Advocates must be realistic as to the "green jobs of the future" and to the education and training policies implemented concerning green jobs.

There are numerous studies contending that green initiatives create substantial numbers of jobs and just the opposite – that they destroy jobs.[12] Nevertheless, the balance of research indicates that investments in green energy programs have favorable net positive economic and jobs benefits. However, these net positive impacts, while significant and powerful for policy purposes, should not blind us to the fact that the major rationale for these programs is the energy and environmental and benefits they create. The cart should not be put before the horse: The energy and environmental and benefits are the reason these programs are desirable. Jobs benefits are an important secondary benefit which must be evaluated as such.

The U.S. Bureau of Labor Statistics (BLS) occupational data are essential for green jobs analysis and forecasting, and they are the basis for most state job forecasts. The BLS data are the gold standard. Nevertheless, they have serious limitations for green jobs assessments.

One problem is that the BLS occupational classifications do not include numerous designations that would be useful in green jobs analyses. More basically, the BLS occupational classifications will never be able to identify many distinct green occupations. For example, BLS will likely never develop classifications for such green occupations as "Green Lawyer," "Green Accountant," "Green Welder," "Green Fund Raiser," "Green Programmer," "Green Economist," "Green Carpenter," etc. Further, how "green" an occupation is does not necessarily depend on the occupational definition. Rather, it is also determined by the product, process, or service involved. Another major problem with using BLS occupational classification data is that they do not identify new and emerging jobs being created by the rapidly growing green economy.

5. Building a Pipeline of Green Jobs Workers

Identifying the job openings and the requisite skills, education, training, and experience required is especially important for education and training purposes.[13] Notably, for jobs requiring years of specialized education and training, planning has to be initiated years in advance of the anticipated demand for these jobs. Similarly, it is important to know which of the jobs being created can be filled with a limited amount of retraining or on-the-job training. For example, to increase the supply of some occupations may require nearly a decade, to increase the supply of workers in some occupations requires less time, but still substantial time, while the workers in other occupations can be increased much more rapidly. The information presented here can be used to develop optimal education, training, and retraining policies and to address the mismatch between the skills that employers want and the skills that employees have.

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[11] See, for example, https://tcf.org/content/report/redefining-green-jobs-sustainable-economy/?agreed=1.

[12] See, for example, http://apolloalliance.org/apollo-14/the-full-report/; https://www.scribd.com/document/29 66 34 23 0/EE-0422-01; https://www.epi.org/publication/studies_cleanenergyandjobs/;
https://www.beaconhill.org/BHIStudies/GreenJobs09/BHIGreen_Collar_Job_Critique090625.pdf;
https://energynow.com/2021/04/commentary-the-truth-about-green-energy-jobs-alex-epstein/;
https://www.globabalenergyinstitute.org/sites/default/files/2019-12/hf_ban_report_final.pdf.

[13] Roger H. Bezdek, "The Hydrogen Economy and Jobs of the Future," *Renewable Energy and Environmental Sustainability*, Vol. 4, No. 1 (2019).

We estimated the average annual job openings for selected jobs generated by the green economy through 2030 (Figure 7). The vast majority of the annual job openings generated – direct, indirect, and induced – by the green economy, from 2021 to 2030, will not be for "green" or even "semi-green" occupations. For example, over the coming decade the average annual USA job openings generated by the green economy will total 30 times more Office Clerks (42,000) than Wind Turbine Service Technicians (1,400); 11 times more Assemblers and Fabricators (26,300) than Solar Photovoltaic Installers (2,300); 16 times more Construction Laborers (22,000) than Foresters (1,400); and 11 times more Customer Service Representative (44,000) than Environmental Engineers (4,000).
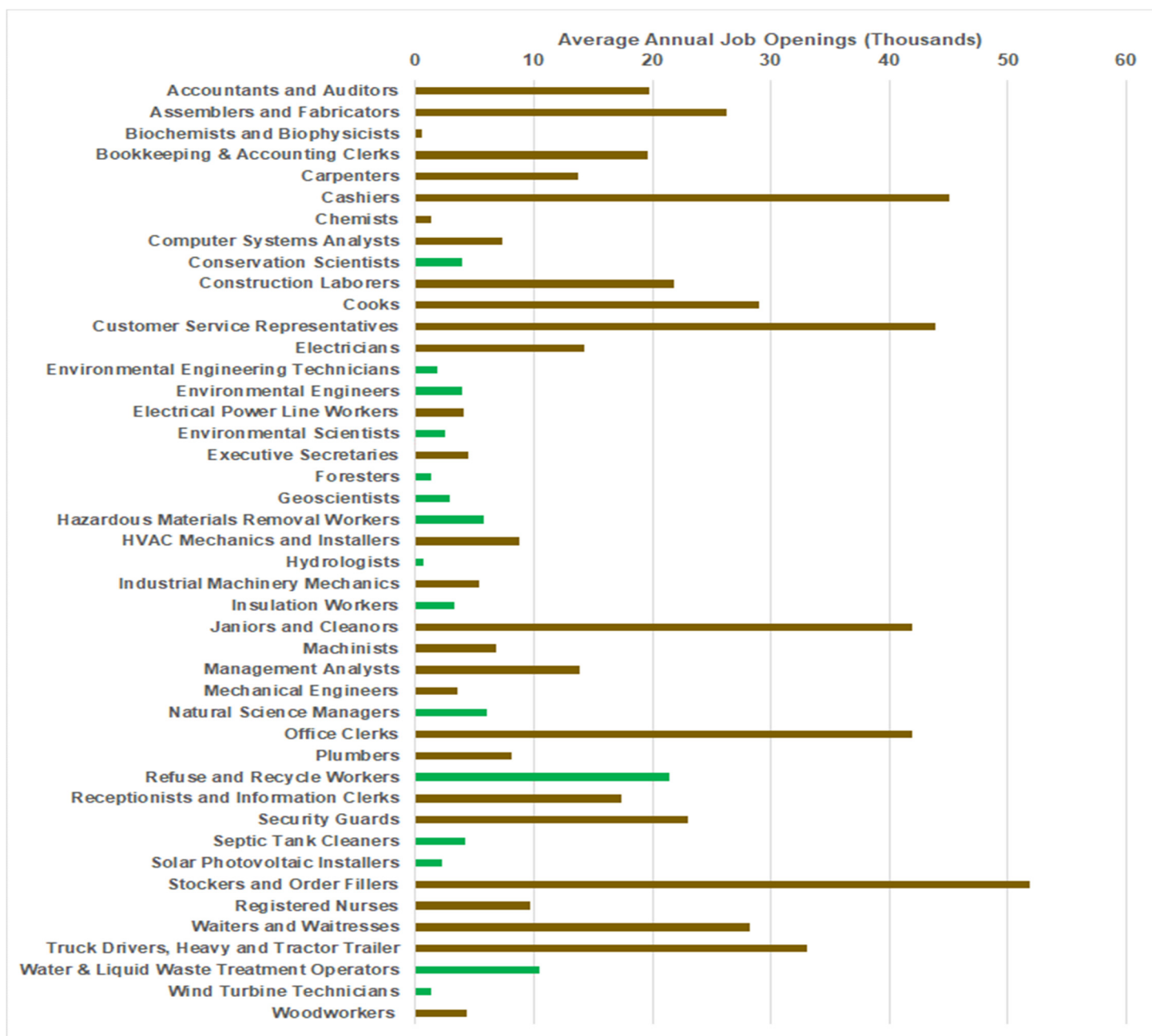
Figure 7. Average annual job openings generated by the U.S. green economy, 2021-2030, by selected occupations

Source: BLS, EIA, and MISI.

Over the coming decade, there will be relatively few annual job openings for Wind Turbine Service Technicians or for Solar Photovoltaic Installers.[14] Accordingly, it is not optimal policy to produce many thousands of workers annually certified in these occupations given the relatively small number of annual job openings available. The end result is likely to be disappointed workers trained in these skills functioning as baristas and fast-food workers. Policymakers should realize that jobs and job training programs must realistically target occupations and skills that have large numbers of workers and that are growing rapidly.

Thus, policymakers must resist fixation on "sexy" green jobs such as Wind Turbine Technicians and Solar Photovoltaic Installers, for which there will be relatively few annual new job openings. This fixation could result in misguided and self-defeating jobs and jobs training programs. It must be emphasized that many occupations contain many more workers, are growing rapidly, will continue to employ many more workers and, crucially, will provide many more annual job openings than will most green jobs.

Green investments will provide a greater than proportionate assist to the USA high-tech and manufacturing sectors, and green investments generate proportionately more jobs in professional, scientific, and technical services than the USA average.[15] This has important implications for economic, jobs, and education and training programs. Nevertheless, green jobs will continue for the foreseeable future to comprise only a small portion of total USA jobs. Employment and job creation programs must take such discrepancies into account.

Further, as noted, even for certifiable green occupations, over the coming decade most of annual job openings generated by the green economy will not be for the types of glamorous green jobs that are the most publicized and hyped; e.g., Wind Turbine Service Technician, Solar Photovoltaic Installer, Environmental Scientist, etc. Rather, most of annual job openings generated by the green economy will be for occupations such as, for example: Refuse and Recycle Workers – 21,400 annual job openings; Water and Waste Treatment Plant Operators – 10,500 annual job openings; Hazardous Materials Removal Workers – 5,800 annual job openings; Septic Tank Cleaners – 4,200 annual job openings; Insulation Workers – 3,300 average annual job openings. Nevertheless, it is unlikely that green job advocates will be publicizing Refuse and Recycle Workers or Septic Tank Cleaners as the glamorous "green jobs of the future."

Jobs generated by the green economy will be created across a new continuum of employment, skills, training, responsibilities, and earnings.[16] Training and retraining for new skills will be needed across a wide spectrum of industries. Some changes in skills are relatively well defined, but many remain difficult to forecast since the technologies are still evolving. Numerous job tasks currently remain unknown, and thus identification of training needs requires interactive research combined with job definition. Many of these jobs do not currently exist and do not have occupational titles defined in federal or state government occupational handbooks. Further, many of these new jobs require different skills and education than current jobs, and training needs must be determined to enable the rapidly growing green economy to have a sufficient supply of qualified employees.

6. Research Methods

The only meaningful way to compare and analyze historical and forecast economic data over a long period is to use constant dollar data, and here dollar estimates given are stated in constant 2020 dollars. MISI derived the constant 2020 dollar data (2020 = 1.00), using the GDP deflators to convert dollar values into 2020 base year estimates.[17]

The jobs issue is a key focus of this research. Specifically, the employment concept used is a full time equivalent (FTE) job in the U.S. An FTE job is defined as 2,080 hours worked annually, and adjusts for part time and seasonal employment and for labor turnover. The FTE concept normalizes job creation among full time, part time, and seasonal employment.

In estimating the impacts on the labor market, it is important to recognize that one lost or gained dollar of economic output or one lost or gained job is not the same as another. Each industry has backward linkages to economic sectors that provide the materials needed for the industry's output, and each industry also has forward linkages to the economic sectors where the industry's employees spend their income. Therefore, in addition to the jobs directly supported by an industry, a large number of indirect jobs may also be supported by that industry. Accordingly,

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[14] https://www.bls.gov/emp/tables/occupational-projections-and-characteristics.htm.

[15] Roger H. Bezdek, "The USA New Green Deal Will Create Over 18 Million Jobs," *Journal of Environmental Science and Renewable Resources*, Vol. 2, No. 1 (June 2020)

[16] Roger H. Bezdek, "The Hydrogen Economy and Jobs of the Future," op. cit.

[17] U.S. Bureau of Economic Analysis, "GDP Price Deflator," https://www.bea.gov/data/prices-inflation/gdp-price-deflator.

MISI estimated the total (direct, indirect, and induced) jobs created by the U.S. green economy:

- Direct jobs are those created directly in the specific activity or process.

- Indirect jobs are those created throughout the required interindustry supply chain.

- Induced jobs are those created in supporting or peripheral activities.

- Total jobs are the sum of all of the jobs created.

In the analysis and forecasting, MISI followed the conventions in EIA's *Annual Energy Outlook 2021* (*AEO 2021*)[18] and *Annual Energy Outlook 2020* (*AEO 2020*).[19] The other standard conventions of the EIA *AEO* reports were also adhered to. In addition, the conventions of the required BLS, BEA, and U.S. Census Bureau data bases were followed.

Table 1 presents the basic parameters MISI used in developing the forecasts – data derived from BEA, BLS, and EIA.[20] This table illustrates that, over the period 2021-2030:

- U.S. real GDP is forecast to increase 24%.

- The U.S. population is forecast to increase 6%.

- The U.S. labor force is forecast to increase 7%.

- U.S. employment is forecast to increase 10%.

- The percent of the U.S. population employed is forecast to increase from 46% to nearly 48%.[21]

There is currently intense debate over what actually is and is not included in green jobs. The problem is at least twofold. First, green jobs are conventionally – and mistakenly – defined much too narrowly. For example, green jobs are usually defined to include the "usual suspects," such as Solar Energy Engineers, Wind Turbine Technicians, Ecologists, Environmental Lawyers, etc. In reality, such narrow definitions exclude at least 90% of the actual green labor force.[22] Specifically, in green companies, most of the employees are not classified as "environmental specialists" or "green energy specialists." For example, the occupational job distribution of a typical wind turbine manufacturing company differs relatively little from that of a company that manufactures other products. Thus, wind turbine production requires large numbers of Engine Assemblers, Machinists, Industrial Engineers, Welders, Mechanics, Managers, Purchasing Agents, Accountants, etc. These are "green" workers only because the company they work for is manufacturing a renewable energy product.

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[18] U.S. Energy Information Administration, *Annual Energy Outlook 2021*, February, 2021.

[19] U.S. Energy Information Administration, *Annual Energy Outlook 2020*, January 2020.

[20] EIA forecast real U.S. GDP in 2012 dollars. MISI converted these data to constant 2020 dollars.

[21] This is not the same as the labor force participation rate, which is defined as the percentage of the population that is either working or looking for work; see https://www.bls.gov/cps/definitions.htm.

[22] MISI is the one of the few research organizations capable of rigorously remedying this serious problem. See, for example Roger Bezdek, "The USA New Green Deal Will Create Over 18 Million Jobs," *Journal of Environmental Science and Renewable Resources*, Vol. 2, No. 1 (June 2020); Roger Bezdek and Robert Wendling, "Job Creation Through Green Energy Economy," Chapter 4 in John Byrne and Young-Doo Wang (editors), *Green Energy Economies*, New Brunswick, New Jersey: Transaction Publishers, 2014, pp 49-86; Roger Bezdek, "Green Collar Jobs: Economic Drivers For The 21st Century," presented at the Environmental and Energy Study Institute Briefing, Russell Senate Office Building, January 2009; Bezdek, Wendling, Paula DiPerna, op. cit.; Roger Bezdek, "Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century," presented at the Environmental and Energy Study Institute Briefing, Hart Senate Office Building, November 8, 2007; Roger Bezdek and Robert Wendling. "Jobs Creation and Environmental Protection." *Nature*, Vol. 434, No. 7033 (March 31, 2005); Roger Bezdek, "The Environmental Protection Industry and Environmental Jobs in the U.S.A.," in Leal Filho and Kate Crowley, eds., *Environmental Careers, Environmental Employment, and Environmental Training: International Approaches and Contexts*. Frankfurt am Main: Peter Lang Publishers, 2001, pp. 161-179; Roger Bezdek, "The Economy, Jobs, and the Environment." *Proceedings of GEMI '95: Environment and Sustainable Development*, Arlington, Virginia, March 1995, pp. 65-79; Roger Bezdek "The Net Impact of Environmental Protection on Jobs and the Economy." Chapter 7 in Bunyan Bryant, editor., *Environmental Justice: Issues, Polices, and Solutions*, Washington, D.C.: Island Press, 1995, pp. 86-105; Management Information Services, Inc., *Potential Economic and Employment Impact on the U.S. Economy of Increased Exports of Energy Efficiency and Environmental Technologies Under NAFTA,* report prepared for the White House, 1993; Roger Bezdek, "Environment and Economy: What's the Bottom Line?" *Environment*, Vol. 35, No. 7 (September 1993), pp. 7-32; Roger Bezdek and Robert Wendling. "Environmental Market Opportunities." Chapter 9 in T.F.P. Sullivan, editor, *The Greening of American Business*, Rockville, Maryland: GII Press, 1992, pp. 196 – 224; Roger Bezdek, "The Economic and Employment Effects of Investments in Pollution Abatement and Control Technologies." *Ambio*, Vol. XVIII, no.3, (1989), pp. 274-279.

Table 1. Forecast parameters

Year	Real GDP (billion 2020 dollars)	Population (millions)	Labor Force (millions)	Employment (millions)
2020	$20,936	330	161	148
2021	$21,292	333	163	153
2022	$21,990	335	165	157
2023	$22,918	337	167	161
2024	$23,706	340	168	163
2025	$24,080	342	169	165
2026	$24,604	344	170	166
2027	$25,086	346	171	167
2028	$25,539	348	172	167
2029	$25,972	351	173	168
2030	$26,462	353	174	168

Source: BLS, EIA, and MISI.

Second, conventional definitions do not include indirect and induced green jobs. As noted, MISI defines total jobs generated by the green economy -- direct, indirect, and induced. This concept is critical because indirect and induced jobs comprise a major portion of green jobs, and this is not accounted for in current green job definitions or estimates.

Ex ante green jobs estimation using BLS occupational classification data can never identify more than a small portion of the jobs generated by the green economy. This is why MISI uses the interindustry ex post approach to estimate the total jobs created by the U.S. green economy. The jobs impacts of the green economy are estimated using the MISI model, data base, and information system.[23] A simplified version of the MISI model as it was applied here is summarized in Figure 8.

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[23] The basic MISI methodology and model are documented in Management Information Services, Inc., *Development of Economic and Job Impacts Analysis Tool and Technology Deployment Scenario Analysis*, report prepared for the U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-402/092509, September 2009. For applications, see Roger H. Bezdek, "The USA New Green Deal Will Create Over 18 Million Jobs," https: //www.researchgate.net/publication/344228366_Journal_of_ Environmental_Science_and_Renewable_Resources_The_USA_New_Green_Deal_Will_Create_Over_18_Million_Jobs; Roger H. Bezdek, "Job Creation Under The New Green Deal," https://www.greenenerg ytimes.org/2020/06/job-creation-for-millions-under-the-green-new-deal/; Roger H. Bezdek, "Economic and Job Forecasts For the Sustainable Energy Industries in the USA," *International Journal of Engineering and Applied Sciences*, https://media.neliti.com/media/ publications/257646-economic-and-job-forecasts-for-the-susta-49946d25.pdf; Roger H. Bezdek and Robert Wendling, "Economic and Jobs Impacts of Enhanced Fuel Efficiency Standards for Light Duty Vehicles in the USA," *International Journal of Engineering and Innovative Technology*, https://www.ijeit.com/Vol%204/Issue%207/ IJEIT141 2201501 _22.pdf; Roger H. Bezdek and Robert Wendling, "The Jobs Impact of GHG Reduction Strategies in the USA," *International Journal of Global Warming*, https://www.inderscience.com/info/inarticle.php?Artid=66 046.
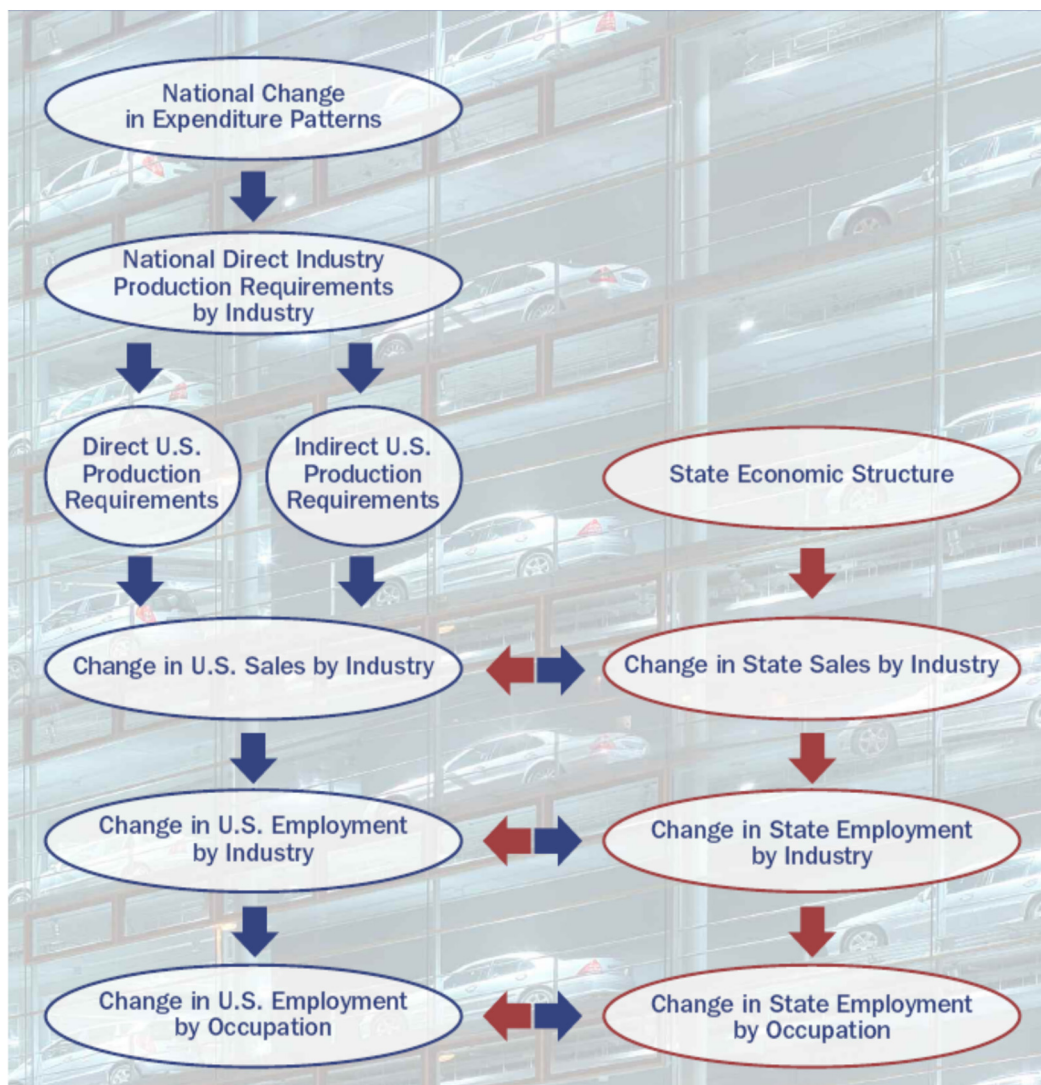
Figure 8. Use of the MISI model to estimate the jobs impacts of the green economy*

*Background depicting fuel efficient, hybrid, and ZEV vehicles.

Source: Management Information Services, Inc.

The first step in the MISI model involves translation of green economy expenditures into per unit output requirements from every industry in the economy.[24] Second, the direct output requirements of every industry affected as a result of the expenditures are estimated, and they reflect the production and technology requirements implied. These direct requirements show, proportionately, how much an industry must purchase from every other industry to produce one unit of output. Direct requirements, however, give rise to subsequent rounds of indirect requirements. The sum of the direct plus the indirect requirements represents the total output requirements from an industry necessary to produce one unit of output. Economic input-output (I-O) techniques allow the computation of the direct as well as the indirect production requirements, and these total requirements are represented by the "inverse" equations in the model.

Thus, in the third step in the model the direct industry output requirements are converted into total output requirements from every industry by means of the I-O inverse equations. These equations show not only the direct requirements, but also the second, third, fourth, nth round indirect industry and service sector requirements resulting from green economy expenditures.

Next, the total output requirements from each industry are used to compute sales volumes, profits, and value added

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[24] While the MISI model contains 500 industries, in the work conducted here an 80-order industry scheme was used.

for each industry. Then, using data on man-hours, labor requirements, productivity, and employment requirements within each industry are estimated. This allows computation of the total number of jobs created within each industry. Utilizing the modeling approach outlined above, the MISI model allows estimation of the effects on the economy and jobs.

The next step requires the conversion of total employment requirements by industry into job requirements for specific occupations and skills. To accomplish this, MISI utilizes data on the occupational composition of the labor force within each industry and estimates job requirements for 1,000 occupations encompassing the entire U.S. labor force. This permits estimation of the impact of green economy expenditures on jobs for specific occupations.

Utilizing the modeling approach outlined above, the MISI model allows estimation of the effects on employment, personal income, corporate sales and profits, and government tax revenues in the U.S. Estimates can then be developed for detailed industries and occupations.

The final step in the analysis involves assessing the economic impacts on individual states, which can be estimated using the MISI regional model, which allows the flexibility of specifying multi-state, state, or county levels of detail – this was not part of the current analysis. The MISI model recognizes that systematic analysis of economic impacts must also account for the inter-industry relationships between regions, since these relationships largely determine how regional economies will respond to project, program, and regulatory changes. The MISI I-O modeling system includes the databases and tools to project these interrelated impacts at the regional level. The model allows the flexibility of specifying multi-state, state, or county levels of regional detail. Regional I-O multipliers can be calculated and forecasts made for the detailed impacts on industry economic output and jobs at the state level for 50 states and D.C. Because of the comprehensive nature of the modeling system, these state impacts are consistent with impacts at the national level, an important fact that adds to the credibility of the results since there is no "overstatement" of the impacts at the state level.

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