Defining and Estimating the U.S. Green Economy and Green Jobs

Prepared by
Management Information Services, Inc.
for

WorkingNation

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FOREWORD

Green Jobs Now. Why we're talking about them.

Since our launch in August of 2016, WorkingNation has had a very clear mission: tell stories about solutions to today's workforce issues and point people in the direction of opportunities that will prepare them for the skills they need to get good, life-sustaining jobs or careers.

For the last two years, we have collectively held our breath while waiting for things to "return to normal." But as we embark on the year 2022, we face a new challenge — one that is less about getting things back to the way they were and more about embracing a future that is entirely different from what we once imagined. Social isolation, an unpredictable job market, and financial uncertainty have taken a mental and physical toll on the American worker, who has grown weary and exhausted. At present, it feels like our nation's recovery hinges on instilling hope for a brighter tomorrow.

So, where do we begin? Our answer is with jobs.

We see job opportunities across the entire economy, but we believe one area that deserves a more in-depth look is the green economy. All too often, conversations about the environment focus solely on the threats to our planet. But protecting and repairing the environment is not just good news for our world, it is also good news for the American worker. With the passage of the *Infrastructure Investment and Jobs Act* at the end of 2021, we know that most of the new infrastructure is being designed or built with climate resilience in mind — and with that comes the potential for massive job creation.

The world of work is changing rapidly and so are the skills needed to successfully compete in today's workforce. The public and private sectors are already hard at work on initiatives and programs to ensure that all Americans have access to opportunities that will ready them for the jobs of today and tomorrow. WorkingNation continues the work we started more than five years ago to tell stories that will point the American worker toward life-sustaining, purposeful jobs. With that in mind, we invite you to read, watch, and listen to our newest storytelling series, *Green Jobs Now*, in which we'll showcase the enormous potential in the green economy, moving it to the foreground in the vital discussion about the future of work.

To help us better inform and shape our journalism, podcasts, and video content, we've partnered with two respected and established leaders in research, data collection, and data analysis -- Emsi Burning Glass, a leading authority on job skills, workforce talent, and labor market dynamics, and MISI, an economic and energy research firm specializing in the environment.

From MISI, we learn that 9% of the American workforce is in a green job already and that number is expected to grow enormously over the next decade. From Emsi Burning Glass, we learn that job postings in the green economy were up 17% in 2021 over the previous year.

So, what do you need to know to be a part of this growth?

Using the original research and analysis, and our skills as journalists and storytellers, *Green Jobs Now* will answer the following questions:

- *What is a green job? Is the current definition too narrow?*
- *Where are the green jobs of today and who is hiring?*
- *What skills are employers looking for to fill these jobs?*
- *How can you acquire the skills that you need to make you employable in this space for years to come?*

It is vitally important to reconsider and expand upon the traditional definition of a green job in order for workers, employers, workforce groups, advocacy teams, and policymakers to see these jobs as an economic driver regionally and nationally in a way they may not have considered before.

Federal authorization for new infrastructure will undoubtedly create jobs in construction, water purification, and solar or electric energy associated with these upgrades. But what about the architects and engineers doing these designs? What about workers installing climate-friendly insulation or water-efficient plumbing in office buildings and homes, which directly and positively impact the environment?

Research tells us those are green jobs too.

Tech companies, law firms, hospitals and retail are already hiring for green positions, but the language describing those jobs is too narrow to connect them to the environment. So these opportunities are not counted as green — even though they should be.

We believe this redefinition and reconsideration is necessary to change how state and local leaders and labor groups talk about the jobs in their region in a way that is inspirational and shows growth.

Over the next year on WorkingNation.org, we will use our original research to tell stories on a national, state, and local level. We will be talking to employers whose businesses have already embraced the green economy, and we will introduce the training programs that will prepare jobseekers with the valued and in-demand skills they need to thrive in this space.

Thanks to the Walton Family Foundation and other funders for making this important and timely discussion of green jobs possible.

We hope that our stories will inspire Americans to appreciate that not only can they attain a great job in any number of sectors, but their work can have a tangible impact on the environment, even if they are not employed in occupations traditionally considered green.

Joan Lynch

Joan Lynch
WorkingNation Chief Content and Programming Officer

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report contradicts disinformation being disseminated by analysts and interest groups who are opposed to green programs and green jobs initiatives and who are attempting to minimize their potential significance.

However, the findings here also upend much of the conventional wisdom being propagated at present by environmental, clean energy, and green jobs organizations and advocates. Further, the findings derived here are of direct relevance to many of the economic, environmental, and job issues currently being debated in the U.S., including infrastructure spending, climate mitigation policies in the wake of COP 26, the Green New Deal, and green jobs, employment, and training policies.

This report can become an acknowledged definitive authority and source for data and analysis on the U.S. green economy and green jobs.

The COVID-19 pandemic has exacerbated worrying trends in the U.S. economy related to the jobs skills gap that is threatening to disrupt the labor market. There is a growing mismatch between the skills that employers want and the skills that employees have and, as the economy struggles to fully reopen, that warning is more relevant than ever, especially for the green economy and green jobs.

A major purpose of this report is to provide compelling empirical information that will facilitate initiatives to develop solutions to the jobs skills gap, especially as they relate to the emerging and rapidly growing U.S green economy and jobs it creates. Specific findings and their implications are summarized below.

The Size of the Green Economy

Perhaps the most important finding derived here is that the U.S. green economy and the jobs generated by it are much larger and more important than is generally realized, are growing more rapidly than the overall U.S. economy or employment, and will continue to increase rapidly in both absolute and percent terms.

Jobs generated by the U.S. green economy currently total nearly nine million and comprise 6% of total U.S. jobs (Figure 1). By 2030, jobs generated by the U.S. green economy are forecast to total nearly 24 million and comprise about 14% of total jobs (Figures 2 and 3).

These estimates are much larger than most currently available green jobs estimates. This information can be critical in garnering support for the green economy and for green initiatives, programs, and incentives. The information can be disseminated to policymakers to emphasize that green jobs in the U.S. are being seriously under-estimated and that the potential implications of this for jobs and training programs are serious.

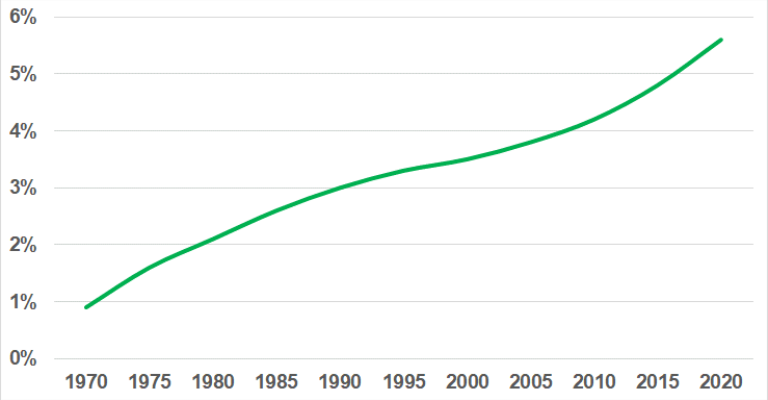
The rapid historical growth of the U.S. green economy and jobs is not recognized, and its significance is not appreciated.
Over the five decades from 1970 to 2020, jobs generated by the U.S. green economy increased from less than 1 million and 1% of total U.S. jobs in 1970 to over 8 million jobs and 6% of total jobs by 2020.

By 2030, MISI forecasts that the jobs generated by the U.S. green economy will total nearly 24 million and will comprise 14% of total jobs in the economy.

Over the six decades from 1970 to 2030, jobs generated by the U.S. green economy are forecast to increase nearly 16 times as rapidly as total U.S. jobs.

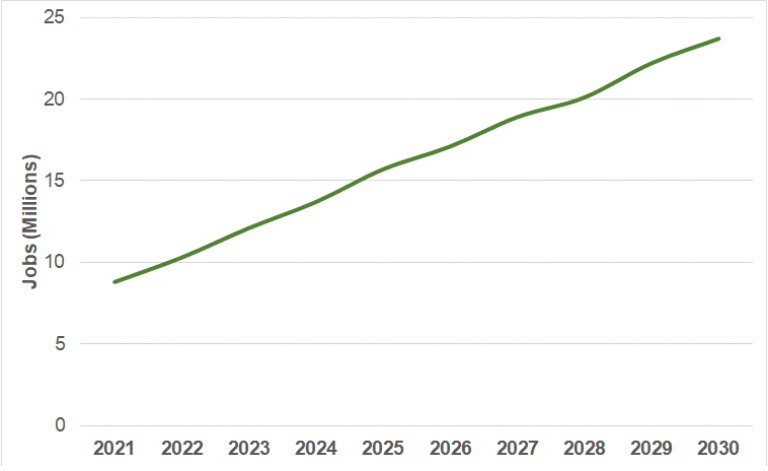
Thus, encouraging green/environmental industries and initiatives nationally and in specific states can form an integral part of economic development strategy and innovative learning opportunities and solutions to the national/state/local jobs skills gap.

Figure 1: Jobs Generated by the U.S. Green Economy as a Percent of Total U.S. Jobs, 1970 - 2020



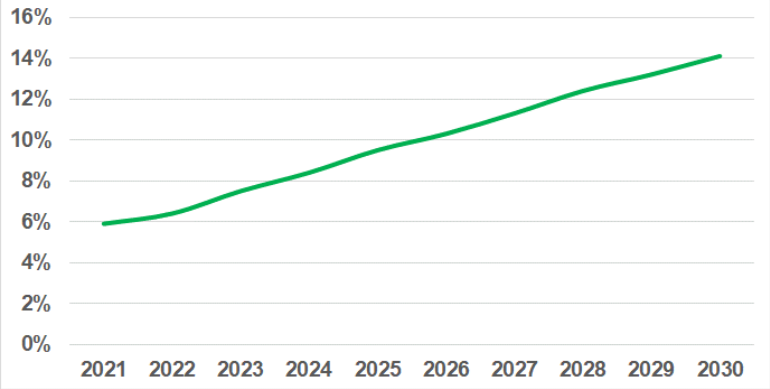
Source: U.S. Bureau of Labor Statistics and MISI.

Figure 2: Jobs Generated by the U.S. Green Economy Forecast, 2021 - 2030



Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.

Figure 3: Jobs Generated by the U.S. Green Economy as a Percent of Total U.S. Jobs Forecast, 2021 - 2030



Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.

Another important finding is that most jobs generated by the U.S. green economy are not "green" (Figure 4). Rather, the vast majority of the jobs generated are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc., and most of the persons employed in these jobs do not realize that they owe their livelihood to the green economy.

This information can be used to 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 in the U.S. are dependent on the green economy for their employment, although they have no way of recognizing this unless it is brought to their attention. Many companies in the U.S., whether they realize it or not, owe their profits – and in some cases their existence – to "green" expenditures.

This will be a revelation to green jobs advocates and others and represents a major contribution to the debate.

Figure 4: Jobs Generated by the U.S. Green Economy in 2030, by Selected Occupations

Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.

Defining a Green Job

There is no consistent definition – in the U.S. or internationally – of a "green job." Further, it is impossible to develop such a definition, and different organizations and researchers have different concepts and definitions of green jobs, many of which are inconsistent and 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.

Accordingly, numerous attempts have been made to define and estimate green jobs by means of occupational classifications, industry sectors, surveys, "transactional triangulation," and various other methods. 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 classified as green and limiting the scope only to businesses that produce green products or services excludes green-related jobs at traditional firms.

The major disadvantage of the survey approach is that interpretation of what constitutes a green job is often left up to survey respondents. Approaches such as transactional triangulation are difficult to evaluate, are impossible to consistently replicate, and are not comparable to job estimates derived from available national statistical data bases.

Different estimates of U.S. green jobs are available from a variety of government and non-government sources, and they evidence a wide range of green jobs estimates depending on the green job definition, the source of the estimate, and other factors. Even estimates from the same organization can differ substantially.

State green jobs estimates also differ markedly and illustrate the enormous range of green jobs estimates among states and even for the same state. Different organizations and states produce vastly different estimates of green jobs at the national and state levels.

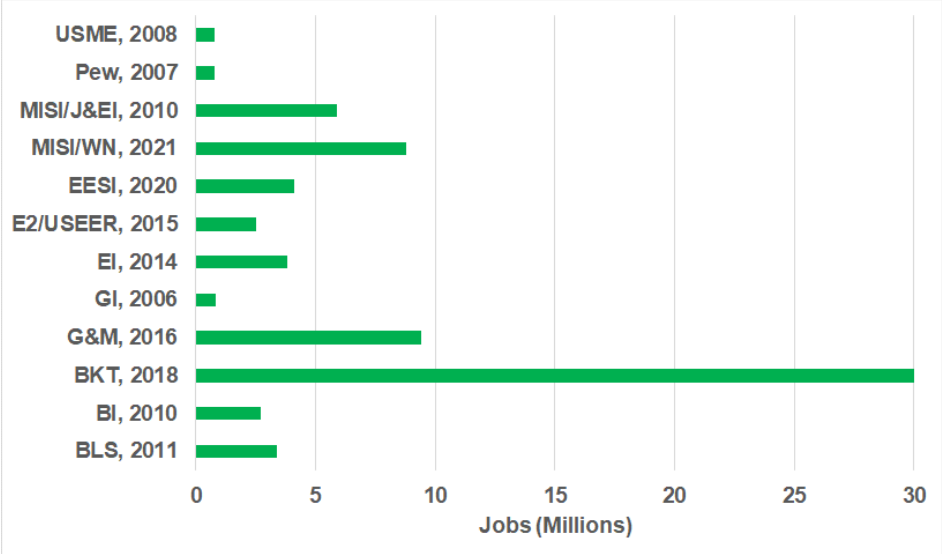
The national estimates differ by a factor of 40, and even the most recent estimates differ by a factor of 10 (Figure 5), and the state estimates also differ markedly. Critically, until now, there has been no consistent time series database of green jobs estimates available at the national level or for any state, and this is a serious failing. For, as Abraham Lincoln once stated, "Prior to determining where we are going, we must first ascertain from whence we came."

The MISI green job concept does not attempt to develop a unique green job definition based on industrial or occupational characteristics or on survey methods. Rather, MISI defines green jobs as those full time equivalent (FTE) jobs generated – directly, indirectly, or induced – by the activities of the green economy. This approach has at least five advantages:

1. It does not bog down into interminable debates over a specific green job definition.
2. It corresponds to interindustry job creation concepts that have been validated over the past half-century and utilized in many disparate economic and job impact analyses.
3. It provides a consistent national data base of estimates of jobs generated by the U.S. green economy over the past five decades.
4. It is viable and credible and produces neither the highest nor the lowest estimates of U.S. green jobs.
5. It emphasizes that most of the jobs created by the green economy are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, etc.,

that the classic green job (solar energy engineer, ecologist, etc.) constitutes only a small portion of the jobs created, and that most of the persons employed in the jobs created may not even realize that they owe their livelihood to the green economy.

Figure 5: Examples of the Variation in U.S. 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 -- U.S. Energy Employment Report; USME -- U.S. Metro Economies; WN – Working Nation.

A Closer Look at the Green Economy

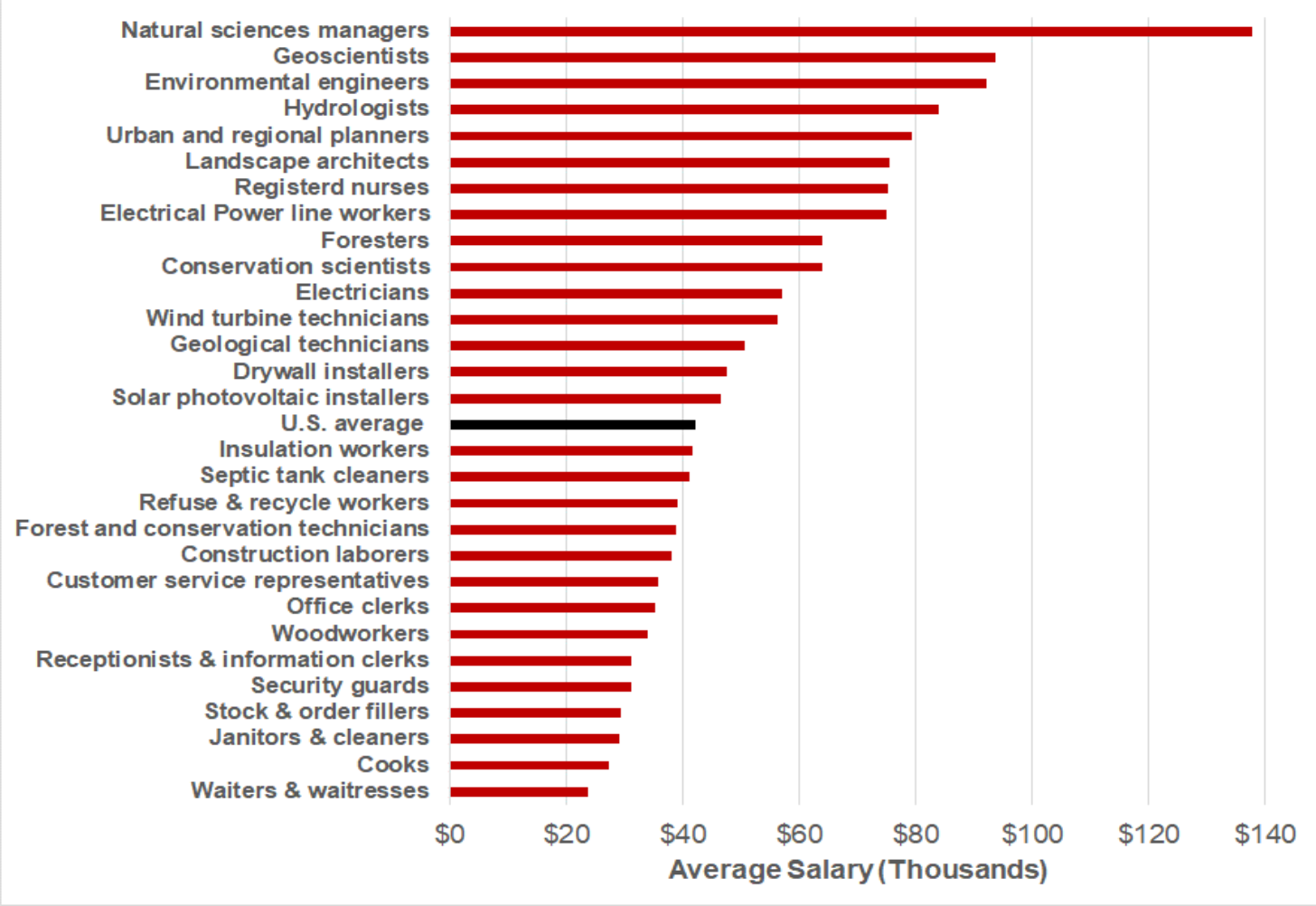
Much discussion and analysis of U.S. green jobs are based on the U.S. Energy and Employment Report (USEER) studies. However, this is misleading and inaccurate: i) The USEER estimates only direct employment in the energy industries – less than 1 million workers, which is only about 0.5% of total U.S. employment and equals only about 10% of the total number of jobs generated by the green economy – and many of the USEER energy jobs are not "green;" ii) the USEER data exclude the overwhelming majority of jobs generated by the green economy – not only indirect and induced jobs, but also green jobs that are not energy related; iii) there are serious methodological and empirical problems with the USEER estimates.

MISI here resolves the contentious debate over the relative salaries of green jobs compared to non-green jobs. Since the vast majority of jobs generated by the U.S. green economy are standard "non-green" jobs, the average salaries for these jobs must – due to the law of large numbers – be relatively close to the U.S. average. The U.S. green economy generates disproportionately more jobs in professional, scientific, and technical services occupations than the U.S. 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 U.S. 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 certifiable green jobs created – Refuse and Recycle Workers, Insulation Workers, and Septic Tank Cleaners – pay below average wages. Thus, at best, the average salary for all of the jobs generated by the U.S. green economy may be only slightly higher than the U.S. average – and the difference is likely to be in the statistical noise of the estimates.

It is simply not valid to contend that the jobs generated by the U.S. green economy pay wages and salaries that are significantly higher – or significantly lower -- than the U.S. averages. However, policy initiatives could be focused on increasing the salaries for green jobs and for greatly increasing the rate of unionization of green jobs.

Figure 6: Average 2020 Annual Salaries of Selected Jobs Generated by the Green Economy



Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.

Many or even most jobs in firms producing green products or services are not necessarily green. For example, in a typical wind turbine 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.

Environmentalists and green jobs advocates can be their own worst enemies. Numerous organizations, advocates, and politicians have significantly tightened the criteria for defining and characterizing green jobs and have, paradoxically, greatly reduced the number of jobs that can according to these criteria or characteristics be legitimately defined as being “green.”

The more stringent the criteria, the fewer the jobs that are defined as green. The reality is that the overwhelming majority of jobs created by the green economy may not adhere to the stringent criteria. A very strict list of necessary criteria will greatly reduce the estimate of the number of green jobs in the economy. Utilization of these criteria will very seriously underestimate the size, importance, and rates of growth of the U.S. green economy and the jobs created by the green economy. 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 the publicity from environmental organizations and green jobs advocates, many green jobs are not necessarily glamorous, exciting, or desirable. Thus, current and forecast jobs 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 Engineering Technician. It is thus essential to be realistic as to the “green jobs of the future” and to the education and training policies implemented concerning green jobs.

There are a large number of studies contending both that environmental regulations and green initiatives create substantial numbers of jobs and just the opposite – that they destroy jobs or create negative net jobs. Nevertheless, the balance of research indicates that investments in environmental and green energy programs have favorable net positive economic and jobs benefits.

However, the net positive economic and jobs impacts, while significant and powerful for policy purposes, should not blind us to the fact that the major purpose and rationale for these programs are the energy and environmental and benefits they will create. The cart should not be put before the horse: The energy and environmental and benefits are the reason these programs are necessary and desirable. Jobs benefits are an important secondary benefit and should be evaluated as such.

The BLS occupational data are of high quality, are essential for green jobs analysis and forecasting, and they are the basis for most state job analyses and forecasts. The BLS data are the gold standard. Nevertheless, the BLS classifications have some serious shortcomings and limitations for green jobs assessments.

One major 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 – and thus state 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 Bookkeeping Clerk," "Green Carpenter," etc. Further, how "green" an occupation or skill 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 the existing BLS occupational classification data is that they do not identify new and emerging jobs being created by the rapidly growing U.S. green economy and green industries.

Building a Pipeline of Green Jobs Workers

Identification of the job openings and the requisite skills, education, training, and experience required is especially important for education and training purposes.

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 successfully 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 supply of 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 growing mismatch between the skills that employers want and the skills that employees have.

MISI estimated the average annual occupational 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 U.S. job openings generated by the green economy will total 30 times as many Office Clerks (42,000) as Wind Turbine Service Technicians (1,400); more than 11 times as many Assemblers and Fabricators (26,300) as Solar Photovoltaic Installers (2,300); more than 16 times as many Construction Laborers (22,000) as Foresters (1,400); and 11 times as many Customer Service Representative (44,000) as Environmental Engineers (4,000). Thus, over the coming decade, annual total U.S job openings for Wind Turbine Service Technicians will total only 1,400 and for Solar Photovoltaic Installers will total only 2,300.

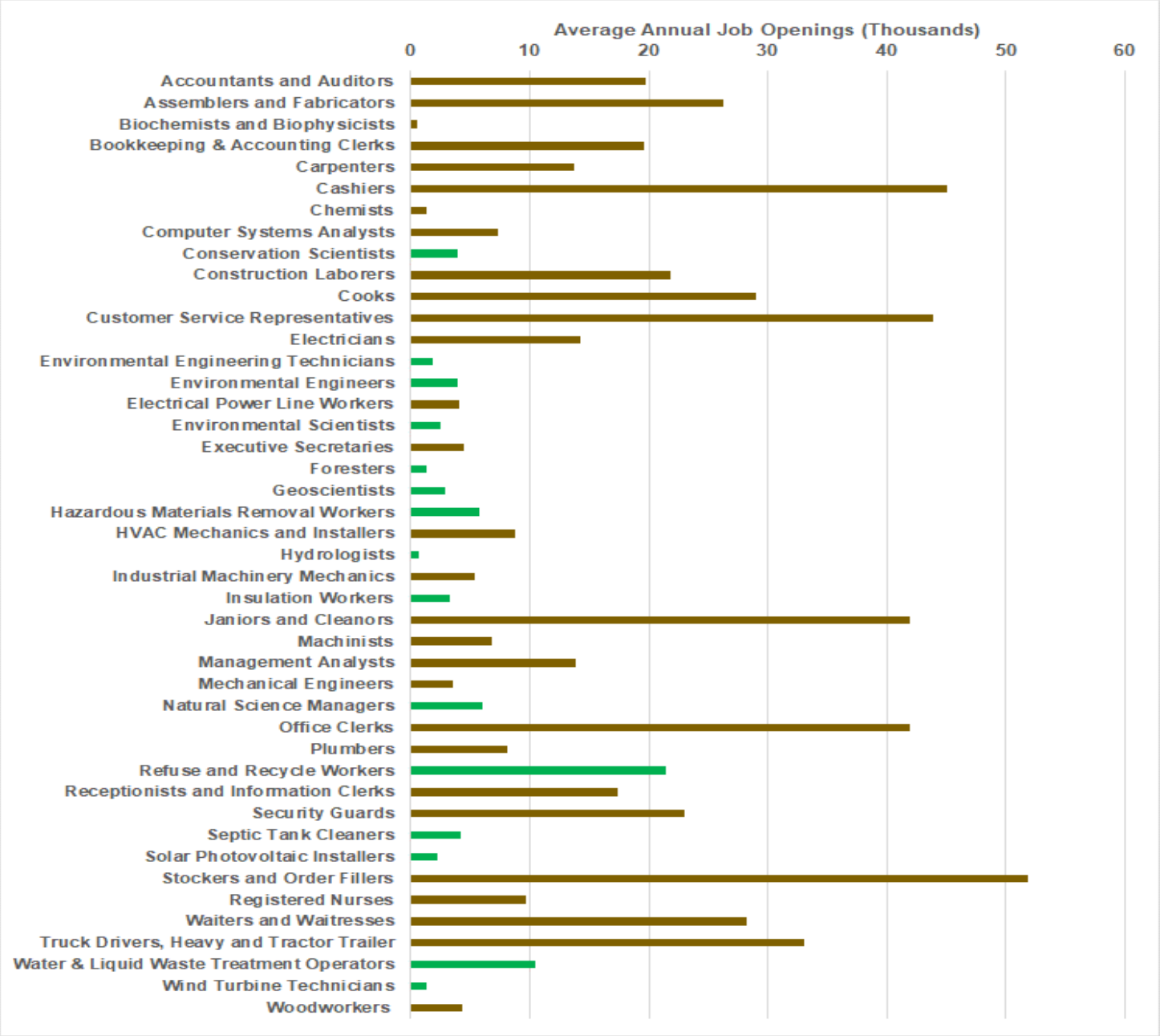
It is not optimal educational or training policy to plan to produce many thousands of workers annually certified in these occupations given the relatively small number of annual job openings likely to be available. The end result is likely to be disappointed workers trained in these skills functioning 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.

Policymakers must resist fixation on “sexy” green jobs such as Wind Turbine Technicians and Solar Photovoltaic Installers, where annual new job openings in the entire U.S. will total only about 1,000 to 2,000 annually. 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.

Figure 7: Average Annual Job Openings Generated by the U.S. Green Economy, 2021-2030, by Selected Occupations



Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.

Green investments will provide a greater than proportionate assist to the U.S. high-tech and manufacturing sectors, and green investments generate, proportionately, more jobs in professional, scientific, and technical services than the U.S. average. This has important implications for U.S. economic, jobs, and education and training programs. Nevertheless, green jobs will continue for the foreseeable future to comprise only a small portion of total U.S. jobs. Any ambitious 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 green job openings generated by the green economy will be for occupations such as, for example: Refuse and Recycle Workers – 21,400 average annual job openings; Water and Waste Treatment Plant Operators – 10,500 average annual job openings; Hazardous Materials Removal Workers – 5,800 average annual job openings; Septic Tank Cleaners – 4,200 average annual job openings; Insulation Workers – 3,300 average annual job openings.

Nevertheless, it is unlikely that any of the environmental organizations or green job advocates will be publicizing Refuse and Recycle Workers or Septic Tank Cleaners as the glamorous and exciting “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. 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 likely changes 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 and employment guides. 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 trained and qualified employees.

Examples of the type of new jobs and requisite skill requirements being created in the green economy – and the associated challenges for workforce planning – were illustrated here by assessing the rapidly growing hydrogen and fuel cell industries. Growth in the hydrogen (H_2) and fuel cell (FC) industries will lead to substantial new employment opportunities, and these will be created throughout a wide variety of industries, skills, tasks, and earnings.

However, many of these jobs do not currently exist and do not have occupational titles defined in official classifications – as is the case for many new and emerging green economy jobs. MISI identified by occupational titles and job descriptions the new jobs that will be created in the expanding H_2/FC cell economy, estimated the average salary for each job, identified the minimum educational attainment required to gain entry into that occupation, specified the recommended university degree for the advanced educational requirements, and provided relevant job descriptions (Figure 8).

These findings can be applied to a wide range of industries, occupations, and skills being created and expanded by the green economy.

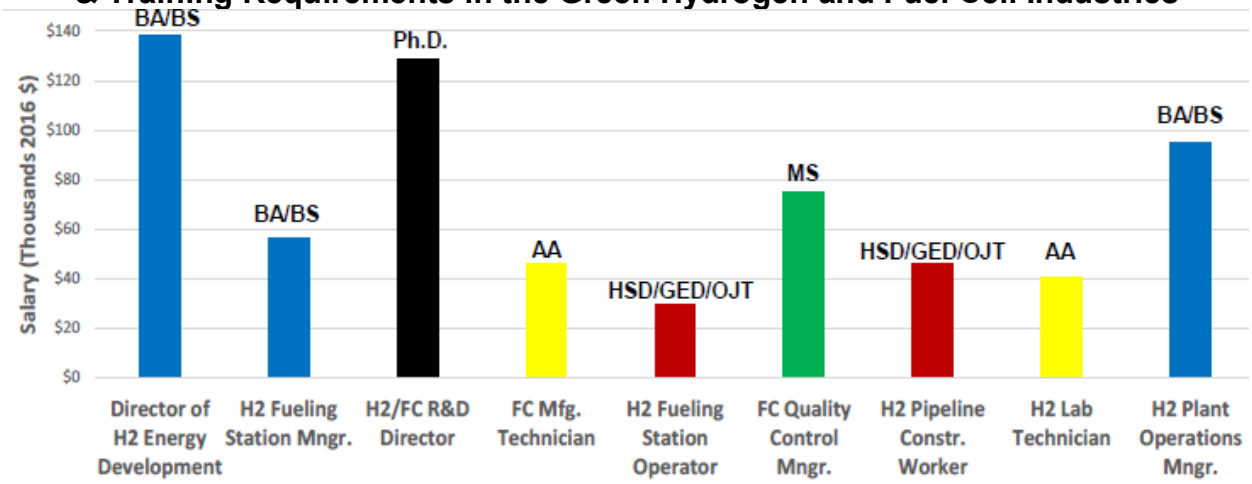
Finally, while conventional debate on the environment, climate change, and alternative energy has focused on applying new technology to offset traditional energy sources, the green economy and related green industries are more than sources of fuel or energy savings. They are sources of jobs.

This report shows that employment growth in the jobs generated by the green economy varies greatly among the different segments of the industries, but breakthroughs in alternative energy and environmental technologies will emerge from the growing sectors of the industries, including architectural and engineering services, manufacturing, IT & smart systems, materials processing, systems design, and R&D.

In addition, utilities are pioneering a number of alternative energy technologies, including H_2 blending with natural gas and superconducting power lines, solar thermal, photovoltaic, H_2/FC, wind systems, and distributed power technologies. However, increasingly advances and breakthroughs in the green economy will come from all areas of the economy and may not necessarily be captured by traditional industry sources of energy/green technologies or current job classifications.

This represents both a challenge and an opportunity. The opportunity is to get ahead of the curve on how and where the jobs of the future are being created as the economy rebuilds from COVID-19, determine which are the best green economy sectors to target, assist companies and communities seeking solutions to their unique workforce issues, and identify for workers and job seekers where the jobs of the future will be. Thus, the opportunity is to identify where these industries, companies, and jobs currently are and where they will be in the near future. There is widespread interest in this type of information from workers, companies, and all levels of government.

Figure 8: Examples of Select Jobs, Salaries, and Education & Training Requirements in the Green Hydrogen and Fuel Cell Industries



Source: MISI.

In sum, this report contains a wealth of valuable information. It makes major contributions to the issues of the green economy, green jobs, evolving jobs skills, and requirements, and the education and training requirements that will be required for jobs post COVID-19.

Post-pandemic, the U.S. will require a clear understanding of the skills required for new jobs -- especially jobs created by the green economy. This report provides critically needed information relating to emerging new green jobs, the experience, skills, and education and training required for these jobs, and the salaries that can be expected, and helps identify for workers, job seekers, and policy-makers where the green jobs of the future will be.

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About WorkingNation

Launched in 2016, WorkingNation focuses on raising awareness of the gaps between the skills workers and job seekers have and the skills employers need and want in their 21st century workforce. WorkingNation knows that it is necessary to ignite a national conversation about the future of work and equitable access to opportunity, especially as we navigate a post-pandemic recovery which has accelerated tech innovation and changes in the way we work.

It is imperative that we frame and deliver strong messages to multiple audiences with a strategic approach. WorkingNation does this through our focused storytelling—articles, video, podcasts, and live events—that both informs the supply-and-demand sides of the workforce equation and champions scalable solutions.

For more information, please visit the WorkingNation website.

About Management Information Services, Inc. (MISI)

Management Information Services, Inc. is an economic and energy research firm with expertise on a wide range of complex issues, including energy, electricity, utilities, labor markets, and the environment. The MISI staff offers specializations in economics, engineering, and finance, and includes former senior officials from private industry, the federal government, and academia.

For more information, please visit the MISI website.

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I. INTRODUCTION

There is currently intense controversy concerning the definition of green jobs, their magnitude and distribution, the issue of net job creation, and the education, training, skills, and salary levels related to green jobs. These controversies are currently especially relevant due to, for example:

- The current lack of consistent definitions and estimates of green jobs and the green economy.
- The increasing prevalence of green jobs in the U.S. economy.
- The rapid growth of these jobs that is forecast.
- The increasing emphasis on environmental and climate concerns.
- The Biden Administration's infrastructure, Green New Deal, clean energy, and related initiatives.
- The skepticism expressed by organized labor with respect to potential job displacement and salary differentials.

This report addresses these and related issues and controversies. Specifically, it:

- Delivers ground-breaking research on these critical topics.
- Presents findings, conclusions, and recommendations for potential projects and initiatives.
- Provides the data and estimates compiled in an electronic format that will enable interested parties to develop relevant searchable databases and valuable IT applications.

The report is organized as follows:

- Chapter II summarizes and analyzes international definitions of the green economy and green jobs.
- Chapter III analyzes the net jobs issue.
- Chapter IV summarizes and analyzes definitions of the U.S. green economy and U.S. green jobs.
- Chapter IV presents estimates of the current U.S. green economy and green jobs.
- Chapter V forecasts the U.S. green economy and green jobs.
- Chapter VI discusses the implications of the findings.

II. DEFINING THE GREEN ECONOMY AND GREEN JOBS

II.A. Defining the Green Economy

II.A.1. International Origin of the Definition

Historical Perspective

The environment and energy can no longer be treated in isolation from mainstream economics and economic policy. Although integrating environmental and related concerns in macroeconomic policies has been long recommended as far back as the Brundtland Commission in 1987,[1] efforts have been insufficient to achieve this goal. In most instances, the environment continues to be addressed as a separate component without clear linkages to social and economic aspects.[2] However, efforts to transition to a sustainable development path and realize the objectives of the UN's Agenda 21 have met with mixed results.[3]

The concept of a "green economy" is thus not an entirely new concept. More recently, with the financial crisis in 2007 and the failure of most countries to move onto a sustainable development path, it has become evidently clear that the current development paradigm is not yielding the desired outcomes on all fronts economic, social, and environmental.[4]

There is no internationally agreed definition of green economy and at least eight separate definitions have been identified in recent publications. For example, the United Nations Environmental Program (UNEP) has defined the green economy as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient, and socially inclusive."[5] This definition has been cited in numerous reports, including those by the UN Environmental Management Group and the Organization for Economic Cooperation and Development (OECD). Another definition for green economy offered by the Green Economy Coalition (a group of NGOs, trade union groups and others conducting grassroots work on a green economy) succinctly defines green economy as "a resilient economy that provides a better quality of life for all within the ecological limits of the planet."[6]

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[1]https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

[2]One of the reasons for lack of significant progress has been inability to clearly make the business case for investing in the environment. In order to encourage policy and decision makers to invest in the environment, they need to be convinced that such a transition would result in economic benefits as well. These benefits include additional jobs generated, increased output, creation of new market niches and increased trade, and a positive impact on GDP. It is thus essential to demonstrate that there is a clear relationship between investing in the environment and socioeconomic and sustainable development.

[3]Hussein Abaza, "Green Economy: A Tool For Transitioning to Sustainable Development, https://www.readkong.com/page/green-economy-in-action-articles-and-excerpts-that-4087406.

[4]Ibid.

[5]https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=126&menu=35.

[6]https://sustainableandsocial.com/green-economic-recovery/.

The term “green economy” was first coined in a 1989 report for the Government of the United Kingdom (UK) by a group of environmental economists, entitled “Blueprint for a Green Economy.”[7] The report was commissioned to advise the UK Government if there was a consensus definition to the term "sustainable development" and the implications of sustainable development for the measurement of economic progress and the appraisal of projects and policies. Apart from the title of the report, there is no further reference to green economy and it appears that the term was used as an afterthought by the authors.

In 1991 and 1994 the authors released sequels to the first report entitled “Blueprint 2: Greening the World Economy”[8] and “Blueprint 3: Measuring Sustainable Development.[9] While the theme of the first Blueprint report was that economics can and should come to the aid of environmental policy, the sequels extended this message to the problems of the global economy, including climate change, ozone depletion, tropical deforestation, and resource loss in the developing world. All of these reports built upon research and practice in environmental economics spanning back several decades.

In 2008, the term “green economy” was revived in the context of discussions on the policy response to multiple global crises. In the context of the financial crisis and concerns of a global recession, UNEP championed the idea of "green stimulus packages" and identified specific areas where large-scale public investment could kick-start a "green economy."[10] This motivated several governments to implement significant "green stimulus" packages as part of their economic recovery efforts.

In October 2008, UNEP launched its Green Economy Initiative to provide analysis and policy support for investment in green sectors and for greening environmentally unfriendly sectors. As part of this Initiative, UNEP commissioned one of the original authors of “Blueprint for a Green Economy” to prepare a report entitled “A Global Green New Deal” (GGND), which was released in April 2009 and proposed a mix of policy actions that would stimulate economic recovery and at the same time improve the sustainability of the world economy.[11] The GGND recommended that governments allocate a significant share of stimulus funding to green sectors and set out three objectives:[12]

1. Economic recovery.
2. Poverty eradication.
3. Reduced carbon dioxide (CO_2) emissions and ecosystem degradation.

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[7]David Pearce, Anil Markandya and Edward Barbier, “Blueprint for a Green Economy,” https://www. researchgate.net/publication/ 39015804_ Blueprint_for_a_Green_Economy.
[8]https://www.routledge.com/Blueprint-2-Greening-the-World-Economy/Pearce/p/book/9781853830761.
[9]https://www.routledge.com/Blueprint-3-Measuring-Sustainable-Development/Pearce/p/book/9781853831836.
[10]https://www.oecd.org/site/worldforumindia/ATKISSON.pdf.
[11]https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=670&menu=1515.
[12]https://sustainabledevelopment.un.org/content/documents/743GE%20Guidebook%202%20-%20Principles_final.pdf.

The GNND also proposed a framework for green stimulus programs as well as supportive domestic and international policies.

In June 2009, in the lead up to the UN Climate Change Conference in Copenhagen, the UN released an interagency statement supporting the green economy as a transformation to address multiple crises.[13] The statement included the hope that the economic recovery would be the turning point for an ambitious and effective international response to the multiple crises facing humanity based on a global green economy.[14]

In February 2010, Ministers and Heads of Delegation of the UNEP Global Ministerial Environment Forum in Nusa Dua acknowledged in their declaration that the green economy concept "can significantly address current challenges and deliver economic development opportunities and multiple benefits for all nations."[15] It also acknowledged UNEP's leading role in further defining and promoting the concept and encouraged UNEP to contribute to this work through the preparatory process for the UN Conference on Sustainable Development in 2012 (Rio+20).

In March 2010, the UN General Assembly agreed that green economy in the context of sustainable development and poverty eradication would form one of the two specific themes for Rio+20 (resolution 64/236).[16] This led to substantial international attention on green economy and related concepts and the publication of subsequent numerous reports and other literature aiming to further define and demystify the concept.

One of the key reports was the flagship “Green Economy Report” released by UNEP in November 2011 under its Green Economy Initiative.[17] UNEP partnered with think tanks and commercial actors (including Deutsche Bank), lending credibility to its economic analyses. Notably, the report also provided a working definition of "green economy" which has since been cited in numerous other publications.

A series of other publications by UNEP, UNCTAD, UNDESA and the UNCSD Secretariat have attempted to elaborate on the concept and outline guiding principles, benefits, risks and emerging international experience. The UN Environment Management Group (UNEMG), a system-wide coordination body of over 40 specialized agencies, programs and organs of the UN, developed its system-wide perspective on green economy, “Working Towards a Balanced and Inclusive Green Economy,” which identified and clarified the use of green economy and other related terms.[18] This report adopted the definition provided by UNEP in its Green Economy Report. In recent years, a number of non-government organizations and partnerships have also developed which promote green economy as a concept and undertake research, analysis, and outreach.

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[13]https://sustainabledevelopment.un.org/index.php?menu=1446.
[14]Ibid.
[15]https://wedocs.unep.org/bitstream/handle/20.500.11822/20333/K1060433.pdf?sequence=6&isAllowed=y.
[16]https://sustainabledevelopment.un.org/content/documents/733FutureWeWant.pdf.
[17]https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=126&menu=35.
[18]https://wedocs.unep.org/handle/20.500.11822/8065.

International Definitions of the Green Economy and Green Jobs

There is no one official international definition of green industries or of green jobs, and different nations and organizations have developed their own definitions. Although the exact definition of green varies across organizations and nations, there are more similarities than differences in what constitutes a green economy.[19] A common theme is to conserve energy and other natural resources and reduce pollution. Most definitions attempt to identify products and services that meet one of several criteria of a green economy. For products and services, most definitions include:

- Environmentally friendly and enhancing products and services.
- Renewable energy products and services.
- Clean transportation and fuels.
- Green buildings.

Some definitions also include the processes by which these products and services are produced. These include:

- Energy efficient manufacturing, distribution, and construction.
- Reduction of energy, materials, and water consumption through high efficiency strategies.
- Transition from carbon to non-carbon components.

In general, there are two main green economy definitions available internationally from the UN System of Environmental Economic Accounting (UNSEEA) and from the International Labor Organization (ILO). The UNSEEA, an international statistical standard for measuring the relationship between the environment and the economy, sets out a definition of the "Environmental Goods and Services Sector" (EGSS), which is "areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources."[20] An advantage of EGSS data is their international comparability, as a common statistical framework that is used across different countries. However, at present there are only a limited number of countries that publish EGSS estimates. Europe is the main region for which EGSS is available, and while country data follow the same framework, sources and methodology vary considerably.

The ILO provides another international definition of "green economy."[21] This definition is derived from a longstanding program of work by organizations with expertise in labor markets, and is commonly cited in research papers as part of framing the discussion. This work was part of "The Green Initiative" and the definition was devised over the past decade by the ILO in partnership with several other organizations (UNEP,

[19]Randall W. Eberts, “OECD Local Economic and Employment Development: Framework and Tools for Assessing and Understanding the Green Economy at the Local Level,” https://dx.doi.org/10.1787/5kgc8n8n66wf-en.
[20]The challenges of defining a "green job," https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/thechallengesofdefiningagreenjob.
[21]https://www.ilo.org/global/topics/green-jobs/WCMS_744358/lang--en/index.htm.

the International Organization of Employers, and the International Trade Union Confederation). The ILO uses a broader definition of what is considered "green", including activities such as community adaptation to climate change.[22]

The activities included in the EGSS and ILO definitions are similar and generally include the following:

- Energy saving and sustainable energy systems.
- Environmental charities.
- Environmental consultancy and engineering services.
- Environmental construction.
- Environmental education.
- Environmental low emissions vehicles.
- Carbon capture and inspection and control.
- In-house environmental activities.
- Insulation activities.
- Management of forest ecosystems.
- Managerial activities of government bodies.
- Organic agriculture.
- Production of industrial environmental equipment.
- Production of renewable energy.
- Recycling.
- Waste.
- Wastewater.
- Water quantity management.

ILO notes that:[23]

- Terms such as “green”, “environmental,” and “sustainable” are often used interchangeably to describe companies, people, or technologies that do “greenish” things.
- All approaches show a path towards a new economic model that is based on ecologically compatible use of resources and economic efficiency.
- Green economy is not a replacement for sustainable economy; it is a means to achieve sustainable development.
- “Green” has become a shorthand term to describe the wide range of issues, processes, products, and services that relate to sustainability and the environment.

The ILO concept of the green economy:[24]

- Promotes economic growth, environmental sustainability and social inclusion.

[22]https://www.ilo.org/wcmsp5/groups/public/@ed_emp/@emp_ent/documents/publication/wcms_152065.pdf

[23]International Labor Office, Department of Statistics, “Definitions of Green Jobs Used in the Employment and Environment Policy Context,” https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/presentation/wcms_195740.pdf.

[24]Ibid.

- Was initially limited to climate change and reduction of CO_2 emission and short-term solution to current crises.
- Evolved to include greening of the entire economy, long-term objectives of sustainable development, and promotion of social justice and decent work.
- Includes broader dimensions of energy and resource efficiency, poverty eradication, social equity, and human well-being.

ILO finds that the concept of green economy and green jobs have not been precisely defined and universally agreed as yet. Thus:[25]

- There are a variety of definitions, but a common theme is preserving and restoring the environment.
- Most studies attempt to identify products and services that meet one of several criteria for a green economy.
- Some definitions also include the processes by which these products and services are produced.
- Some have focused on environmental protection and or on sectors of the economy such as forestry and renewable energy.
- Some focused on looking at different occupations and how they contribute to the greening of the economy.

ILO defines the green economy as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities." In this connection, a green economy can be thought of as one which is low carbon, resource efficient, and socially inclusive. "The green economy includes economic activity related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy." It broadly defines a green job as "any decent job that contributes to preserving or restoring the quality of the environment whether it is in agriculture, industry, services or administration."[26]

According to the ILO, jobs are green when they help reduce negative environmental impact ultimately leading to environmentally, economically, and socially sustainable enterprises and economies. More precisely green jobs are "decent jobs" that:[27]

- Reduce consumption of energy and raw materials.
- Limit greenhouse gas emissions.
- Minimize waste and pollution.
- Protect and restore ecosystems.

[25]Ibid.
[26]Ibid.
[27]Ibid.

ILO defines the “greening" of occupations as the extent to which green economy activities and technologies increase the demand for existing occupations, shape the work and worker requirements needed for occupational performance, or generate unique work and worker requirement. This includes:

- Green increased demand occupations.
- Green enhanced skills occupation.
- Green new and emerging occupations.

ILO defines green collar workers as:

- Managers, professionals and technicians who work in green organizations or who have green skills and responsibilities within other organizations that may not be considered green.
- Services, clerical, sales, and semi-skilled workers who work in green organizations.

The UNEP defines a green economy as “low carbon, resource efficient and socially inclusive.” According to UNEP, “In a green economy, growth in employment and income are driven by public and private investment into such economic activities, infrastructure and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services.”[28]

Specifically, UNEP notes that the roles of green economy, sustainable consumption, and production and resource efficiency for sustainable development are closely related:[29]

- Sustainable consumption and production aims to improve production processes and consumption practices to reduce resource consumption, waste generation and emissions across the full life cycle of processes and products.
- Resource efficiency refers to the ways in which resources are used to deliver value to society and aims to reduce the amount of resources needed, and emissions and waste generated, per unit of product or service.
- The green economy provides a macro-economic approach to sustainable economic growth with a central focus on investments, employment and skills.

The three main areas for work on green economy are:

- Advocacy of macro-economic approach to sustainable economic growth through regional, sub-regional and national fora.
- Demonstration of green economy approaches with a central focus on access to green finance, technology and investments.
- Support to countries in terms of development and mainstreaming of macro-economic policies to support the transition to a green economy.

[28]https://www.unep.org/explore-topics/green-economy.
[29]Ibid.

These green investments need to be enabled and supported through targeted public expenditure, policy reforms and changes in taxation and regulation. The UNEP promotes a development path that understands natural capital as a critical economic asset and a source of public benefits, especially for poor people whose livelihoods depend on natural resources. The notion of green economy does not replace sustainable development, but creates a new focus on the economy, investment, capital and infrastructure, employment and skills and positive social and environmental outcomes across Asia and the Pacific.[30]

Thus, multiple green economy and green growth definitions have been developed, including the following:[31]

- UNEP -- "A green economy is one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcity."[32]
- OECD – "Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies."[33]
- Green Economy Coalition -- "An economy that provides better quality of life for all within the ecological limits of the planet."[34]

The definitions of green economy/growth may vary, but their key elements are recurrent – as illustrated in Table II-1.[35]

According to the European Commission (EC) and the European Environment Agency (EEA), an inclusive green economy is a balanced and realistic pathway to sustainable development. As an economic model, it differs from traditional ones in that it takes due consideration of environmental and social externalities, and does not focus on GDP growth as ultimate economic goal. Rather, it focuses on resource efficiency and on ecosystems, as a building block of the economy, taking into account that environment degradation undermines long term economic growth and human development.[36]

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[30]Ibid.

[31]"Advancing an Inclusive Green Economy: Rationale and Context," https://wedocs.unep.org/bitstream/handle/20.500.11822/8659/-%20Green%20economy_%20what%20do%20we%20 mean%20by % 20 green%20economy_%20-2012Main%20briefing%202012--Final.pdf

[32]UNEP, "Green Economy Report," https://whygreeneconomy.org/information/unep-green-economy-report/.

[33]Organization for Economic Cooperation and Development, "Towards Green Growth," https://www.oecd.org/greengrowth/48012345.pdf.

[34]Green Economy Coalition, http://www.greeneconomycoalition.org/.

[35]UN Department of Economic and Social Affairs, "A Guidebook to the Green Economy: https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=634&menu=35.

[36]"Inclusive Green Economy," https://www.switchtogreen.eu/inclusive-green-economy/#:~:text=The%20transition%20to%20an%20inclusive%20green%20economy%20entails%20joined%20efforts,facilitation%20of%20resource%20efficiency%2C%20and.

Table II-1
Green Economy Principles

Type	Principles
Economic	• Recognizes natural capital and values • Integrated in economic development and growth models • Internalizes externalities • Promotes resource and energy efficiency • Creates decent work and green jobs
Environmental	• Protects biodiversity and ecosystems • Invests in and sustains natural capital • Recognizes and respects planetary boundaries and ecological limits • Advances international environmental sustainability goals (e.g. MDG 7)
Social	• Delivers poverty reduction, well-being, livelihoods, social protection and access to essential services • Is socially inclusive, democratic, participatory, accountable, transparent, and stable • Is equitable, fair and just – between and within countries and between generations

Source: UNEP.

As defined by the EC/EEA, a green economy can be understood as one in which environmental, economic, and social policies and innovations enable society to use resources efficiently -- enhancing human well-being in an inclusive manner, while maintaining the natural systems.

The inclusive green economy is associated to a wealth of opportunities, for both people -- to improve their living environments and have decent jobs -- and for businesses – to increase benefits through more efficient production practices that generate savings, take advantage of the growing market for environmental goods and services, improve their image, etc. (Figure II-1)

According to the EC/EEA, the transition to an inclusive green economy entails joined efforts at many levels, including in stimulating sustainable lifestyles, scaling up sustainable consumption and production (SCP) and encouraging green entrepreneurship, through the advancement of eco-innovations, the facilitation of resource efficiency, and the mainstreaming of green consumer behavior. In the course of change, new green jobs are to be created without compromising on existing employment, and a significant reduction on carbon emissions, waste and other forms of pollution is to be achieved.[37]

[37]Ibid.

Figure II-1

Source: European Commission.

International Estimates of the Green Economy and Green Jobs

Both Statistics Canada and Eurostat, the European Commission's statistical arm, have published reports on the green economy and green employment, or what they refer to as EGSS. These reports define and measure the extent of the green economy in Canada and the European Union with an emphasis on products and services related to explicit protection and conservation of natural resources. However, the reports focus on measuring the size of the environmental economy; they do take into account employment, but it is not the primary focus of these reports.[38]

Statistics Canada has been estimating the size of the "environment economy" in Canada (it does not use the term "green") with its Canadian Environment Industry Strategy since 1994. The estimates of revenue (gross) and employment are derived mostly from the Environment Industry Survey, which surveys establishments identified as producing environmental goods and services, supplemented by other sources.[39] Statistics Canada defines environmental goods and services as those which "are used to measure, prevent, limit, or correct environmental damage (both natural or by human activity) to water, air, soil, as well as problems related to waste, noise, and ecosystems."[40] They also include clean or resource-efficient technologies that decrease material inputs, reduce energy consumption, recover valuable by-products, reduce emissions and/or

[38]"State of Green: The Definition and Measurement of Green Jobs," https://cew.georgetown.edu/wp-content/uploads/2010/08/Literature-Review_Green.pdf.
[39]https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=1209.
[40]Ibid.

minimize waste disposal problems. Statistics Canada emphasizes end-use and not physical attributes of goods and services; consumer goods such as LED light bulbs, organic produce, hybrid vehicles, etc., are not included. Employment is estimated directly by the survey; it is not estimated based on revenue.[41]

The European Commission's report is a comprehensive manual and reference for countries that are interested in collecting data on the EGSS, and developed by a task force comprised of representatives from many European countries with input from Canada. The EC seeks to ensure comparability across countries within the EU as well as with their coding systems, the European System for the Collection of Economic Data on the Environment (SERIEE), and the System of Integrated Environmental and Economic Accounting (SEEA), as well as the European equivalent of NAICS, the NACE system and the Classification of Environmental Protection Activities (CEPA). In addition, a new classification system pertaining to resource management activities was created for the purpose of collecting data on EGSS (Classification of Resource Management Activities -- CReMA). Definition and classification of the EGSS, therefore, is based on the existing SERIEE and SEEA frameworks.[42]

The EC emphasizes that the interest in collecting these statistics, and its impetus, derives not from a need to obtain accurate employment figures but to obtain a better understanding of how EU environmental policies and regulations impact the economy. The EC defines the EGSS as "The environmental goods and services sector consists of a heterogeneous set of producers of technologies, goods, and services that measure, control, restore, prevent, treat, minimize, research, and sensitize environmental damages to air, water and soil as well as problems related to waste, noise, biodiversity, and landscapes."[43] This includes "cleaner" technologies, goods and services that prevent or minimize pollution, and goods and services that measure, control, restore, prevent, minimize, research, and sensitize resource depletion. This results mainly in resource-efficient technologies, goods and services that minimize the use of natural resources. There are thus two main groups of EGSS: The environmental protection group and the resource management group. The first encompasses products and services of a preventative or remedial nature; the latter is to manage and conserve the stock of natural resources.[44] Fundamental to the definition is that these goods and services must be produced for their environmental protection or resource management purpose -- that is, it should be their prime objective. Only products and services that meet these criteria are

[41]See Management Information Services, Inc., *Environment and Employment in Canada: Final Report of the Symposium*, prepared for the Canada Employment and Immigration Advisory Council, Ottawa, Canada, 1992.

[42]State of Green: The Definition and Measurement of Green Jobs, https://cew.georgetown.edu/wp-content/uploads/2010/08/Literature-Review_Green.pdf.

[43]https://ec.europa.eu/eurostat/documents/3859598/7700432/KS-GQ-16-008-EN-N.pdf/f4965221-2ef0-4926-b3de-28eb4a5faf47.

[44]These include "inland waters, natural forests, wild flora and fauna and subsoil reserves (fossil energy and minerals)"

to be measured; the “user" purpose is, on the contrary, never to be used in the EGSS context."[45]

To measure employment, if an establishment is concerned only with EGSS, all employees are considered a part of EGSS. However, if there are both non-EGSS and EGSS goods and services produced, the EC recommends several methods, all based on estimating ratios: Calculating employment as the same proportion of suppliers that produce EGSS goods and services within the general economy; using the turnover rate; or using the ration of environmental revenues to total revenues at the sector level. The EC also specifies several other ratios that can be applied, including productivity. Alternatively, it also suggests asking directly for employment in a survey. In measuring EGSS, the EC approach favors a supply-side approach. It identifies a variety of different approaches for identifying EGSS producers, either by using NACE codes to conduct an analysis of activities, or by selecting products and services with an environmental purpose and relating them to production activities. Compiling a register is recommended; then collecting data either from existing statistics or by surveys sent to a sample of establishments.[46]

Defining a “green job” is even more difficult, and there are two main definitions available internationally. These are from the UN System of Environmental Economic Accounting (UNEEA) and from the ILO. The UNEEA, an international statistical standard for measuring the relationship between the environment and the economy, specifies a definition of the "Environmental Goods and Services Sector" (EGSS), which is "areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources." A "green job" in this context would then be a job engaged in any of these areas of the economy.[47]

The Office for National Statistics produces estimates of employment in the UK under this definition, using 17 relevant activities.[48] These include a range of activities

[45]Producers of components, as well as retailers, are not included, nor are those who supply non-exclusively environmental components. There are other rules as well, related to “connected" and “adapted" goods and services. For example, if new piping is installed for ordinary maintenance, but not for environmental purposes, they are not counted; when they are carried out exclusively for reducing water consumption, they are counted. When the installer is specialized in environmental services, it is counted. Also, if a product is „cleaner" than its counterpart—for example, biodegradable shampoo versus regular shampoo—it is not included in the total amount of economic aggregates related to adapted goods, but only an “environmental share" which can be measured by the extra cost compared to its equivalent normal good.

[46]https://ec.europa.eu/eurostat/documents/3859598/7700432/KS-GQ-16-008-EN-N.pdf/f4965221-2ef0-4926-b3de-28eb4a5faf47.

[47]“The Challenges of Defining a ‘Green Job,’" https://www.ons.gov.uk/economy/environmental accounts/ methodologies/ thechallengesofdefiningagreenjob.

[48]These activities are energy saving and sustainable energy systems; environmental charities; environmental consultancy and engineering services; environmental construction; environmental education; environmental low emissions vehicles, carbon capture and inspection and control; in-house environmental activities; insulation activities; management of forest ecosystems; managerial activities of government bodies; organic agriculture; production of industrial environmental equipment; production of renewable energy; recycling; waste; wastewater; and water quantity management. See https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalgoodsandservicessectoregssestimate.

from the production of renewable energy to environmental university education to organic agriculture. These estimates are also disaggregated by the UK's Standard Industrial Classification and by Eurostat's Classification of Environmental Protection Activities and CReMA. Obtaining data under the definition can be difficult, and modelling is often required. The quality of the method varies by activity and is continually under development.

An advantage of EGSS data is their international comparability, since a common statistical framework is used across different countries. However, there are a limited number of countries that publish EGSS estimates. Europe is the main region for which EGSS is available, and while country data follow the same framework, as noted, sources and methodology differ. Nevertheless, EGSS estimates have been used in several papers on "green jobs."[49]

As discussed, the ILO provides another international definition of "green job", which is cited in its 2018 flagship report on green work, and uses a broader definition of what is considered "green," including activities such as community adaptation to climate change.[50] A second difference from the EGSS definition is that to be "green," jobs must also be "decent:" They (green jobs) reduce the consumption of energy and raw materials, limit greenhouse gas emissions (GHGs), minimize waste and pollution, protect and restore ecosystems, and enable enterprises and communities to adapt to climate change.[51]

However, adding a quality dimension adds a further level of complexity to the definition of green jobs. It also then makes estimating their number much more difficult. As with green jobs, there is no single definition of "decent," although good pay, adequate benefits, and safe working conditions are often cited. In the UK, some exploratory work has taken place on estimating the proportion of jobs that fulfil some job quality criteria, although not in relation to green jobs. The concept of "quality" also corresponds to other international commitments, such as the Paris Agreement.[52] Under this Agreement, signatory countries must consider "the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities."[53]

There has been further discussion on the quality question in, for example, the London School of Economics report “Looking For Green Jobs: The Impact of Green Growth on Employment.[54] The authors contend that the additional requirement of quality for "green jobs" could cause problems in less economically developed countries, where employment to alleviate poverty is desirable even if the jobs are not as high quality as they could be. In University of Strathclyde report “The Green Factor: Unpacking Green

[49]See, for example, https://ideas.repec.org/p/zbw/vfsc16/145500.html.
[50]https://www.ilo.org/global/publications/books/WCMS_628654/lang--en/index.htm.
[51]https://www.ilo.org/global/publications/books/WCMS_628654/lang--en/index.htm.
[52]https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.
[53]Ibid.
[54]https://www.lse.ac.uk/granthaminstitute/publication/looking-for-green-jobs-the-impact-of-green-growth-on-employment/.

Job Growth" the authors explain that applying a blanket definition to the whole economy is difficult in practice.[55]

The UK Office for National Statistics initiated the Low Carbon and Renewable Energy Economy (LCREE) survey in 2015 to collect information from businesses conducting "low carbon" and renewable energy activities, including employment in these activities.[56] The survey focuses on 17 sectors defined through consultation with stakeholders, which are deemed to be "low carbon" or related to renewable energy. The specific definition of these sectors is: "economic activities that deliver goods and services that are likely to help the UK generate lower emissions of greenhouse gases, predominantly carbon dioxide." Note that these are not the same as the 17 activities covered by the EGSS definition.[57]

Some activities that might be considered green, such as recycling and the protection of biodiversity, are not among the sectors included, so the scope of LCREE is narrower than the international definitions given above. However, LCREE potentially captures more activity as it samples businesses across the economy, no matter their primary purpose. The survey has found that many businesses have some activity in LCREE sectors and that only a small number of businesses are active solely in LCREE. For example, a business may conduct construction activities. If a certain proportion of the work is in sustainable buildings, even if this is not the primary business activity, this would be reported in the survey. The non-LCREE aspects of the activity would be excluded. Since LCREE covers "low carbon," it is often used in conjunction with other measures when a wider estimate of "green jobs" is required.

It is thus difficult to establish set one determinative definition of "green job" that is applicable for every policy brief, media article, or analysis. The approach taken in much of the literature on the topic is to first select the sectors of interest, and then either define jobs in this sector to be "green," or to review the jobs within those sectors for further assessment. However, the former approach is simple (in terms of setting a definition), as there is no specific definition used beyond "jobs in sector X".

The renewable energy production industry is used as the sector of focus in many reports on green jobs. Jobs statistics are more readily available for this sector internationally than others, and the International Renewable Energy Agency (IRENA) publishes an annual review.[58] In addition, the "circular economy" -- focusing on reducing waste and increasing the re-use of materials – is often considered to be "green." Some

[55]https://pureportal.strath.ac.uk/en/publications/the-green-factor-unpacking-green-job-growth.
[56]https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/finalestimates/latest.
[57]Results from the survey have been cited in various papers, especially those focused on domestic policy within the UK. For example, the Local Government Association commissioned a report on local green jobs, which uses LCREE. In the "Ten Point Plan for a Green Industrial Revolution," LCREE estimates are cited. See https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title.
[58]https://www.irena.org/publications/2020/Sep/Renewable-Energy-and-Jobs-Annual-Review-2020.

OECD papers use the "circular economy" concept to identify first relevant sectors and then jobs.[59]

II.A.2. U.S. Green Economy and Green Jobs Definitions

Defining the U.S. Green Economy and Green Jobs

As internationally, in the U.S. there is no simple answer to the questions "what is the green economy?" and "what is a green job?"[60] U.S. researchers, data collectors, and policy-makers have yet to reach consensus on a methodology for identifying what is green. Such a methodology is needed to accurately estimate the green economy's size and rate of growth, and to identify the jobs associated with it.[61] The definitional issue is not trivial. The industries that qualify as green serve as a benchmark for the current size of the green economy and a standard to estimate the rate by which the economy becomes greener. A rigorous definition is essential to facilitate government policy, research funding, business investment, and hiring decisions – including such major initiatives as the Green New Deal (GND).

At its most basic level, the U.S. green economy is the clean energy economy, consisting primarily of four sectors: Renewable energy (e.g. solar, wind, geothermal); green building and energy efficiency technology; energy-efficient infrastructure and transportation; and recycling and waste-to-energy.[62] The green economy includes not just the ability to produce clean energy, but also technologies that allow cleaner production processes, as well as the growing market for products which consume less energy, from fluorescent lightbulbs to organic and locally produced food. Thus, it might include products, processes, and services that reduce environmental impacts or improve natural resource use.[63]

The lack of an agreed definition of "green," as well as other factors such as data availability and coherence across different groups such as industries, give rise to numerous challenges in defining and measuring "green economy" and "green jobs". Another challenge is determining how "green" a specific job is in practice: Even if the job is in a "green" sector, its net effect on the environment might not be positive (or as positive as may be expected). For example, an individual may work in environmental education,

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[59]"Labor Market Consequences of a Transition to a Circular Economy," https://www.oecd.org/publications/labour-market-consequences-of-a-transition-to-a-circular-economy-e57a300a-en.htm.

[60]Center for Community Innovation, "Defining the Green Economy," ttps://communityinnovation.berkeley.edu/sites/default/files/defining_the_green_economy_a_primer_on_green_economic_development.pdf?width=1200&height=800&iframe=true.

[61]Timothy F. Slaper and Ryan A. Krause, "The Green Economy: What Does Green Mean? https://www.ibrcindiana.edu/ibr/2009/fall/article3.html.

[62]Kate Gordon and Jeremy Hays, *Green-Collar Jobs in America's Cities: Building Pathways out of Poverty and Careers in the Clean Energy Economy,* http://www.apolloalliance.org/downloads/ green collarjobs.pdf.

[63]*California's Global Warming Solutions Act of 2006 – A Background Paper for Labour Unions,* https://laborcenter.berkeley.edu/californias-global-warming-solutions-act-of-2006-a-background-paper-for-labor-unions/.

and take frequent flights as part of their job. As another example, organic food processors are little different from other food processors according to the economic accounts that collect and report production and employment data. There is no green accounting standard when it comes to what to include as a green product or industry and what to exclude. A producer of citrus-based solvents may readily be classified as green. But what about the house painting company that uses the citrus-based solvents instead of mineral spirits? Is that company green? Some researchers and economists would say yes. Others may contend that citrus based solvent is being double counted as green, once for the firm selling it and the second time for the painting company reselling it to the home owner.

Most industries produce both green and non-green goods and services, so making distinctions is difficult. It may be spurious to include industries that produce non-green products or services but use green inputs and processes in their production. For example, are a tailor's suits and shirts green if he makes them from organic cotton cloth? The production process is exactly the same irrespective of the type of cloth he uses to make his clothes.

There are several approaches which could be taken to help address this problem in the U.S. These include adopting existing statistical frameworks like the LCREE survey or the EGSS estimates – discussed in Section II.A.1. Another approach would be to use the definition proposed by the ILO. Selecting a sector of interest and then identifying relevant jobs is another option, and close linkages with required skills are common. Often multiple definitions are used together. The best definition to use is likely to depend on the question under consideration. With increasing policy and public interest in "green jobs," further developments in this area are likely.[64]

There are at least two empirical approaches to measuring green jobs: An industry approach and an occupational approach. The industry approach estimates the number of employees at a firm that, based on the firm's output, makes the economy greener. An approach that uses occupations estimates the number of employees at all types of firms with work activities that contribute to the greening of the economy. The industry approach is akin to the industry-output side of green production. That is, counting the number of employees at firms that produce green products or services – also termed "greenmaking."

Different U.S. studies often include multiple (often inconsistent) definitions of a "green job." For example, an approach -- used by kMatrix -- to assessing the scale of the U.S. green economy within the global context utilizes the "Low Carbon and Environmental Goods and Services Sector" dataset.[65] This is based on the EGSS and research by the UK government into the "low carbon" economy. While empirical data for the U.S. are available from a wide range of sources, as noted, the major difficulty is that U.S.

[64]"The challenges of defining a "green job," https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/thechallengesofdefiningagreenjob.

[65]Lucien Georgeson and Mark Maslin, "Estimating the Scale of the US Green Economy Within the Global Context," https://doi.org/10.1057/s41599-019-0329-3.

researchers, data collectors, and policy-makers have yet to determine a means for defining what is green. What is green and how can it be estimated?

According to the Pew Charitable Trusts, "A clean energy economy generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources."[66] Pew used an industry output approach to categorize and estimate the number of U.S. green jobs. The industry output approach to estimating green jobs -- if a firm's products or services are green, then that firm's employees can be considered green – has its challenges. For example, NAICS industry codes[67] are often not specific enough to separate the core green firms from those that are green-related in a secondary or tertiary sense. Pew used a proprietary database that, in contrast to the standard government industry definitions used to report economic data, allowed researchers to define industries based on specific products.

The occupational approach to estimating green jobs is somewhat similar to the industry-input side of green production. That is, irrespective of a firm's output, estimate the number of green jobs based on whether the occupational activities of the job make production greener. In other words, the green economy demands or uses certain types of green jobs as labor input (with certain sets of green skills) and those jobs are counted as green.

Thus, the major obstacle to understanding and measuring the U.S. green economy and green jobs is defining them. In the U.S., the task of defining and enumerating green jobs in the economy has been attempted by many disparate parties, including industry groups, labor unions and other worker's rights activists, academic and policy institutions, local, state, and federal governments, and workforce development and labor market information organizations.[68] There are dozens of different definitions and approaches. Environmental and workforce advocates brought green to national prominence, but it has generally been the labor market economists and workforce development analysts that have been at the forefront of measuring the U.S. green economy. Reports undertaken by labor market analysts have been the most influential among labor economists in defining and counting green jobs, including the Bureau of Labor Statistics, the Department of Commerce, the Department of Energy, the Occupational Information Network, and the Workforce Information Council – as discussed below.

The bottom line is that the major difficulty is defining the U.S. green industry. Questions that must be addressed in defining green include, for example:

- Is being green the same as being environmentally friendly? If so, how is environmentally friendly defined?
- Does it include just products and services that are environmentally friendly?
- What about environmentally friendly production processes?

[66]https://www.pewtrusts.org/en/projects/archived-projects/clean-energy-project.
[67]https://www.census.gov/naics/.
[68]State of Green: The Definition and Measurement of Green Jobs, https://cew.georgetown.edu/wp-content/uploads/2010/08/Literature-Review_Green.pdf.

- Environmentally friendly can be a continuum, so how green does a product or process have to be to count?
- If a product is environmentally friendly but it is packaged, delivered, and marketed in an environmentally unfriendly way, is it still green?

In the U.S. these questions and attempts to answer them have led to at least three types of green definitions:

1. The social justice/worker-centered definition, which makes green contingent on the job quality and its potential to address poverty and related social and economic issues.
2. The renewable energy and energy efficiency (RE/EE) definition, which defines green as activities in the sectors related to renewable energy and increasing energy efficiency, also known as "clean energy."
3. The broad environmental definition, which defines green as anything relating to environmental protection and quality.[69]

The social justice/worker-centered definition is primarily employed by union groups, community advocates, the Vice President's Middle Class Task Force,[70] and some research institutions. Examples of these groups include Green For All,[71] the Apollo Alliance,[72] the BlueGreen Alliance,[73] and numerous state and local level organizations. Reports produced by these organizations, which are numerous, share their emphasis on job quality and are focused on getting traditionally disadvantaged workers into this "emerging" sector of the economy. In general, these reports are advocating for greater investment in green workforce development targeted towards low-income individuals and families, and policies to promote a green economy, which they assert will benefit these workers. While this concept of green jobs and "green collar workers" may increase political support for green jobs, it is not useful for rigorous analysis.

The RE/EE definition is the most measurable and concrete definition, and is also consistent with federal legislation. The RE/EE definition encompasses everything related to clean energy -- investments in reducing energy and fossil fuel consumption (i.e., energy efficiency), including "green construction"/retrofitting homes and buildings, engineers who design new, hybrid, electric, and hydrogen vehicles, workers who build these vehicles, and all work on renewable energies such as wind, biomass, solar, geothermal, hydrogen, oceanic (wave and tidal), hydropower, and, in some cases, nuclear energy. The RE/EE definition is used by some states and the U.S. Energy Employment Reports, and all reports on the green economy include RE/EE as a primary component.

[69]This definition is employed by many state surveys, BLS, and O*NET, as discussed below.
[70]https://obamawhitehouse.archives.gov/the-press-office/vice-president-biden-issues-middle-class-task-force-annual-report#:~:text=About%20the%20Middle%20Class%20Task,Services%2C%20Education%2C%20Energy%2C%20the
[71]https://www.thedreamcorps.org/our-programs/green-for-all/.
[72]https://www.apolloalliance.org/.
[73]https://www.bluegreenalliance.org/.

The broad environmental definition is expansive and the most widely-used by labor market analysts and economists. This definition, which encompasses all environmental activities, includes environmental protection and remediation, and generally any activity that enhances, preserves, or restores the quality of the environment. Reports aside, the RE/EE definition is the one favored by the national (and some state) legislation, such as the Green Jobs Act,[74] ARRA,[75] and the proposed New Green Deal.[76] However, while in these there is no stated definition of what green jobs are or what the green economy is, it is clear that the RE/EE definition is employed.

Nevertheless, in the U.S. what green is and what the green economy and green jobs constitute is still a matter of contention. These "green" concepts, which broadly refer to an increasing environmental awareness among both consumers and producers, are both ambitious and ambiguous. There are many different stakeholders advocating for increased attention to and investment in "green." Proponents, such as those advocating the Green New Deal, contend that green jobs will revitalize the American economy and are well-paying jobs providing pathways out of poverty for a large number of historically under-served, under- and un- employed workers.[77] Others counter that the green economy is much overrated and is a politically useful but economically overhyped sales pitch.[78]

Numerous studies have been conducted attempting to understand the green economy, and the quality of these vary greatly. Industry groups have also published reports on the green economy, as have individual states, research institutes, international organizations, task forces, think tanks, etc. All reports related to the green economy confront the same problem: How to define and quantify an amorphous concept. There is as much political advocacy as there is research and rigorous empirical research uses different methods and scope making comparison nearly impossible. Nevertheless, there are important points of consensus.

As discussed, in the U.S., there is currently no universally accepted definition or methodology, but the definition adopted by most reports is inclusive and generally includes economic activity related to enhancing or preserving the environment and natural resources. Among the studies that are research and not advocacy, there is a clear preference for an industrial, survey-based approach. Such an "industrial" approach makes sense as a way to track macro-economic impacts and the relative "greening" of specific sectors. However, such an approach may not be helpful for the millions of unemployed workers hoping to train for and obtain a "green" job. Although there has been some research conducted on what skills, knowledge, and abilities will be needed

[74]https://www.congress.gov/bill/113th-congress/house-bill/2863.
[75]https://www.transit.dot.gov/regulations-and-guidance/legislation/arra/american-recovery-and-reinvestment-act-arra.
[76]https://www.congress.gov/116/bills/hres109/BILLS-116hres109ih.pdf.
[77]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/.
[78]https://www.instituteforenergyresearch.org/regulation/a-net-zero-economy-puts-jobs-at-risk/.

for workers in green jobs[79] it is insufficient to draw large conclusions other than that green jobs are traditional jobs that will change very slightly or not at all, depending on the occupation. Finally, the research about the wages for green jobs is inconclusive, although discussion on skills appears regularly in reports on "green jobs", especially if they are setting or recommending policy.

Measuring the U.S. Green Economy and Green Jobs

If defining green is difficult, measuring green is even more challenging because the conventional methodology for understanding, estimating, and classifying trends in the labor market is through the U.S. categories of industry and occupation which do not have a category for "green." Green jobs present an especially difficult problem in this context, as the Texas Workforce Commission noted: "The greenness of jobs even within a single occupation will vary according to the nature of the firm or establishment, the current project or specific work assignment and the specific employer's workplace rules and policies. Thus, labor market analysts can't merely count all employees in a particular occupation (much less in an entire industry) as green collar workers. Moreover, the greening of the economy is an evolutionary process (albeit one that is picking up a head of steam). That is, employers in virtually every sector are striving to conserve energy and resources while reducing their carbon footprint and switching from oil-dependence to renewable energy. Arrayed along any of the various dimensions popularly identified as comprising the green movement, there is no current benchmark at which green companies can be separated from non-green ones. Nor is there any useful milestone for deciding at what point in time to move all of a company's employees from the non-green column to the green column. Therefore, labor market analysts can't simply count all of the employees of a specific firm as green and employees of other companies in the same industry as non-green."[80]

Thus, for example, an engineer that designs hybrid vehicles may spend half of his time designing non-hybrid vehicles, or may work at an office or plant where some of the employees spend time on "green" activities and others do not. Further, what is true of a particular employee or firm may not be true of the whole firm or industry. In other words, there is no way, short of asking every employer about every employee, to determine whether an occupation or industry should be counted as green.

A review of 25 U.S. national and regional reports on the green economy found that although few specifically define the green economy, all agree that clean energy is its core.[81] The reports varied in how much they emphasize environmental and/or job quality.

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[79]With respect to hydrogen economy jobs see Roger H. Bezdek, "The Hydrogen Economy and Jobs of the Future," presented at the 2019 Fuel Cell Seminar & Energy Exposition, Long Beach, California, November 2019; Roger H. Bezdek, "The Hydrogen Economy and Jobs of the Future," *Renewable Energy and Environmental Sustainability*, Vol. 4, No. 1 (2019).

[80]https://www.economicmodeling.com/2008/09/29/texas-workforce-commission-on-green-collar-jobs-2/.

[81]Center for Community Innovation, "Defining the Green Economy," https://communityinnovation.berkeley.edu/sites/default/files/defining_the_green_economy_a_primer_on_green_economic_development.pdf?width=1200&height=800&iframe=true

A transition to clean energy will improve environmental quality by reducing GHGs and impact sustainability by reducing energy use. However, only 16 of the reports mentioned transportation and infrastructure as part of the green economy, despite the key role of built form and city planning in shaping energy use. Only two of the reports focused on job quality, typically defined as well-paid jobs with benefits and opportunities for advancement.[82]

Figure II-2 represents one conceptualization of the U.S. green economy. The green economy map groups green businesses into 17 categories, based on a review of industries discussed in the 25 reports. It also highlights how frequently each industry sector is mentioned in the reports (with the darkest shades representing the sectors cited most frequently). The figure presents the range of green business categories along two axes. The vertical axis shows the range from traditional businesses, such as utilities, and professional services that are greening their operations, to businesses in emerging industries, such as nanotechnology research, solar panel manufacturing, hydrogen fuel cells, and eco-tourism. On the horizontal axis, businesses move from those that produce green products, such as manufacturers and food processors, to those that sell green products or participate in the green lifestyle economy, such as farmer's markets and local park maintenance operators. Production industries produce goods that can be exported and imported between regions. Lifestyle or consumption businesses are local-serving only. Business categories located in the middle of the horizontal axis contain both production and consumption aspects. Within the green economy, businesses interact with and are influenced by the government agencies, universities, non-profit organizations, unions, utilities and trade associations in the regional innovation system (shown at the bottom of the figure).

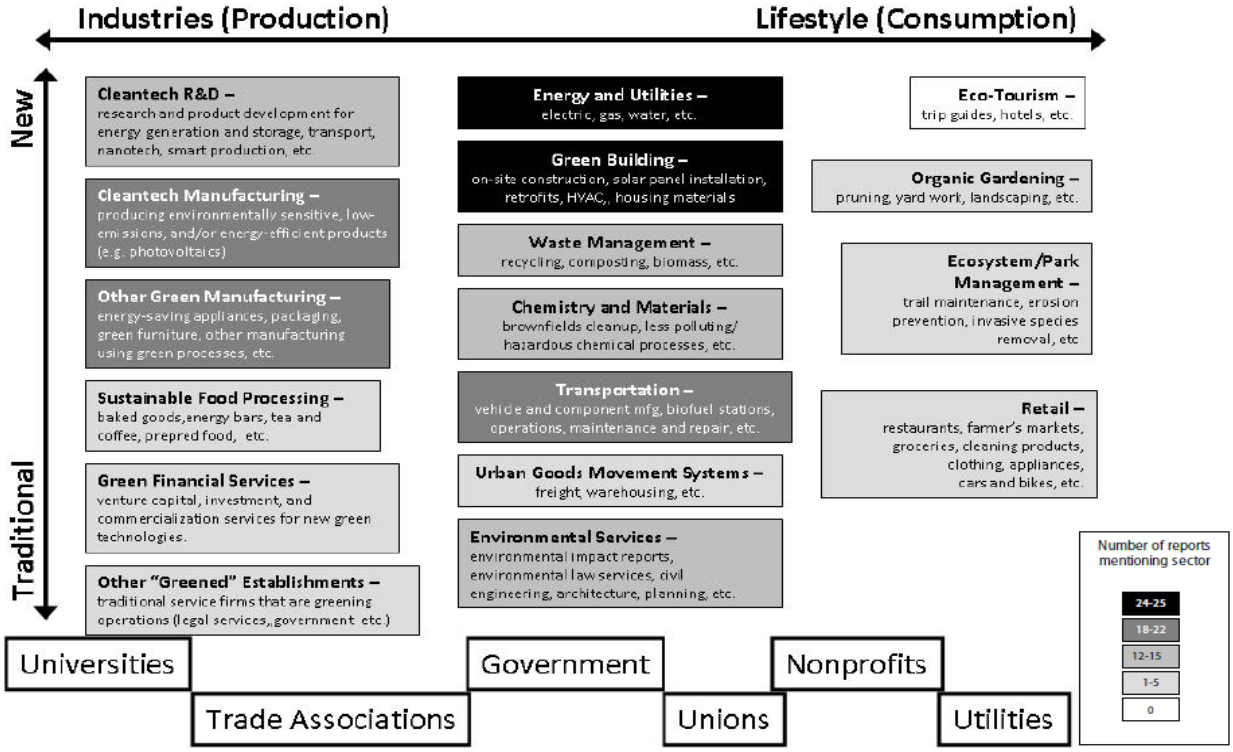
Several attempts have been made over the past decade to assess the U.S. green economy, including those by:

- The U.S. Bureau of Labor Statistics.
- The U.S. Department of Commerce.
- The U.S. Department of Energy.
- The Occupational Information Network.
- The Workforce Information Council.

These are summarized below.

[82]Ibid.

Figure II-2
Sectors of the Green Economy



Source: Center for Community Innovation.

The BLS Approach

The FY 2010 and FY 2011 budgets funded the U.S. Bureau of Labor Statistics (BLS) to estimate U.S. green jobs at the national level via an establishment survey.[83] BLS developed a green definition as well as a green methodology. The collection of data on green jobs was designed to:[84]

- Understand the number of jobs and the trends over time related to green employment.
- Determine the industrial, occupational, and geographic distribution of jobs.
- Ascertain the wages of workers in green jobs.

[83]The Green Jobs Act (Title X in the Energy Independence and Security Act of 2007) focused on workforce development. It amended the Workforce Investment Act (WIA), mandated the establishment of an energy efficiency and renewable energy worker training program, and directed BLS to collect statistics related to workforce trends in the energy sector. Although there is no stated definition of what green jobs are or what the green economy is in this bill, it was clear that the RE/EE definition is employed.
[84]U.S. Bureau of Labor Statistics, "Measuring Green Jobs," https://www.bls.gov/green/.

BLS also noted that no standard classification system then currently used in the U.S. (i.e., NAICS and SOC) identifies 'green" as a grouping of industries or occupations. That fact necessitated a new way to accurately capture and count uniquely green occupations.[85]

After reviewing numerous studies, including international studies, and consulting with stakeholders, BLS decided to define green jobs as "jobs involved in economic activities that help protect or restore the environment or conserve natural resources. These economic activities generally fall into the following categories: renewable energy, energy efficiency, greenhouse gas reduction, pollution reduction and cleanup, recycling and waste reduction, agricultural and natural resources conservation, and education, compliance, public awareness, and training."[86]

BLS was interested in estimating direct jobs associated with both green products, such as solar panels or environmentally friendly soap, and processes, such as a plastic bottle that uses only recycled materials or a retail store that has installed solar panels. BLS thus broadly defined green jobs as 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. Green goods, services, and production processes generally fall into the following categories: renewable energy; energy efficiency; greenhouse gas reduction; pollution reduction and cleanup; recycling and waste reduction; natural resources conservation; and education, compliance, public awareness and training.

In settling on a final definition, BLS revised the categories that green goods and services may be placed into. They were classified into one or more of five groups:

1. Energy from renewable sources.
2. Energy efficiency.
3. Pollution reduction and removal, greenhouse gas reduction, and recycling and reuse.
4. Natural resources conservation.
5. Environmental compliance, education and training, and public awareness.

In addition, BLS discarded four categories that they were going to further categorize green goods and services in, and made numerous technical changes and deletions to the industry list it had initially developed.

The BLS activities were to be conducted through the Quarterly Census of Employment and Wages (QCEW) and Occupational Employment Statistics (OES) programs. The goal of the BLS green jobs initiative was to develop information on (1) the

[85]State of Green: The Definition and Measurement of Green Jobs, https://cew.georgetown.edu/wp-content/uploads/2010/08/Literature-Review_Green.pdf.
[86]https://www.congress.gov/116/bills/hres109/BILLS-116hres109ih.pdf.

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

BLS used two approaches to measuring green jobs:

- The output approach, which identifies establishments that produce green goods and services and counts the associated jobs.
- The process approach, which identifies establishments that use environmentally friendly production processes and practices and counts the associated jobs.

In the output approach, BLS was concerned with jobs related to producing a specific set of goods and services, and is not concerned with the environmental impact of the production process. However, the output approach alone would not cover some activities and associated jobs that favorably impact the environment although the product or service produced is itself not "green." The process approach is intended to address this aspect of green jobs. In the process approach, BLS was concerned with whether the business uses practices or technologies that have a favorable impact on the environment, regardless of the good or service produced. The process approach is relevant to any industry. Each approach requires different measurement strategies and will tend to count different jobs, with some overlap in industries that produce green goods and services.

BLS determined that green jobs are either:

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

BLS reviewed a wide range of studies, including several surveys conducted by state workforce agencies and research conducted internationally. BLS also consulted with a variety of stakeholders, including Federal agencies, state labor market information offices, and industry groups. The common thread through the studies and discussions was that green jobs are jobs related to preserving or restoring the environment. Several categories of green activity were nearly universally cited, and these included producing energy from renewable sources, improving energy efficiency, preventing and cleaning up pollution and greenhouse gases, and conserving natural resources. The studies reviewed showed that neither of the standard classification systems used in BLS data, the North American Industry Classification System (NAICS) and the Standard Occupational Classification (SOC), identifies a green or environmental grouping of industries or occupations.[87]

BLS worked to develop a definition that is objective and measurable. In addition, because BLS jobs data are categorized and described according to industry (product or service produced) and occupation (type of work performed), BLS data on green jobs would be based on NAICS and SOC.[88]

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[87]Ibid.

[88]Using these standard classifications will allow comparison of green jobs data with existing measures of employment and wages that are based on NAICS or SOC, as well as meet OMB statistical standards.

To implement the output approach, BLS planned to collect data on jobs associated with producing green goods and services through a mail survey of a sample of establishments identified as potentially producing such products and services based on their NAICS classification. The purpose of the Green Goods and Services (GGS) survey was to identify whether the establishment is producing any green goods and services and, if so, to measure the number of associated jobs in the establishment. The BLS methodology would estimate the number of green jobs for a NAICS industry based on the green jobs found at individual establishments classified within the industry. The methodology would not simply designate an industry as "green" and count all jobs in that industry as green jobs, since establishments in the industry may also produce goods and services that are not considered green.

In addition to the number of jobs by industry associated with GGS production, BLS planned to estimate the occupational employment and wages for establishments identified as producing green goods and services. These estimates would be based on data collected from establishments in the GGS survey through the Occupational Employment Statistics (OES) program. The OES survey sample will be supplemented as needed.

The GGS survey would result in data on the number of jobs related to production of green goods and services, total and by industry and by ownership (public and private), for the nation, states, and the District of Columbia. The expanded OES collection would have resulted in estimates of employment and wages by detailed 2010 SOC occupation for the same scope of industries, ownerships, and geography. The GGS survey and the expanded OES collection would include wage and salary employment in industries identified as potentially producing such products and services based on their NAICS classification.

BLS identified 333 detailed (6-digit NAICS) industries where green goods and services are classified. This industry list constitutes the scope for the GGS survey. For these industries, the survey would identify establishments that actually produce green goods and services and estimate the number of associated jobs. The industry list is summarized in Table II-2, which shows the industry sector with detailed industries in scope, the number of establishments in these detailed industries, and these establishments as a percent of all establishments in scope.

BLS used Federal product ratings or standards, where they existed, to determine which goods and services to include as green goods and services. Such standards provide an objective method to distinguish green goods and services from other similar goods or services. These standards also assisted BLS clearly communicate to respondents which goods and services they produce should be reported on the survey, and to communicate to data users what products and services are represented in the resulting data on associated jobs.[89]

[89]Examples of such Federal standards include USDA Certified Organic and Energy Star. Well established and widely recognized industry standards also are used to the extent they are objective and measurable. An example of such an industry standard is the Leadership in Energy and Environmental Design (LEED)

Table II-2
Number and Percent Distribution of Establishments in Industries Where Green Goods and Services Were Classified by BLS, By Industry Sector, 2009[90]

Industry sector	Number of establishments	Percent distribution
Construction	820,700	38.1
Professional and business services	779,100	36.2
Other services (Repair and maintenance services, Professional organizations)	183,300	8.5
Natural resources and mining	88,700	4.1
Information	77,000	3.6
Manufacturing	77,700	3.6
Trade, transportation, and utilities	49,300	2.3
Public administration	42,100	2.0
Education and health services	26,400	1.2
All other sectors	10,400	0.5
Total	2,154,700	100.0

Source: U.S. Bureau of Labor Statistics.

If a business establishment produces a single good or service, and if the good or service is green according to the BLS definition, all jobs at that establishment would be counted as green jobs, including production, management, and administrative staff. For sampled establishments that produce more than one good or service, the GGS survey would capture the share of establishment revenue received from the sale of green goods and services (an alternative would be used for establishments with little or no revenue from sale of products or services). BLS planned to use the revenue share as a proxy for the share of the establishment's employment associated with the production of green goods and services.[91]

Unfortunately, on March 1, 2013 President Obama ordered into effect the across-the-board spending cuts (commonly referred to as sequestration) required by the Balanced Budget and Emergency Deficit Control Act, as amended.[92] In order to achieve some of the savings required by the order, BLS eliminated all "measuring green jobs" products. These products included data on employment by industry and occupation for businesses that produce green goods and services; data on the occupations and wages

Green Building Rating System. A potential limitation of using these types of labeling programs is that they are voluntary and some employers may not participate although they may in fact meet the standards.

[90]Data are 2009 annual averages from the QCES.

[91]BLS research and field tests of the GGS survey forms indicated that businesses are unlikely to be able to report shares of employment related to the green good or service and that revenue share is both a reasonable proxy and collectable.

[92]U.S. Bureau of Labor Statistics, “Measuring Green Jobs,” op. cit.

of jobs related to green technologies and practices; and green career information publications.

BLS currently conducts the Occupational Employment Statistics (OES) Survey. The data from the OES help to evaluate many elements of labor dynamics. And, because occupations can be linked with educational and training needs, these data can help inform training programs that develop the skill and knowledge sets needed for the future. Nevertheless, a green economy satellite account does not preclude or replace an occupational survey. Data from the OES can facilitate evaluation of many elements of green labor dynamics.[93]

The Department of Commerce Approach

The U.S. Department of Commerce (DOC) estimated private sector green employment in the U.S. based on publically-available Economic Census data.[94] DOC defined green products or services as those whose predominant function serves one or both of the following goals:

- Conserve energy and other natural resources -- this includes products or services that conserve energy to reduce fossil fuel use and promote water, raw material, land, and species and ecosystem conservation.
- Reduce pollution -- this includes products or services that provide clean energy or prevent, treat, reduce, control or measure environmental damage to air, water and soil. The remediation, abatement, removal, transportation, or storage of waste and contaminants also are considered to reduce pollution.

DOC estimates of the green economy were based almost entirely on the 2007 Economic Census.[95] The Economic Census does not cover several sectors of the economy. The largest excluded sector is government, including Federal, state, and local government activities, which accounted for about 12.6% of GDP in 2007. This means that government-owned establishments are excluded, including public utilities, the postal service, publicly-operated buses and subway systems, and construction performed by government employees. Other excluded sectors are agriculture, rail transportation, educational institutions, political organizations, and private households.

The data available from the Economic Census have limitations for assessing green products and services. First, product codes were not designed to identify the

[93]The green jobs surveys conducted by some states are similar to the OES survey.

[94]https://www.commerce.gov/data-and-reports/reports/2010/04/measuring-green-economy; https://www.commerce.gov/sites/default/files/migrated/reports/greeneconomyreport_0.pdf; https://www.commerce.gov/sites/default/files/migrated/reports/appendix2_0.pdf.

[95]The Economic Census is taken every five years. The 2007 Economic Census measured business activity based on responses from more than 4.7 million companies in late 2007 and early 2008. Businesses are primarily classified as manufacturing or services industries using six-digit North American Industry Classification System (NAICS) codes. The industry data are further disaggregated into individual product/service codes.

environmental impact of products or services. Second, only products and services that have their own product code can be separately assessed. As a result, there are some products and services that may be generally recognized as green that could not be separately assessed within the current 2007 Economic Census coding framework. This includes products such as alternative fuel vehicles and energy efficient appliances.

DOC attempted to account for certain green products and services not covered in the Economic Census by using other data sources to estimate the sales and employment associated with these products and services. Data were obtained from a variety of public and private sources to estimate the green proportion of each product or service relative to its overall market (usually based on shipments/receipts). When possible, supplemental data were used to estimate green shipments/receipts and employment as a share of related Economic Census product or service categories. DOC included supplemental estimates for alternative fuel vehicles and hybrids, green building construction, energy efficient appliances, photovoltaic cells and organic agricultural products. Although this exercise helped create a more complete measure of green business, there remain several notable green products and services not included in our analysis.

Estimating the share of green economic activity requires assessing all products and services that could be considered green. DOC examined the more than 22,000 product and service codes in the 2007 Economic Census to make this assessment. To take into account some of the disagreements regarding the "greenness" of various products or services, DOC categorized products and services using both a narrow definition and a broad definition of green. The narrow definition included only those products and services for which ESA analysts assumed there was wide agreement regarding their classification as green. The broad measure included products and services whose green status may be more open to debate. Using the more conservative, narrow definition, DOC identified 497 product and service codes as green; using the broad definition, it identified 732 product and service codes as green.[96]

As a general rule, ESA analysts considered a product to be green based on its usage, not the production process by which it was produced or the environmental consequences associated with its disposal. While DOC acknowledged that the natural resource and environmental consequences related to a product's life cycle are important in defining green business activity, the use of the Census product and service codes does not permit the examination of these aspects. Also, the product codes, and therefore the data, do not distinguish among similar products produced using different techniques, some of which might help to conserve energy or natural resources, or be less polluting. However, an exception was made for product codes that clearly could only be produced using greener inputs or manufacturing processes. Examples include products that were labeled as "recycled," "rebuilt, "reused," "remanufactured," or replacing products

[96]https://www.commerce.gov/data-and-reports/reports/2010/04/measuring-green-economy; https://www.commerce.gov/sites/default/files/migrated/reports/greeneconomyreport_0.pdf.

produced from new materials and resources, and therefore, meet the criteria described above.[97]

Due to the structure of the available product and service codes, some of the DOC green product and service categories contain a share of non-green products and services. Similarly, some excluded categories contain a share of green products and services. For example, product codes related to plastic materials do not include separate codes for "bioplastics," which are produced from renewable feedstock and may be biodegradable.

For some products and services, it was difficult to discern the importance of certain green characteristics relative to the overall product or service. For example, the "tire servicing" category includes activities that inflate and balance tires, which improve mileage and reduce energy use. However, since this is not the predominant purpose of tire servicing, DOC analysts did not classify tire servicing as green. Another example is bicycle production. While only a small portion of bicycles are used for commuting purposes, they were included as a green product because DOC analysts determined that on balance the use of bicycles is beneficial for reducing energy use. However, because the inclusion of bicycles as a green product could be debated, they were included in only the broad (not narrow) category of green products and services.[98]

BLS vs. DOC Approaches

The major difference between the BLS and DOC approaches to green economy and green jobs is in the data source: BLS planned to survey establishments, whereas DOC relied on data from the Economic Census. The Economic Census has the advantage of being a publically available data source, but it also has several disadvantages. First, it is taken only every five years, and is released after a two year lag -- the next Census released after the DOC project was in 2012, and the results for the 2017 Census were released in December 2021). Given the rapidly changing nature of the “greening" economy, this could provide numbers that are seriously outdated. In addition, the Economic Census has the potential to under-estimate green jobs, since it does not estimate the agriculture, rail transportation, private education, and public administration sectors, nor government-owned establishments (including public mass transit), all of which are covered under BLS"s green definition.

Further, since DOC measured by product code, some product codes could not be separated by green and non-green (i.e., energy efficient cars and appliances, and, importantly, green construction). DOC tried to account for this by estimating the green share of the total market using other sources. Nevertheless, even after taking into account other sources, some green products and services are still not included, such as green personal care and beauty products, green IT, and small wind turbines, hydro turbine manufacturing, green chemicals, architectural, landscaping, and urban planning, and utility scale wind turbine manufacturing; fuel cells and hybrid batteries accounted for

[97]Ibid.
[98]Ibid.

such a small percentage of their respective markets that they were also not counted). In addition, BLS planned to estimate the number of green jobs for a NAICS industry by summing the green jobs found at individual establishments within an industry.

Nevertheless, BLS and DOC developed similar approaches. Both apportioned green jobs to an industry based on revenue, unless an establishment produces only a single service or product and it is green. Total revenue was to be based either at the level of establishment (BLS) or of an industry's green products and services (DOC). The proportion of green revenue to non-green revenue would have been used to estimate the proportion of green jobs in an industry. For example, if for every $100 of an establishment or a product's revenue, $10 is a green product or service or percentage of establishment revenue, then 10% of revenue is green. The same proportion transfers over to employment. Therefore, for every 100 workers in an industry, are green workers.

The Department of Energy Approach

U.S. Energy Employment Reports (USEERs) have been published since 2016. The 2020 USEER is an annual $1 million+ good-faith attempt by nonprofit agencies to estimate employment-related activities in the various energy sectors of the U.S. economy.[99] The results, published in a number of graphics-laden documents, total 621 pages in length. Unfortunately, the database and data tables required for deeper economic and employment research are not to be found among the 621 pages, making the USEER appear more of a coffee-table type book than a comprehensive, rigorous analysis.

However, the analysis in the USEER is benchmarked to the basic data available at the Bureau of Labor Statistics (BLS) and the BLS Quarterly Census Employment and Wages (QCEW) from a single quarter in 2019. It is not clear why a longer period was not chosen, but the BLS data themselves are of the highest quality for that singular 90-day period.

Problems arise as the data are stratified and tens of thousands of surveys are distributed to companies around the county by a contractor. While the survey may have been approved by the Office of management and Budget (OMB), it is not a government survey and is therefore not necessarily responded to by all companies completely, seriously, or accurately. This problem is especially acute for the 2018, 2019, and 2020 USEERs, which were conducted by private sector nonprofit organizations rather than DOE – as were the 2016 and 2017 USEERs.

One major weakness of the 2020 USEER is that it only covers what the USEER deems "direct" sales, so that much economic activity that is classified as "indirect" is not included. These major, important sectors of the economy -- for example, polysilicon production (a backwards linkage to solar panels) and gasoline station management and sales (a forward linkage to fuels) and their economic activity and employment – are not

[99]https://www.usenergyjobs.org/.

included. This is unfortunate since the backward and forward input-output linkages for energy technologies is very specific and not easily modeled.

The importance of this for the 2020 USEER and for estimating the jobs impacts of the energy industries cannot be over-emphasized. Some energy-related industries generate 10, 15, or 20 total (direct, indirect, and induced) jobs for every direct job. Thus, focusing only on direct jobs can underestimate the actual impact of some energy jobs and industries by a factor of 10, 15, 20, or more. This is especially worrisome because the direct, indirect, and induced jobs concept is widely used and publicized by numerous energy related organizations and interest groups. By ignoring these concepts, the 2020 USEER is potentially distorting its policy interpretations and implications.

Other salient issues with the 2020 USEER include:[100]

- When former DOE Secretary Ernest Moniz launched the nonprofit Energy Futures Initiative (EFI) during the summer of 2017, he stated that EFI would produce the USEER reports on "deep decarbonization pathways." This indicates that there may be some implicit biases against fossil fuels in the 2018, 2019, and 2020 USEERs.
- The use (or misuse) of “mixed” North American Industry Classification System (NAICS) categories containing a mix of energy and non-energy jobs and combinations of them.
- Different methodologies and data concepts are used in some of the annual USEERs, which makes it difficult to estimate some multi-year employment trends.
- The use of both company-specific and contractor jobs, with a failure often to adequately differentiate between the two.
- Confusion over which “job” concepts are being used in the USEER. There are repeated references to “employment,” “workforce,” “jobs,” and “net jobs.” Further, these concepts are sometimes used interchangeably in an inconsistent and confusing manner.
- Failure to use the concept of a full time equivalent (FTE) job in the U.S. As discussed in Section II.A.2, an FTE job is defined as 2,080 hours worked in a year’s time, 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 and an FTE job is the standard job concept used in these types of analyses and allows meaningful comparisons over time and across jurisdictions because it consistently measures the input of labor in the production process. This is a nontrivial issue: FTE v non-FTE jobs estimates differ substantial among industries – especially at the more detailed level. The estimates for detailed industries can differ by 25%, and the variance among industries is very high and the ratios can change year over year.
- The USEER publishes separate supplementary reports *Energy Employment by State*, which contains for each state and D.C. a 7-page summary chapter of the energy employment data. All 51 state reports are generically similar and are

[100]See the critique of the USEER in Management Information Services, Inc., “The Green Economy, Green Jobs, and Green Companies in Pennsylvania,” prepared for WorkingNation, May 2021.

produced according to the same template. While perhaps of some use – and these state reports are widely quoted and referenced, their actual value is uncertain, at best. Basically, the 2020 USEER state reports are of limited value and usefulness and, perhaps even more important, seriously misleading for the purposes of such reports, which include energy industry and job forecasting and planning, education and training programs, workforce and educational planning, etc.

Nevertheless, the 2020 USEER offers the best analysis possible given the millions of dollars it cost and may be of value and use to the Federal government, numerous industry groups and NGOs, and to the state and local government community as a strategic planning tool for economic development and education and employment training purposes. However, it is clear that this activity and data need to be fully integrated into the accounts at the BLS (and the Commerce Department's Census Bureau and the Bureau of Economic Analysis) and should probably be conducted by the Federal Government through the BLS. The 2021 USEER is presumably being conducted by DOE – as were the 2016 and 2017 USEERs, and this is, hopefully, a favorable development.

The MISI Approach

MISI considers that jobs can be considered to be "green" relative to the way the job was performed previously, i.e., in a production process, a change in technology that reduces waste emissions or energy consumption makes the jobs in that process "greener" than before. Still, can these jobs continue to be counted as green jobs when newer technology makes available ways of furthering green production, e.g., further reducing energy consumption?

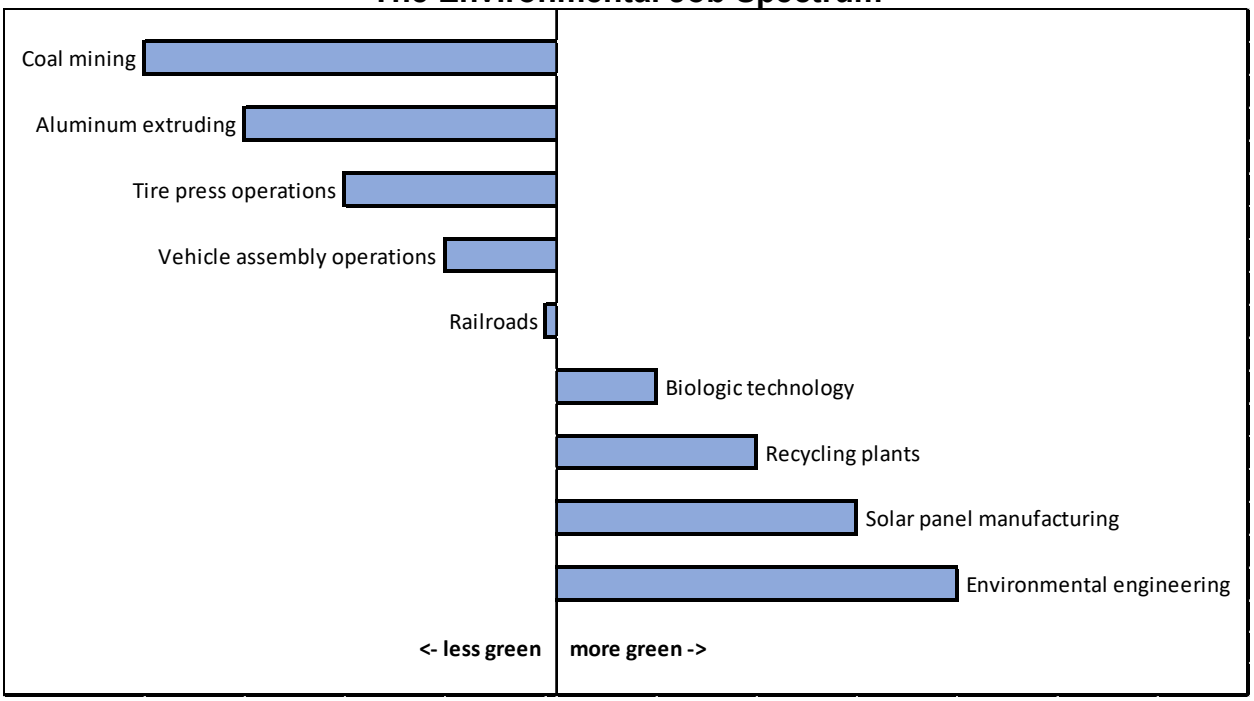
Two approaches can be used to address the relativity cited. The first approach targets green jobs, which could be new jobs or the greening of existing jobs, and defines a green job as one that emphasizes activities that contribute to an energy and environmentally sustainable development. A second approach focuses on the economy as a whole, defining a green economy as an economy that is sustainable, and green jobs as those jobs required to make an economy environmentally sustainable. Similarly, the term "green sector" is used to collectively describe companies involved in businesses designed to limit negative environmental and energy impacts. However, this definition of green jobs as employment opportunities arising from expenditures on activities that support sustainable development, or which reduce negative impacts on the environment, also presents ambiguities.

Therefore, based on extensive research and literature review, MISI considers that green jobs are perhaps best understood when viewed in a continuum across a spectrum, with jobs that generate obvious energy and environmental resource degradation or extraction at one end; a range of greener jobs involving clean production measures and technologies to reduce environmental impacts in the center, and the other end of the spectrum where jobs have a positive environmental impact – Figure II-3.[101]

[101]See the discussion in Bezdek, Wendling, and DiPerna, op. cit.

Using the spectrum concept, MISI defines environmental industries and green jobs as those which, as a result of environmental pressures and related concerns, have produced the development of numerous products, processes, and services, which specifically target improved sustainability and the reduction of environmental impact. Green jobs include those created both directly and indirectly by green expenditures. MISI's assumptions and methodology are discussed in greater depth in Chapters III, IV, and V.

Figure II-3
The Environmental Job Spectrum



Source: Management Information Services, Inc.

The Occupational Information Network Approach

In contrast to most other methodologies, which heavily emphasize industry, the Occupational Information Network (O*NET) takes an occupational approach to green jobs assessment.[102] From a green industry and green jobs development perspective, the O*NET approach is useful because it examines how the green economy will affect occupational requirements and demand across twelve green sectors. The actual definition of the green economy is similar to those of BLS and DOC; however, it is how O*NET approaches the green economy that is different. O*NET defines the green economy as: "The economic activity related to reducing the use of fossil fuels, decreasing

[102]https://www.onetcenter.org/reports/Green.html.

pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy."[103]

This approach is unique in several respects. O*NET contends that considering an occupation green or not green is misguided. Instead, it takes an occupational approach, and recommends that the focus of labor economists and green job advocates should be on the "greening" of the economy. O*NET contends that by doing so, workforce development specialists and economists can concentrate on the effects that a green economy will impose on occupational requirements. Thus, O*NET discards the concept of static green jobs, and instead contends that the degree to which the "green" economy affects the work context and worker requirements, is dynamic. The greening of occupations is defined as: "The extent to which green economy activities and technologies increase the demand for existing occupations, shape the work and worker requirements needed for occupational performance, or generate unique work and worker requirements." O*NET's is therefore a framework in which an occupation can be partially green.

O*NET is explicit in stating that technology is the driver of the green economy. Thus, "The extant green economy literature has not taken an occupational-level approach, focusing instead on broader industry-level outputs or products, such as renewable power generation and environmental protection enhancement." However, because the direction that the green economy will take is still unclear and the technologies are not all invented and developed, O*NET contends that the focus should shift from "green jobs" to "green occupations," so that analysts and policy-makers focus on the work performed and worker requirements.

Building on this concept, O*NET identifies three general categories that describe the effects of the green economy and green technologies on occupational requirements:

1. Green increased demand occupations, where the work context may change, but the tasks, knowledge, skills, and abilities do not.
2. Green enhanced skills occupations, where the occupation's purposes "remain the same, but tasks, skills, knowledge, and external elements, such as credentials, have been altered."
3. Green new and emerging occupations, where the demand of the green economy and technologies have created the need for "unique work and worker requirements."

The 12 sectors identified by O*NET as being affected by the greening of the economy are:

1. Renewable energy generation.
2. Transportation.
3. Energy efficiency.
4. Green construction.
5. Energy trading.
6. Energy and carbon capture and storage.

[103]Ibid.

7. Research, design, and consulting services.
8. Environment protection.
9. Agriculture and forestry.
10. Manufacturing.
11. Recycling and waste reduction.
12. Governmental and regulatory administration.

O*NET also describes in detail the sectors it identifies as green, delineating potential areas of growth, workforce implications, and the consequences of the greening of occupations on the sector.

O*NET thus provides an alternative definition to of “green jobs.” It selected sectors that could comprise the "green economy," such as energy efficiency and transport, then devised three occupational categories for the relevant jobs based on the skills needed:

1. Green increased demand.
2. Green enhanced skills.
3. Green new and emerging.

This approach can be useful because it considers the "green transition," rather than identifying jobs as either "green" or "not green." This makes specifying a definition of "green jobs" more difficult, but such an approach be useful for reflecting the complexities of the transition.

The Workforce Information Council’s Approach

The Workforce Information Council (WIC) defines green jobs and describes and recommends methods to estimate and analyze them.[104] WIC’s focus is on “identifying lessons learned and sharing information among states” and its work is essentially a how-to manual for analysts, describing guidelines, recommendations, and best practices for defining green jobs and conducting green economy and green jobs studies.

WIC emphasizes that green jobs should be classified as jobs “whose work is essential to green economic activity,” which is then disaggregated into categories.[105] Thus, these jobs are defined by their relationship to economic activity that is considered green, and not by their particular skills or skill-level, wages, or other compensation, or even the tasks being performed. This also means direct jobs, not indirect jobs, although this is not explicitly stated.

The specific definition WIC proposes is “a green job is one in which the work is essential to products or services that improve energy efficiency, expand the use of renewable energy, or support environmental sustainability. The job involves work in any of these green economic categories: renewable energy and alternative fuels; energy

[104]https://businessdocbox.com/Human_Resources/87511541-Measurement-and-analysis-of-employment-in-the-green-economy.html; https://ijbed.org/details&cid=181.
[105]Ibid.

efficiency and conservation; pollution, waste, and greenhouse gas management, prevention, and reduction; environmental cleanup and remediation and waste clean-up and mitigation; sustainable agriculture and natural resource conservation; education, regulation, compliance, public awareness, and training and energy trading."[106] It is significant here that WIC"s definition makes the job the unit of observation.

II.A.3. State Green Jobs Definitions and Estimates

Individual U.S. states have attempted to define and measure their green economies and green jobs. Several of these analyses are summarized below.

California Green Economy

The California Employment Development Department's Labor Market Information Division (LMID) conducted a study of California's green economy, in partnership with state, local and national policy makers and researchers.[107] There was strong interest in understanding the nature of the green economy, the number of green jobs, and the effects of environmental policy initiatives on the growth of industries in the state. LMID staff compiled and studied available research summarizing the assumptions and findings from more than 100 documents produced worldwide. Based on this research, LMID staff found little reliable data on the extent to which the green economy was affecting employment in California. LMID decided to conduct a survey covering all segments of California's economy in order to estimate the number of green jobs and green business practices.

The survey was mailed to a stratified random sample of more than 51,100 private and public-sector employers representing all industries, firm sizes, and counties in the state. The survey objectives were to:

- Obtain an estimate of the current number of green jobs in California.
- Identify the current and changing business practices that are helping California to achieve a cleaner, more sustainable environment — in terms of both producers and users of green or sustainable technology/energy.
- Identify the occupations that are emerging in our movement toward a cleaner, more sustainable economy.
- Identify resources and strategies to assist businesses in cutting costs by reducing energy usage and greenhouse gas emissions.

The survey estimated the number of green jobs, categorized according to LMID's working definition of "green" -- jobs that produce goods or services that result in:

- Generating and storing renewable energy.
- Recycling existing materials.

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[106] Ibid.

[107] https://www.labormarketinfo.edd.ca.gov/contentpub/GreenDigest/CA-Green-Economy-SummarySurveyResults.pdf.

- Energy efficient product manufacturing, distribution, construction, installation, and maintenance.
- Education, compliance, and awareness.
- Natural and sustainable product manufacturing.

The results of the survey indicated that 7.9% of California businesses employ workers to produce green products or supply green services. Employment in the production of green goods and services accounted for an estimated 3.4% of California's total wage and salary employment for the survey time period, with close to 433,000 individuals performing green work at least part time. Among the workers with green responsibilities, more than 263,000 spend 50% or more of their working hours in green activities.

The state's most heavily populated regions reported the largest number of green jobs, although the greatest concentrations were found in some of the least populated regions. Within industry sectors, manufacturing reported the largest number of workers performing green activities, while utilities reported the highest percentage of workers performing green activities.

The Green Economy Survey also asked businesses to respond to several questions about the extent of their adoption of green business practices. The findings indicated that an estimated 63% of firms in California are involved in green business practices, regardless of whether or not they directly produce a green good or service. The most common practices are recycling and using recycled materials.

Thirty-four occupations commonly associated with green work activities were included in the Green Economy Survey. Employers were asked to report the number of staff working in those positions. The occupations most frequently reported were assemblers, carpenters, hazardous material removal workers, recycling center operators, and sustainable farmers and farm workers. About 9% of workers were identified by respondents as "All Other" -- a category that may be viewed as capturing new or emerging green occupations. LMID has compiled and is analyzing the job titles listed in the "All Other" category.

Colorado Green Economy

MISI and the American Solar Energy Society (ASES) estimated the 2007 RE and EE jobs in Colorado.[108] In Colorado, they found that for RE (Table II-3):

- Gross revenues totaled nearly $1.1 billion.
- The total number of jobs created totaled more than 10,000.

[108]Management Information Services, Inc. and the American Solar Energy Society, *Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century*, Boulder, Colorado, 2009; Roger H. 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.

- Jobs created were disproportionately for scientific, technical, professional and skilled workers and about half of the jobs were in private industry.
- The largest number of jobs was in the Federal government sector (primarily NREL), followed by the wind and ethanol sectors.

Table II-3
The Colorado Renewable Energy and Energy Efficiency Industries, 2007

Industry	Revenues (millions)	Industry Jobs	Total Jobs
Renewable Energy	$1,082	4,415	10,075
Energy Efficiency	9,129	35,470	81,210
TOTAL	$10,211	39,885	91,285

Source: Management Information Services, Inc. and American Solar Energy Society.

In Colorado, they found that for EE (Table II-3):

- Gross revenues totaled over $9 billion.
- The total number of jobs created totaled more than 81,000.
- The largest number of jobs was generated by the recycling, reuse, & remanufacturing sector, and the second largest number of jobs was generated by the miscellaneous durables manufacturing sector, followed by the nondurable manufacturing sector and the construction sector.

In Colorado, they found that for RE&EE (Table II-3):

- RE&EE accounted for more than $10 billion in revenues.
- RE&EE generated over 91,000 jobs.
- The EE sector in Colorado is more than eight times larger than the RE sector.

Thus, in Colorado RE&EE accounted for more than four percent of gross state product and for more than three percent of total employment in the state

Table II-3 summarizes the RE&EE industries in Colorado in 2007 and shows that:

- RE&EE accounted for more than $10 billion in revenues.
- RE&EE generated over 91,000 jobs.
- The EE sector in Colorado is more than eight times larger than the RE sector.
- RE&EE accounted for more than four percent of gross state product and for more than three percent of total employment in the state.

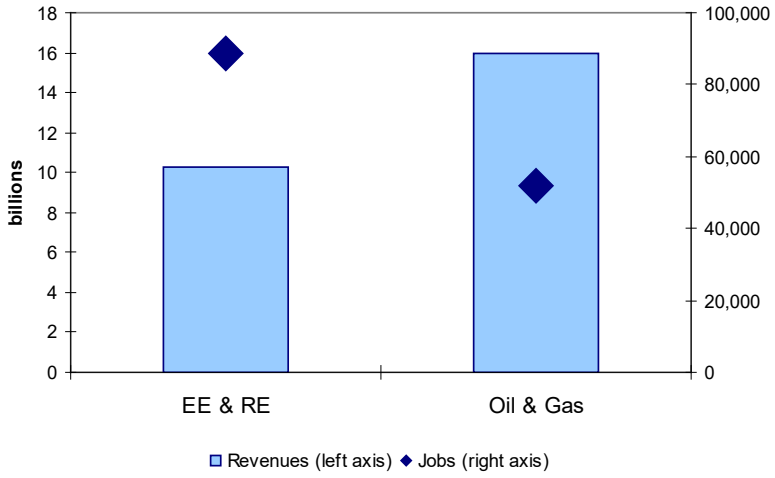
MISI/ASES found that there were hundreds of RE&EE companies located throughout Colorado. Given the wide diversity in the size, function, and technologies of these companies, it was impossible to estimate the job profile of the “average” RE&EE firm. However, it was possible to identify the jobs and earnings profiles of typical types

of firms involved in RE&EE-related areas of work.[109] First, firms working in the RE&EE and related areas employ a wide range of workers at all educational and skills levels and at widely differing earnings levels.

Second, in RE&EE companies, few of the employees are classified as renewable energy or energy efficiency specialists. Most of the workers are in occupations such as machinists, engineers, laborers, clerks, bookkeepers, accountants, maintenance workers, cost estimators, etc. All of these employees owe their jobs and livelihoods to RE&EE, but, in general, they perform the same types of activities at work as employees in firms that have little or nothing to do with RE&EE.

MISI/ASES compared the economic impact of the RE&EE sector to that of the Colorado oil and gas (O&G) sector in the state.[110] The comparative impacts of the sectors are illustrated in Figure II-4, which shows that, in terms of revenues, the O&G sector in Colorado was more that 50 percent larger ($5.7 billion) than the EE&RE sector. However, the RE&EE sector generated about 70 percent more jobs (39,000) than the O&G sector. Thus, the RE&EE sector in Colorado generated, in total, more than 2.5 times as many jobs per dollar of revenues as did the O&G sector in the state.

Figure II-4
Comparative Economic and Jobs Impact in Colorado of the RE&EE Sector and the O&G Sector



Source: Management Information Services, Inc. and American Solar Energy Society.

[109]Ibid.
[110]Ibid.

MISI estimated that in 2019:[111]

- Sales generated by green industries in Colorado totaled $29.4 billion.
- The number of green jobs totaled over 266,000.
- The green industry in Colorado comprised 7.5% percent of gross state product.
- Colorado green industries accounted for 4.5% of the sales of the U.S. environmental industry.
- Green jobs comprised 8.9 percent of Colorado employment.
- Green jobs in Colorado comprised 3.3 percent of the total number of green jobs in the U.S.

MISI forecasts that, post COVID-19, green jobs will increase four to five times more rapidly than total employment in the state.

Table II-4 shows the industrial distribution of green jobs in Colorado in 2019. This table shows that a significant portion of the green jobs is in the public administration sector which, given the public nature of green programs, is to be expected. However, most of the green jobs in Colorado are in the private sector, and focusing on these reveals that they are heavily concentrated in several sectors. Of particular note is that the private sector green industry in Colorado is more manufacturing intensive than other private sector activity in the state:

- Over 10 percent of private sector jobs in the green industry are in manufacturing, compared to less than five percent in manufacturing among all private sector industrial activities in Colorado.
- Over 17 percent of private sector green jobs are in professional, scientific, and technical services, compared to 14.7 percent of all private sector jobs in the state.
- Nearly 12 percent of private sector green jobs are in administrative, support, and waste management services, compared to less than four percent of all private sector jobs in the state.
- Over 11 percent of private sector green jobs are in construction, compared to less than six percent of all private sector jobs in the state.

Conversely, there are relatively few green jobs in other parts of the Colorado economy (Figure II-5):

- Less than four percent of green jobs are in the retail trade sector, compared to over five percent in retail trade among all jobs in the state.
- Less than one percent of green jobs are in the finance and insurance sector, compared to nearly six percent among all private sector jobs in the state.
- Less than one percent of green jobs are in the health care and social service sector, compared to over nine percent among all jobs in the state.
- Less than two percent of green jobs are in the transportation and warehousing sector, compared to over four percent among all jobs in the state.

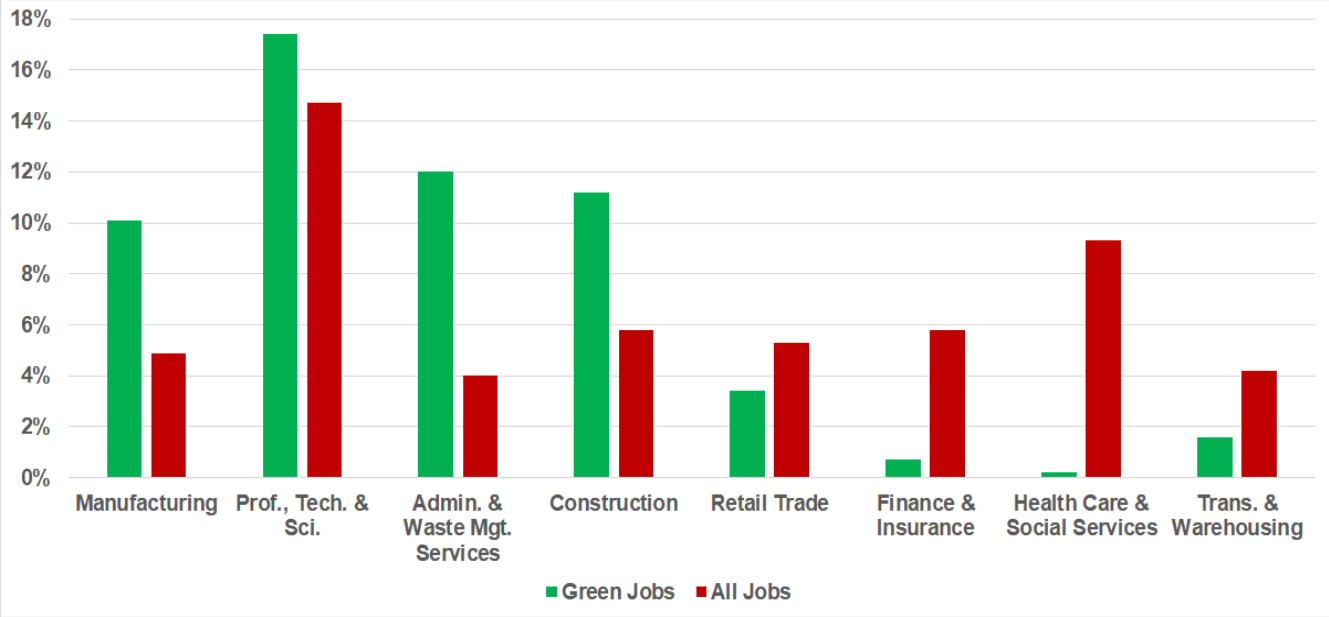
[111]Management Information Services, Inc., "The Green Economy, Green Jobs, and Green Companies in Colorado," prepared for WorkingNation, June 2021.

Table II-4
Green Jobs in Colorado in 2019, by Industry

Industry	2017 NAICS Code	Green Jobs
Agriculture, Forestry, Fishing and Hunting	11	2,004
Mining	21	5,122
Utilities	22	6,607
Construction	23	29,860
Manufacturing	31-33	26,772
Wholesale Trade	42	7227
Retail Trade	44-45	9,148
Transportation and Warehousing	48-49	4,166
Information	51	1,557
Finance and Insurance	52	1,895
Real Estate and Rental and Leasing	53	2,532
Professional, Scientific, and Technical Services	54	46,372
Management of Companies and Enterprises	55	2,189
Administrative/Support/ Waste Management/ Remediation Services	56	31,754
Educational Services	61	2,133
Health Care and Social Assistance	62	624
Arts, Entertainment, and Recreation	71	2,507
Accommodation and Food Services	72	3,122
Other Services	81	39,174
Public Administration	92	41,555
State Total		266,321

Source: U.S. Bureau of Labor Statistics, Colorado Department of Employment and Labor, and Management Information Services, Inc.

Figure II-5
Comparison of the Industrial Distribution of Jobs in Colorado



Source: U.S. Bureau of Labor Statistics, Colorado Department of Employment and Labor, and Management Information Services, Inc.

Assessing the portion of total state employment in each industrial sector accounted for by green jobs indicates that the 266,300 green jobs accounted for nearly nine percent of the total 3.08 million jobs in Colorado in 2019. However, this distribution is uneven among industry sectors:

- Over 40 percent of employment in the utilities sector consists of green jobs, primarily water, waste treatment, sanitation, and related facilities.
- Nearly 10 percent of public administration employment (federal, state, and local) in the state consists of green jobs.
- Over 17 percent of Colorado jobs in the professional, scientific, and technical services are green jobs.
- Over 10 percent of the state's manufacturing employment is green-related
- Only very small portions of total state employment in sectors such as food services, entertainment, real estate, transportation, and retail trade are comprised of green jobs.

The concentration of green jobs within certain industrial sectors is instructive and interesting. While accounting for nearly five percent of total state employment, the industrial sector composition of green employment is highly skewed in favor of certain sectors. For example, more than 10 percent of private sector green jobs are in manufacturing, compared to less than five percent of all employment, and more than 17 percent of green jobs are in professional, scientific, and technical services, compared to less than 15 percent of all private sector jobs in the state.

This indicates that green investments will provide a greater than proportionate assist to Colorado's high-tech and manufacturing sectors. Colorado is seeking to modernize and expand its high-tech industrial and manufacturing base. Table I-2 and Figure I-1 indicate that the green industry can aid in this objective.

Similarly, green investments generate disproportionately more jobs in professional, scientific, and technical services as the state average. Jobs in this sector are the high-skilled, high-wage, technical and professional jobs that Colorado – and other states – seeks to attract and retain. Table I-2 and Figure I-1 indicate that investments in green protection can be of considerable assistance here.

Connecticut Green Economy

MISI analyzed green jobs in Connecticut for the Connecticut General Assembly House Speaker's Working Group on Green Jobs.[112] MISI noted that "green jobs" were currently much-hyped and have become a panacea for U.S. economic and employment problems. Such jobs are important and will be increasingly important in the future – in Connecticut and the U.S. However, MISI noted:

- There is currently no standard definition of a "green job."
- There is a lack of reliable estimates of current green jobs at the national or state levels –including Connecticut.
- There is a lack of reliable forecasts of green jobs at the national or state levels -- including Connecticut.

Thus, the problem is that we cannot rigorously define green jobs, do not know how many there currently are, and cannot forecast future green job growth. These issues must be addressed before optimal green job policies can be developed for the U.S. or Connecticut.

MISI has identified three categories of green jobs:

- Environmental jobs – e.g. pollution abatement and remediation, etc.
- Renewable energy jobs – e.g., solar, wind, biofuels, etc.
- Energy efficiency jobs – e.g., weatherization, recycling, etc.
- There is some overlap in the categories, and double counting must be avoided.

MISI uses the direct and indirect job concept: Every direct, primary green job generates indirect, induced, and supporting jobs. MISI estimated the total number of green jobs created in Connecticut in 2009:[113]

- Environmental protection: 70,000.
- Renewable Energy: 7,000.

[112]Roger H. Bezdek, "Green Jobs in the U.S. and Connecticut: Reality and Potential," Presented to the Connecticut General Assembly House Speaker's Working Group on Green Jobs, Hartford, Connecticut, January 7, 2010.
[113]Ibid.

- Energy Efficiency: 116,000.
- Total, net of double counting: Approximately 165,000.

This represented about 9% of total Connecticut jobs and about 1.3% of total U.S. green jobs. Connecticut green jobs comprised about 1.25% of total U.S. green jobs. Thus, Connecticut had slightly more than its proportionate share of total U.S. green jobs. These data must be starting point for any Connecticut green jobs analyses or policies

MISI noted that green technologies offer development opportunities for Connecticut. Employment growth varies among sectors: Growing sectors include A&E, R&D, ESCO, environmental technologies, fuel cells, bio-fuels, power technologies, industrial processes, distributed generation, computer controls and systems, HVAC systems, and others. The green economy creates a variety of high-paying jobs, many of which take advantage of state new energy and environmental initiatives. Connecticut can recruit green companies to take advantage of its skilled workforce for wind turbine manufacturing, biofuels production, etc. Wages in many green sectors are higher than the U.S. average, and green technologies require a wide mix of occupations.

Green occupations include many jobs that require associate's degrees, on-the-job training, or trade certifications and which pay high wages and are a realistic target for job creation in Connecticut: State and local communities can build clusters around industry sectors. There are many entrance points makes green market easier to penetrate if Connecticut can utilize its strengths in workforce, tech, mfg., R&D, education, etc.

MISI emphasized that Connecticut must realize that there is intense interest in all states in "green" components of stimulus and related initiatives. Therefore:

- Rigorous metrics are required to track jobs impact of green programs and spending.
- Times series benchmarking of actual jobs is required.
- Methodology for determining the marginal impact of specific initiatives is required.
- Must develop methodology to compare jobs creation of green programs with that of other programs.
- Forecasts required, but must be supported by current data.
- Must provide detailed estimates that policy-makers desire: Technology, industry, state, city, jobs, occupations, skills, education requirements.
- Develop realistic expectations for green jobs.

MISI provided recommendations for Connecticut:[114]

- Develop reliable Connecticut baseline green economic and jobs data -- if we don't know where we are, how do we know where we are going?
- Develop green economic and jobs forecasts based on realistic scenarios–not wishful thinking.
- Monitor progress of stimulus programs, e.g., "cash for clunkers," and other Federal green initiatives.

[114]Ibid.

- Coordinate diverse green initiatives of various state agencies; e.g., Workforce Development Council, DEP, DECD, Development Authority, Employment and Training Commission, etc.
- Coordinate diverse green initiatives of various private and quasi-govt. agencies; e.g. Connecticut Innovations, Clean Energy Fund, Economic Resource Center, etc.
- Work with labor and education officials to identify emerging new green occupations, skills, and education and training requirements.
- Target education and training initiatives to realistic objectives -- must train for likely jobs, not "idealized" jobs.

Louisiana Green Economy

A Louisiana State University (LSU) research team was tasked with defining green jobs and the scope of the green economy in Louisiana.[115] Their definition of Louisiana's green economy was based on that developed by BLS. Green jobs were defined as being involved in one of seven areas of green economic activity:

1. Renewable Energy.
2. Energy Efficiency.
3. Greenhouse Gas Reduction.
4. Pollution Reduction and Cleanup.
5. Recycling and Waste Reduction.
6. Sustainable Agriculture, Natural Resource Conservation and Coastal Restoration
7. Education, Compliance, Public Awareness and Training Supporting the Above Categories.

Each activity category includes the research, development, production, and distribution of a final good or service; the supply of unique parts or inputs to a final good or service; and production processes and business practices regardless of the final good or service. The definition distinguished between two levels of a job's involvement in green activity:

- Primary green jobs were defined as those having a primary job function, i.e. a function consuming more than 50 percent of the employee's time, in one of seven green activity categories.
- Support green jobs are those essential to an organization's involvement in one of the activity categories, but not requiring more than 50 percent of an employee's effort.

Green economic activity exists in every sector of the economy, but the types of environmentally friendly activities vary greatly across sectors. They can range from the development of innovative technologies that address growing energy demand to the implementation of business initiatives aimed at reducing the impact of a company's

[115]"The Greening of Louisiana's Economy," https://www.lsu.edu/business/eprg/files/Green_Jobs_Summary_Report_D1.pdf.

operations on the environment. This range of green economic activity has varying implications for the workforce. For instance, a company that produces biofuels or installs solar photovoltaic technology will undoubtedly require its employees to be heavily involved in green activities. Alternatively, a company that does not produce a green good or service, but is attempting to reduce its impact on the environment by implementing new business practices or production processes would likely require only a fraction of its employees' time to manage or implement such an initiative.

The LSU survey of green employment in Louisiana focused on quantifying current levels of employment and the distribution of employment across industries and occupation groups. A sample of 12,882 business establishments from every region of the state was asked to participate in the survey. Direct responses from individual employers allowed for the most accurate estimate of current green employment in Louisiana to date. These estimates were augmented by a comprehensive qualitative assessment of green economic activity in Louisiana which included focus groups and interviews with stakeholders throughout the state. The resulting body of knowledge provided a very broad perspective of how the greening of the global economy is impacting Louisiana businesses, workers and consumers.

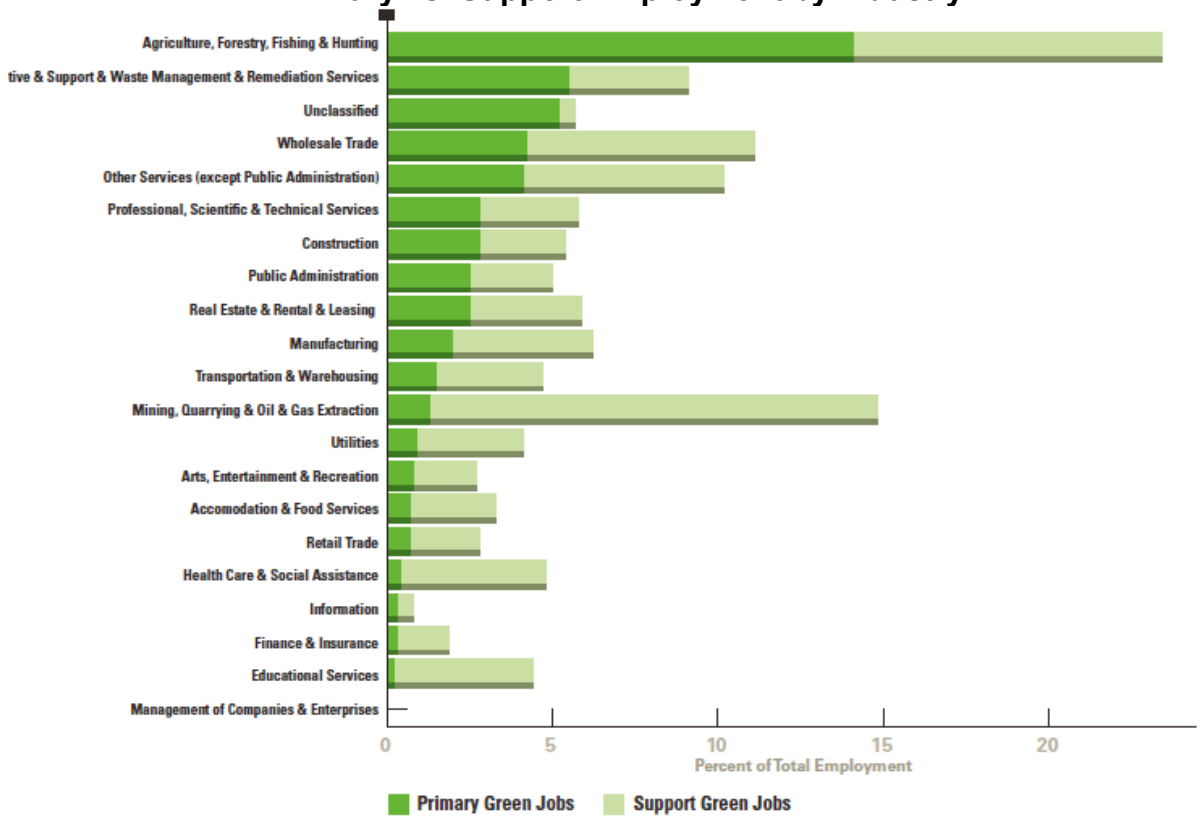
Analysis of the survey results resulted in an estimated 97,796 primary and support green jobs in Louisiana representing 5.3 percent of total nonfarm employment. Primary green jobs, those having a primary job function in a green activity, accounted for 30,205 jobs, or 1.6 percent of total nonfarm employment. Support green jobs contribute 67,591 jobs to total green employment representing 3.7 percent of nonfarm employment.

Further analysis of the survey results by industry provided the number of primary green jobs for each North American Industry Classification System (NAICS) sector. The two sectors with the largest number of primary green jobs were the Administrative and Waste Services sector and the Construction sector. The large number of primary green employment in the Administrative and Waste Services sector is a result of establishments in the sector that are conducting recycling operations and industrial hazardous waste management. The Construction sector's large number of primary green employment illustrates the workforce impact of growing interest in sustainable building practices and construction work related to the installation of green technologies on existing structures.

The overall impact of a greening economy on the workforce is better obtained by assessing green employment as a percent of total employment. This perspective demonstrates the varying degree to which workers within different sectors of the economy are becoming involved in activities that benefit the environment. Figure II-6 shows the percent of Louisiana NAICS sector employment comprised of primary and support green employment. The Agriculture, Forestry, Fishing and Hunting sector has the highest rate of total green employment followed by the Administrative and Waste Services sector. Figure 2 also provides a comparison of primary green employment versus support green employment. The difference in the rate of primary versus support green employment is important because it illustrates the distinction between the number of employees involved in an activity and the amount of time employees are spending on an activity. The Mining,

Quarrying, and Oil and Gas Extraction sector has a large number of employees involved in activities that help protect the environment. However, the large majority of these employees do not have a primary job function in these activities. This sector demonstrates the workforce implications of an industry in which businesses are working to limit the environmental impact of their operations even if the business is not producing a green product or service.

Figure II-6
Primary vs. Support Employment by Industry



Source: LSU.

LSU collected detailed information about primary green jobs because of the implicit effects of their greater involvement in green economic activity. In the survey, businesses were asked to provide job titles of employees with primary job functions in green activities. This information helped identify the types of employees at these organizations that are most impacted by the greening of the economy. By knowing the job titles of green job incumbents, it is also possible to infer the nature of the work most often associated with green economic activity. This additional information allowed for the analysis of green employment estimates by occupational groups based on the Standard Occupational Classification (SOC) taxonomy. Survey results indicated that the largest share of primary green employment is located in the Construction and Extraction occupational group.

LSU research found that green economic activity is occurring in every region of the state. There were many examples of businesses profiting from efforts to protect or restore Louisiana's environment, ranging from coastal restoration construction projects south of Houma to the recycling of natural gas drilling fluid in the Haynesville shale near Shreveport.

Michigan Green Economy

The Michigan Bureau of Labor Market Information and Strategic Initiatives (BLMISI) in the "Michigan Green Jobs Report" determined that the new green economy provides Michigan a dynamic opportunity to rebuild the state's job base, attract new investment, and diversify the state's economy and that the state was at a tipping point of awareness, understanding, and opportunities that a green economy can provide for Michigan's workforce, businesses, and communities.[116] BLMISI defined green jobs as jobs directly involved in generating or supporting a firm's green related products or services. The state's green economy was defined as being comprised of industries that provide products or services in five areas:

1. Agriculture and natural resource conservation.
2. Clean transportation and fuels.
3. Increased energy efficiency.
4. Pollution prevention or environmental cleanup.
5. Renewable energy production.

BLMISI used a three pronged methodology that included quantitative, analytical and qualitative research. The quantitative work involved a survey sent to thousands of employers to uncover private sector green job trends. The analytical work involved merging labor market information and economic intelligence with survey results to uncover industry and occupational trends. The qualitative approach involved using focus groups to enhance our understanding of green-related workforce issues.

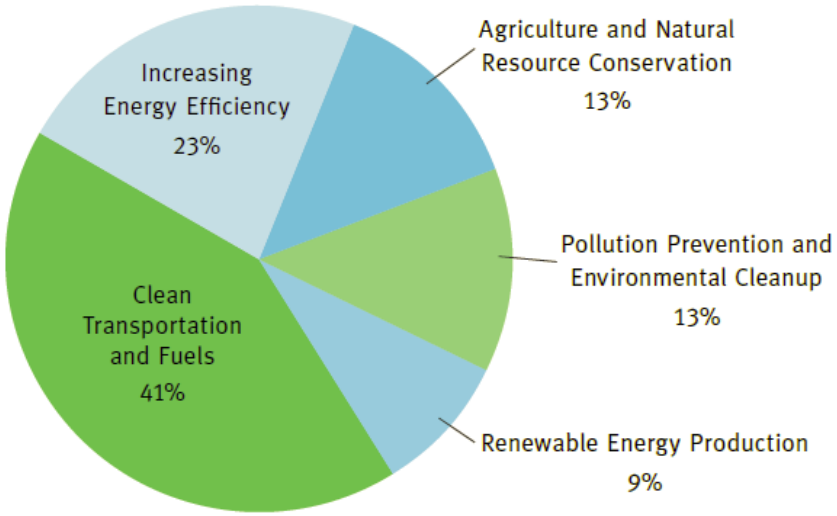
BLMISI estimated that in 2008 Michigan had 109,067 total green jobs -- both direct and support positions -- among private sector employers: 96,767 direct green jobs and 12,300 support green jobs. Michigan's total 2008 private sector employment was 3.2 million and green jobs were thus estimated to comprise 3% of total jobs.[117]

Through an employer survey, BLMISI categorized direct green jobs in Michigan into five core areas – Figure II-7. The Clean Transportation and Fuels area comprised just over 40 percent -- nearly 40,000 jobs -- of all green jobs. Nearly one quarter of green jobs were attributable to the Energy Efficiency core area, and most of the positions were associated with the state's construction industry. This distribution reflects Michigan's large automotive and construction sectors. Green jobs were most common in these

[116]Michigan Bureau of Labor Market Information and Strategic Initiatives "Michigan Green Jobs Report." Michigan.gov. May 2009, https://www.michigan.gov/documents/nwlb/GJC_Green Report _Print _277833 _7.pdf.
[117]Ibid.

specific industries: Transportation Equipment Manufacturing (25,780 jobs), Professional, Scientific, and Technical Services (22,178 jobs), Specialty Trade Contractors (9825 jobs), and Construction of Buildings (3,571 jobs).

Figure II-7
Distribution of Direct Green Jobs by Core Area



Source: Michigan Bureau of Labor Market Information and Strategic Initiatives.

From an occupational perspective, over 70 percent of direct green workers fall into three broad categories:

1. Production occupations (28 percent).
2. Engineering occupations (24 percent).
3. Construction occupations (19 percent).

Over one-third of the positions in the Clean Transportation and Fuels Core area were engineers, and a large portion of the remainder were production positions such as assemblers or machinists. In Energy Efficiency, the two most common occupations were related to construction: HVAC installers and general maintenance workers. Farmworkers comprised a quarter of green jobs in Agriculture and Natural Resource Conservation, while various kinds of engineers and environmental specialists were important in the Pollution Prevention and Environmental Cleanup core area. The Renewable Energy Production core area had the most diverse mix of green occupations, employing engineers, technicians, mechanics, and production staff.[118]

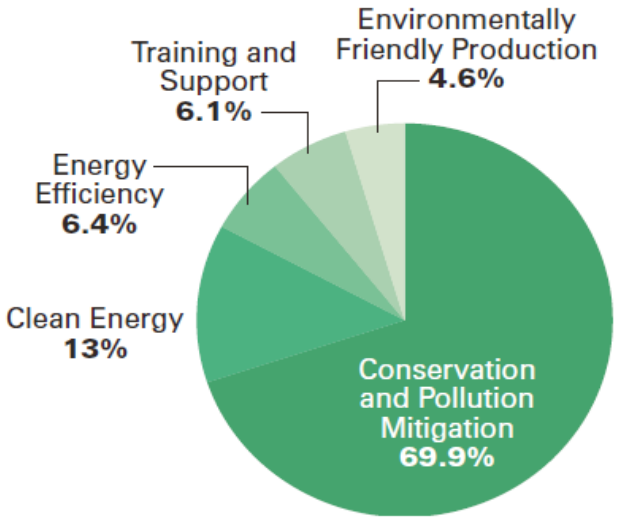
Green jobs were distributed across the spectrum of broad occupational categories, such as professional workers with specific skill sets directly needed by green-related firms; production, maintenance, and transportation occupations; critical occupations for

[118]Ibid.

small start-up green-related firms, such as sales engineers or technical sales representatives; and jobs in teaching or training.

When aggregating the number of green jobs, the Michigan Green Jobs Report used the industry input approach as the central method for counting green jobs in the state. The Pew Charitable Trusts estimated Michigan's green jobs using an industry output framework to estimate green jobs, and according to Pew, a clean energy economy generates jobs, businesses, and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources.[119] Pew estimated that there were 22,674 green jobs in Michigan in 2007, less than 1% of total employment – Figure II-8. As noted, BLMISI estimated that there were 109,067 green jobs in Michigan in 2008, about 3% of total employment. These respective green economy activity distributions are shown in Figures II-7 and II-8.

Figure II-8
Pew Report Job Categories for the State of Michigan



Source: Pew Charitable Trusts.

These two figures illustrate that not only do the two "green jobs" estimates for the state differ by more than a factor or four, but also that the green jobs classifications are not comparable.

[119]https://www.pewtrusts.org/~/media/legacy/uploadedfiles/peg/publications/report/clean20energy20economypdf.pdf.

Minnesota Green Economy

The Minnesota NGA Policy Academy Team (MNGAPT) noted that Minnesota's longstanding and new energy policies are sending a signal to businesses that are comparing investment opportunities.[120] It found that the state's steady support is stimulating growth across clean energy sectors, creating a diversity of good-paying jobs, a concentration of expertise, substantial clean energy infrastructure, and a variety of businesses spanning the value chain.[121]

As a result, Minnesota has a growing clean energy economy that sustains local jobs and attracts investment. These clean energy businesses employ workers and generate revenue directly from products or services that use less energy to provide the same service, or produce heat, power, or fuel from renewable sources of energy. This assessment included clean energy sectors (along with their value chains) known to have a direct but undetermined impact on the economy: energy efficiency, wind, solar, bioenergy, and smart grid. A strong local value chain, including manufacturing, supplying components or raw material, sales and distribution, installation and maintenance, and research or development, can give the state a competitive advantage in the industry.

MNGAPT determined that:[122]

- Minnesota's clean energy economy was growing quickly in terms of jobs, wages, and market development. Minnesota's early start and continued support of clean energy policies creates a competitive advantage: State policies dating back to 1980 sent strong market signals to investors. These policies provided incentives that encouraged development and adoption of energy efficient and renewable energy technologies. For example, Minnesota passed a law in 2013 to provide an incentive payment for solar systems manufactured in the state, and in 2010 a state goal for utilities to achieve 1.5 percent annual energy savings took effect. These policies have further stimulated markets by influencing federal standards and supporting development of community-centered enterprises.
- The clean energy market was developing rapidly, reducing the state's dependence on imported energy: Biofuels production capacity, energy efficiency savings, and solar and wind installations all had triple-digit percentage increases between 2000 and 2012. As of 2012, annual energy efficiency savings and renewable electricity capacity in Minnesota was enough to power over 1.4 million homes in the state for a year. State biofuel production capacity was enough to replace traditional fuel for 1.7 million vehicles for one year.
- Employment in clean energy sectors reached 15,300 in 2014 and was growing faster than total state employment: Clean energy employment in Minnesota increased 78 percent between January 2000 and the first quarter of 2014, growing steadily through the recession. The state's total employment grew only 11 percent

[120]MNGAPT was comprised of Minnesota's Department of Employment and Economic Development, Department of Commerce, Department of Agriculture, and Environmental Quality Board.
[121]"Minnesota Clean Energy Economy Profile," https://mn.gov/commerce-stat/pdfs/mn-clean-energy-econ-full-rpt.pdf.
[122]Ibid.

over the last 15 years. Over 15,300 workers were employed in a diversity of clean energy sectors in Minnesota. Of these workers, about 60 percent were in the energy efficiency sector, and the rest were spread across bioenergy, wind power, solar energy, and smart grid.

- Workers in clean energy earn high average wages compared with the state average: Minnesota workers in the clean energy economy earned over $1 billion in wages in 2013. Average annual wages in the clean energy economy reached over $71,000 in 2013, which was 42 percent higher than the statewide average for all jobs of about $50,000. Within clean energy sectors, average wages range from $61,500 in wind to $80,300 in smart grid. These jobs range from installation and maintenance to manufacturing and research.
- Minnesota is advancing innovation in clean energy sectors, with strong patent and investment activity: Minnesota companies are developing and deploying new clean energy technologies at an increasing rate. Minnesota ranked eighth in the US in total clean energy patents in 2013 – an increase from a decade ago when the state ranked 20th -- and companies received about $450 million in early stage investment over the last 10 years. Companies also received nearly $11 billion in project financing from the private sector to install renewable energy projects between 2004 and 2013.

For Minnesota, the National Resource Defense Council (NRDC) contended that curbing global warming is the work of a generation, and specifically, the work of millions of people, performing the jobs needed to build the green economy. Further, "Clean energy investments will create opportunities for welders, sheet metal workers, machinists, truck drivers, and others."[123] In Minnesota, NRDC estimated that there are more than 252,000 jobs in a representative group of job areas that could see job growth or wage increases by putting global warming solutions to work – TableII-5. It found that the benefits of those new jobs would spread to a much wider swath of the economy.[124]

Thus: "Train operators who currently deliver furniture may one day deliver wind turbine component parts, meaning that their work will be contributing to building a green economy, and that a green economy is creating new employment in rail transportation. By examining the number of people who are employed in each of the occupations that will be affected by these six green economy strategies, and the average wages in each state for each of these job types, it becomes clear that millions of U.S. workers, across a wide range of occupations, states, and income levels, will all benefit from defeating global warming and transforming the United States into a green economy. A push to dramatically increase America's clean-energy supply will mean increased demand for these workers, and rising demand could also lead to rising wages."[125]

[123]https://www.nrdc.org/sites/default/files/minnesota.pdf.
[124]Ibid.
[125]Ibid.

Table II-5

Jobs that Will Build the Green U.S. Economy

Green Economy Strategy	Representative Jobs
Building Retrofitting	Electricians, heating/air conditioning installers, carpenters, construction equipment operators, roofers, insulation workers, carpenter helpers, industrial truck drivers, construction managers, building inspectors
Mass Transit	Civil engineers, rail track layers, electricians, welders, metal fabricators, engine assemblers, production helpers, bus drivers, first-line transportation supervisors, dispatchers
Energy-Efficient Automobiles	Computer software engineers, electrical engineers, engineering technicians, welders, transportation equipment painters, metal fabricators, computer-controlled machine operators, engine assemblers, production helpers, operations managers
Wind Power	Environmental engineers, iron and steel workers, millwrights, sheet metal workers, machinists, electrical equipment assemblers, construction equipment operators, industrial truck drivers, industrial production managers, first-line production supervisors
Solar Power	Electrical engineers, electricians, industrial machinery mechanics, welders, metal fabricators, electrical equipment assemblers, construction equipment operators, installation helpers, laborers, construction managers
Cellulosic Biofuels	Chemical engineers, chemists, chemical equipment operators, chemical technicians, mixing and blending machine operators, agricultural workers, industrial truck drivers, farm product purchasers, agricultural and forestry supervisors, agricultural inspectors

Green Jobs in Minnesota

Solving global warming will require all kinds of workers with a wide range of skills. Tens of thousands of Minnesotans have good-paying job skills that are representative of a broad range of skills needed to build clean energy solutions:

- **Carpenters** will be needed to make buildings more energy efficient. There are nearly 19,000 carpenters in Minnesota, paid an average of nearly $20 per hour.
- **Electricians** are essential to expanding mass transit solutions. There are nearly 12,000 electricians in Minnesota, paid an average of over $27 per hour.
- **Operations managers** are needed to manufacture of energy-efficient automobiles. There are nearly 32,000 operations managers in Minnesota, paid an average of over $42 per hour.
- **Machinists** craft essential components for wind power. There are over 9,000 machinists in Minnesota, paid an average of nearly $19 per hour.
- **Welders** are vital to solar power manufacturing. There are nearly 9,000 welders in Minnesota, paid an average of over $17 per hour.
- **Industrial truck drivers** transport supplies and fuels for the cellulosic biofuels sector. There are over 10,000 industrial truck drivers in Minnesota, paid an average of nearly $16 per hour.[2]

Source: NRDC.

These six strategies are by no means exhaustive. For example, a study by McKinsey and Company, "Reducing Greenhouse Gas Emissions: How Much at What Cost?," discussed five broad clusters of approaches to reducing greenhouse emissions, including improving energy efficiency in buildings and appliances; increasing fuel efficiency in vehicles and reducing carbon intensity of transportation fuels; improving efficiency in energy-intensive industrial production; expanding and enhancing carbon sinks; and reducing the carbon intensity of electrical power production.[126] Within these five broad clusters, they identified a total of 41 strategies that, in combination, are capable of significantly reducing greenhouse emissions.

Pennsylvania Green Economy

A Pennsylvania Department of Labor & Industry report The Pennsylvania Green Jobs Survey Report" summarized the results of a 2010 green jobs survey of employers in Pennsylvania.[127] The primary goals of the survey were to identify the number and type of green jobs that exist within the state's economy and to forecast changes in green jobs based on employers' two-year projections. While dated, the report does provide a useful benchmark and has some useful green jobs definitions.

[126]https://www.mckinsey.com/NotFound.aspx?item=%2fclientservice%2fccsi%2fgreenhousegas&user=extranet%5cAnonymous&site=website.
[127]Pennsylvania Department of Labor & Industry, "The Pennsylvania Green Jobs Survey Report," 2010.

It defined green jobs as those that employ workers in producing or offering products or services that:

- Promote energy efficiency
- Contribute to the sustainable use of resources or renewable energy
- Prevent pollution
- Clean up the environment
- Promote the reduction of harmful emissions
- Provide green education/training, awareness, or compliance

The results show an estimated 183,029 green jobs in Pennsylvania in 2010, which account for 3.4 percent of the total employment in the state. Green jobs are found in each of the six core areas represented in the state's definition, and these jobs are found in varying concentrations in all industries in the state. One out of every five responding companies employs workers in green jobs, and small companies with less than 50 employees report that they have green jobs more often than large firms.

Green jobs exist in all industry sectors of Pennsylvania; however, the bulk of this employment occurs in relatively few sectors. The top six industries account for three-quarters of all green jobs; the three largest industries – construction, manufacturing, and professional, scientific & technical services – account for more than half of all green jobs. As a percent of total employment, the proportion of green jobs varies greatly by industry sector, from a high of nearly 19 percent for construction, to a low of just one tenth of one percent in the health care & social assistance industry sector.

Green jobs also tend to be concentrated within relatively few occupations. The top 25 occupations include more than half of all green jobs in the state. The top five occupations combined constitute about one-fifth of all green jobs: production workers; heating, air conditioning & refrigeration mechanics & installers; carpenters; electricians; and retail salespersons.

Overall, employers estimated green job growth at 6.2 percent annually over the next two years, resulting in 23,232 positions. Growth was forecast across most green occupations, with increases expected in 20 of the 25 most common green jobs. This growth forecast may be due to an increase in new green jobs, a shift in the work of existing employees into jobs considered green, or both. These forecasts probably reflect a conservative estimate, since the survey does not take into account openings due to attrition and retirements. Also, no attempt was made to estimate additional jobs through indirect or induced employment that may be associated with current or future employment in green jobs.

The report found:

- The energy efficiency core area accounts for more than one-third of all green jobs (65,137).
- The construction industry sector was the largest employer in this core area, with almost 42 percent of these green jobs.

- Heating, air conditioning, & refrigeration mechanics & installers are the occupation with the largest number of jobs in this core area.
- Resource sustainability/renewable energy is the second-largest core area, with 41,141 green jobs, or 22.5 percent of the total.
- Manufacturing was by far the largest employer in this core area, with more than 40 percent all green jobs.
- Production worker was the most common occupation, accounting for nearly 15 percent of sustainability renewable energy jobs.
- Pollution prevention accounts for 16.7 percent of green employment in the state, with an estimated 30,566 jobs.
- Green jobs are most numerous in the manufacturing, construction, and professional, scientific, & technical services industry sectors.
- Production workers and refuse & recyclable material collectors constitute the largest green occupations.
- Green education/training or compliance constitutes 13 percent of all green jobs (23,991). One third of these jobs are in public administration, and 18 percent are in professional, scientific & technical services.
- The most common occupation in this core area is elementary school teachers (except special education), with nearly 16 percent of these jobs. These teachers often instruct students in green-related subject areas such as general science, biology, or environmental studies, for example.
- Environmental cleanup accounts for 6.4 percent of green jobs (11,672). One-quarter of the environmental cleanup jobs are in the professional, scientific & technical services industry sector. Refuse & recyclable material collectors account for nearly 11 percent of the jobs in this core area.
- Harmful emissions reduction has the smallest number of green jobs among the six core areas (10,522), accounting for 5.7 percent of the state's green employment.
- Transportation & warehousing, and retail trade each cover roughly one-quarter of all jobs in this core area.
- Automotive service technicians & mechanics account for 28 percent of all jobs in this core area.

MISI estimated that in 2019:[128]

- Sales generated by green industries in Pennsylvania totaled $42.9 billion.
- The number of green jobs totaled over 376,000.
- The green industry in Pennsylvania comprised 5.3% percent of gross state product.
- Pennsylvania green industries accounted for 6.6% of the sales of the U.S. environmental industry.
- Green jobs comprised 6.1 percent of Pennsylvania employment.
- Green jobs in Pennsylvania comprised 4.7 percent of the total number of green jobs in the U.S.

[128]Management Information Services, Inc., "The Green Economy, Green Jobs, and Green Companies in Pennsylvania," prepared for WorkingNation, May 2021.

MISI forecasts that, post COVID-19, green jobs will increase three to four times more rapidly than total employment in the state.

Table II-6 shows the industrial distribution of green jobs in Pennsylvania in 2019.

Table II-6
Green Jobs in Pennsylvania in 2019, by Industry

Industry	2017 NAICS code	Green Jobs
Agriculture, Forestry, Fishing and Hunting	11	3,041
Mining	21	4,189
Utilities	22	9,233
Construction	23	48,990
Manufacturing	31-33	61,505
Wholesale Trade	42	11,836
Retail Trade	44-45	17,393
Transportation and Warehousing	48-49	10,032
Information	51	3,715
Finance and Insurance	52	3,347
Real Estate and Rental and Leasing	53	3,257
Professional, Scientific, and Technical Services	54	65,361
Management of Companies and Enterprises	55	5,659
Administrative/Support/ Waste Management/ Remediation Services	56	37,212
Educational Services	61	10,802
Health Care and Social Assistance	62	4,844
Arts, Entertainment, and Recreation	71	1,848
Accommodation and Food Services	72	3,438
Other Services	81	8,478
Public Administration	92	62,474
State Total		376,655

Source: U.S. Bureau of Labor Statistics, Pennsylvania Department of Labor and Industry, and Management Information Services, Inc.

Comparison of the industrial sector distribution of green jobs in Pennsylvania with that of total employment in the state is instructive. A significant portion of the green jobs is in the public administration sector which, given the public nature of green programs, is to be expected. However, most of the green jobs in Pennsylvania are in the private sector, and focusing on these reveals that they are heavily concentrated in several sectors. Of

particular note is that the private sector green industry in Pennsylvania is more manufacturing intensive than other average private sector activity in the state:

- Over 16 percent of private sector jobs in the green industry are in manufacturing, compared to nine percent in manufacturing among all private sector industrial activities in Pennsylvania.
- Over 17 percent of private sector green jobs are in professional, scientific, and technical services, compared to less than six percent of all private sector jobs in the state.
- Nearly 10 percent of private sector green jobs are in administrative, support, and waste management services, compared to less than six percent of all private sector jobs in the state.
- Less than three percent of private sector green jobs are in educational services, compared to over four percent of all private sector jobs in the state.

Conversely, there are relatively few private sector green jobs in other parts of the Pennsylvania economy:

- Less than five percent of private sector green jobs are in the retail trade sector, compared to over 10 percent in retail trade among all private sector jobs in the state.
- Less than one percent of green jobs are in the finance and insurance sector, compared to nearly five percent among all private sector jobs in the state.
- A little over one percent of green jobs are in the health care and social service sector, compared to over 17 percent among all private sector jobs in the state.
- Less than three percent of green jobs are in the transportation and warehousing sector, compared to four percent among all private sector jobs in the state.

Assessing the portion of total state employment in each industrial sector accounted for by green jobs indicates that the 376,700 green jobs accounted for about a little over six percent of the total 6.2 million jobs in Pennsylvania in 2019. However, this distribution is uneven among industry sectors:

- Over one-third of employment in the utilities sector consists of green jobs, primarily water, waste treatment, sanitation, and related facilities.
- Nearly ten percent of public administration employment (federal, state, and local) in the state consists of green jobs.
- Nearly 20 percent of Pennsylvania jobs in the professional, scientific, and technical services are green jobs.
- 11 percent of the state's manufacturing employment is green-related
- Only very small portions of total state employment in sectors such as food services, entertainment, real estate, transportation, and retail trade are comprised of green jobs.

The concentration of green jobs within certain industrial sectors is instructive and interesting. While accounting for a little over six percent of total state employment, the industrial sector composition of green employment is highly skewed in favor of certain sectors. For example, more than 16 percent of private sector green jobs are in

manufacturing, compared to nine percent of all private sector employment, and more than 17 percent of private sector green jobs are in professional, scientific, and technical services, compared to less than six percent of all private sector jobs in the state.

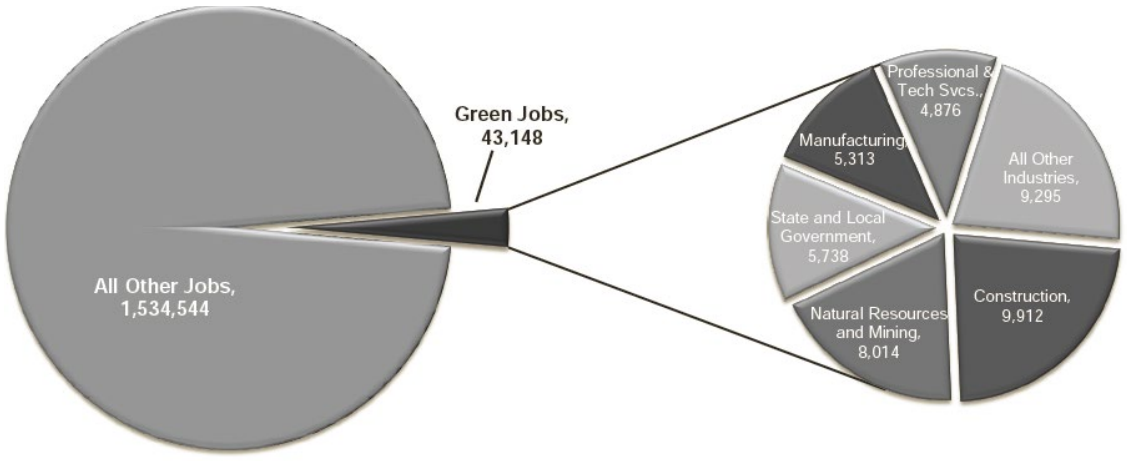
Oregon Green Economy

Oregon defines a green job a job that provides a service or produces a product in any of the five green categories:[129]

1. Producing energy efficiency.
2. Producing renewable energy.
3. Preventing, reducing, or mitigating environmental degradation.
4. Cleaning up and restoring the natural environment.
5. Providing education, consulting, policy promotion, accreditation, trading and offsets, or similar services supporting the above four categories.

Oregon found that green jobs can be found in every major industry and occupational group, and in every region of the state, but tend to be concentrated a few industries and occupations. More than three-fourths of all green jobs can be found in five industries: construction; natural resources and mining; state and local government; manufacturing; and professional and technical services – Figure II-9 and Table II-7. Nearly one out of every four green jobs in 2010 was in the construction industry alone. Similarly, 45 percent of all green jobs fall into one of 11 occupations, although employers reported at least one green job in 185 different occupations.[130]

Figure II-9
Green Jobs and Component Industries Relative to Total Employment, Oregon Statewide, 2010



Source: WorkSource Oregon Employment Department.

[129]https://digital.osl.state.or.us/islandora/object/osl%3A21624/datastream/OBJ/view.
[130]Ibid.

Table II-7
Green Jobs and Industry Employment, Oregon Statewide, 2010

Industry	Green Jobs	Share of All Green Jobs	Total Jobs	Green Jobs Share of Total Jobs
Construction	9,912	23%	71,594	14%
Natural Resources and Mining	8,014	19%	46,761	17%
State and Local Government	5,738	13%	78,623	7%
Manufacturing	5,313	12%	163,402	3%
Professional and Technical Services	4,876	11%	70,890	7%
Administrative and Waste Services	1,955	5%	82,658	2%
Transportation and Warehousing	1,450	3%	51,347	3%
Wholesale and Retail Trade	1,226	3%	255,900	less than 1%
Utilities	1,075	2%	7,396	15%
Other Services	937	2%	61,892	2%
Educational and Health Services	708	2%	361,802	less than 1%
Management of Companies and Enterprises	678	2%	31,513	2%
Financial Activities	606	1%	87,647	1%
Leisure and Hospitality	581	1%	172,078	less than 1%
Not Classified	46	less than 1%	665	7%
Information	33	less than 1%	33,524	less than 1%
Total	**43,148**	**100%**	**1,577,692**	**3%**

Source: WorkSource Oregon Employment Department.

While some green jobs are found in emerging occupations such as wind turbine service technicians and solar panel installers, most are found in occupations that have existed for a long time – Table II-8. Many green workers differ from their non-green counterparts in the same occupation due to an essential, green function. However, many aspects of green and non-green jobs in the same occupation function in essentially the same capacity. In other words, there are usually many similarities between green and non-green jobs in the same occupation, but often with just one or two key differences. Oregon referred to this as the "greening of Oregon's workforce."[131] Rather than a separate green industry, most green jobs are integrated into the existing economy.

Almost one-third (30%) of Oregon's green jobs required related work experience and no degree to be competitive for positions. Over one-fourth (28%) required a bachelor's or advanced degree. In addition, 114 occupations had some green jobs with a license, certification, or special requirement. Educational requirements differed significantly among the industries and occupations with the most green jobs.

Green jobs paid slightly higher wages than non-green jobs in 2010. The average hourly wage for all green jobs was $23.07, compared to $19.83 for all jobs – Table II-9. Green workers in occupations that required higher levels of education generally earned higher wages.

[131] Ibid.

Table II-8
Green Jobs by Occupational Group, Oregon Statewide, 2010

Occupational Group	Green Jobs	Share of All Green Jobs
Construction and Extraction	6,839	16%
Farming, Fishing, and Forestry	5,857	14%
Life, Physical, and Social Science	5,609	13%
Installation, Maintenance, and Repair	5,254	12%
Production	3,989	9%
Transportation and Material Moving	3,732	9%
Architecture and Engineering	2,698	6%
Business and Financial Operations	2,582	6%
Management	1,791	4%
Protective Service	1,138	3%
Office and Administrative Support	958	2%
Building and Grounds Cleaning and Maintenance	954	2%
Education, Training, and Library	384	1%
Sales and Related	376	1%
Arts, Design, Entertainment, Sports, and Media	311	1%
Food Preparation and Serving Related	291	1%
Computer and Mathematical	188	less than 1%
Health Care Practitioners and Technical	119	less than 1%
Community and Social Service	54	less than 1%
Personal Care and Service	13	less than 1%
Legal	11	less than 1%
Total	43,148	100%

Source: WorkSource Oregon Employment Department.

Table II-9
Green Jobs in Oregon: Quick Stats

43,000
The number of green jobs statewide
3 %
Green jobs' share of Oregon's workforce
185
The number of occupations with at least one green job
44 %
The share of green jobs that require related work experience and no degree, or have no requirement
39 %
Portion of all green jobs that require postsecondary education
$23.07
The average hourly wage of all green jobs
-1 %
Employers' projected change in green jobs by 2012

Source: WorkSource Oregon Employment Department.

By region, green jobs mirrored overall employment trends in the state. The largest shares of green jobs were reported in the Portland area (41%) and the Willamette Valley (17%). Southern Oregon accounted for 11 percent of all green jobs, and smaller shares were reported in Central Oregon and the Columbia Gorge, along the coast, and in Eastern Oregon.

Employers projected little change in the number of green jobs statewide between 2010 and 2012. They anticipated a net loss of 598 green jobs (-1%) over the two-year period. Three industries expected to add green jobs, and manufacturing employers anticipated an increase. Another increase was expected in administrative and waste services – a broad group which includes employment agencies; landscaping services; waste collection, treatment, and disposal services; and other businesses. Finally, employers expected to add green jobs in other services, another broad group that includes repair services; religious, social, civic, and similar organizations; and other businesses.

Pew estimated a 2007 total of 19,340 clean energy jobs in Oregon,[132] while the Oregon study estimated 43,000 green jobs, three percent of total employment. The Oregon report did not disaggregate its jobs figure by core green area.

Washington State Green Economy

Washington State employs the broad environmental definition of green, and it explicitly includes RE/EE within that definition.[133] Washington State's Employment Security Department was the first state to produce a green jobs report.[134] The initial report was published in 2009, and was followed up with an additional report published in 2010. These reports, mandated by the Washington State legislature during the 2008 legislative session, identified the number and type of green jobs in Washington State, as well as established a baseline against which to measure future industry and job growth of the green economy in the state. The reports were supposed to be used in conjunction with other research to, among other things, "guide state policies and strategies that will support future growth in Washington's green economy."[135] Washington defines green economy as "rooted in the development and use of products and services that promote environmental protection and energy security." It is composed of industries and businesses engaged in (Figure II-10):[136]

- Energy efficiency.
- Preventing and reducing pollution.
- Renewable energy.

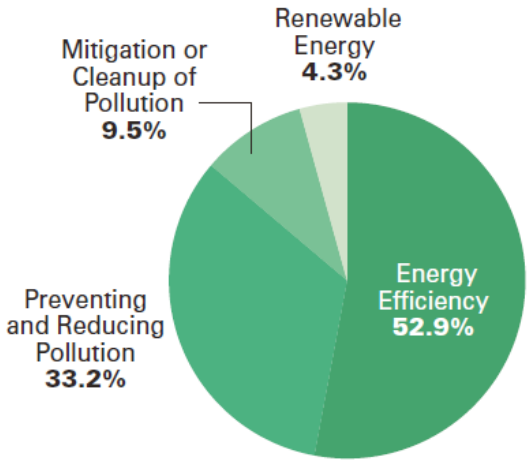
[132]https://www.pewtrusts.org/~/media/legacy/uploadedfiles/peg/publications/report/clean20energy20economypdf.pdf.
[133]http://cleanenergyexcellence.org/wp-content/uploads/WSU-GreenEconomyReport_1-23-12.pdf.
[134]State of Green: The Definition and Measurement of Green Jobs, https://cew.georgetown.edu/wp-content/uploads/2010/08/Literature-Review_Green.pdf.
[135]http://cleanenergyexcellence.org/wp-content/uploads/WSU-GreenEconomyReport_1-23-12.pdf.
[136]Ibid.

- Mitigating or cleaning up pollution.

The reports contended that green jobs promote environmental protection and energy security. The 2010 report defined of green jobs as being where employees are directly and predominately employed in the four core areas cited above. Both reports estimated only direct jobs.

For Washington State, Pew estimated 17,013 green jobs, or roughly 0.6 percent of total employment. The state's report estimated 99,000 green jobs. Categorical classifications of these green jobs are given Figure II-1o and Figure II-11.

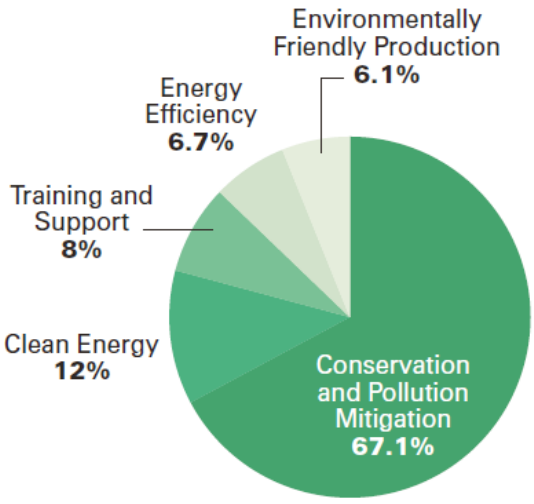
Figure II-10
Washington Report Job Categories for the State of Washington – Industry Input Framework



Source: Washington State Employment Security Department.

Pew estimated that the majority of green jobs were in in conservation and pollution mitigation, while the Washington State study estimated that the majority of green jobs were in providing energy efficiency. Pew estimated that only 7% of the green jobs were in energy efficiency and this implies many of the energy efficiency jobs that the state estimated were in non-green businesses.

Figure II-11
Pew Report Job Categories for the State of Washington – Industry Output Framework



Source: Pew Charitable Trusts.

II.B. Assessment

Many different organizations and analysts have attempted to define the green economy and green jobs, and all have encountered similar problems: How to define an amorphous and still-emerging concept and how to estimate jobs that do not easily fit into current occupational systems. Several approaches have been attempted: The survey approach, a labor market information approach, an industry approach, and occupational approach, and various combinations of these. While there is a large and rapidly growing body of literature on the subject, the green jobs picture still remains amorphous.[137] This is due in part to the lack of consensus on a definition, but it also results from a lack of information and the existence of different concepts and definitions. While there has been considerable research at the state level, there exists little unbiased information about which sectors, industries, and jobs will grow the most rapidly, and which are stagnant.

In addition, relatively little attention has been paid to the effects that public policy, has had on green jobs beyond stating that it has had an effect. Public policy in the U.S. is driving these changes and influencing investment and workforce training, and it would be useful to know how and how much. Researchers have even argued that leadership in the green economy will pay enormous rewards in the 21st century, as this growing market

[137]Pew Charitable Trusts, "Who's Winning the Clean Energy Race? 2013, http://www.pew environment. org/uploadedFiles/PEG/Publications/Report/-clenG20-Report- 2012-Digital.pdf.

experiences vast expansion over the coming decades.[138] They warn that while the U.S. is just waking up to these realities, China – a major global economic competitor -- is already acting on them.[139]

Finally, except for MISI, missing from the literature is a retrospective look at the green economy -- that is, tracing its growth over the past decades and investigating the reason that it developed the way that it did and the impact that it has already had on workforce development.

The choice of industry versus occupational approach partly explains why studies have reported such different green job totals. Limiting a study's scope to just businesses that produce green products or services excludes green-related jobs at traditional firms. For example, if a motor vehicle manufacturer hires an engineer trained in energy efficient design, this job would not be counted in the industry output approach, but would have been counted in the state-based studies. While the occupational approach makes the green job total more comprehensive, the data collection method used to estimate these jobs leaves more room for ambiguity and loose interpretation in the final results.

Different definitions of the green economy, and their corollary approaches require different methods of identifying and quantifying green jobs and the green economy. As long as one can identify a firm's line of business as green, that firm's employees can be considered green from the industry-output approach, and this is the approach that Pew has used. Pew searched for firms that met their specific guidelines for green classification, and added those firms' employment figures to the green jobs total.

Conversely, a number of states used an industry input approach and conducted surveys as the primary means of information-gathering. This approach recognizes that firms may have employees with the same Standard Occupational Classification (SOC) code, but not all of them may be green.

An industry-output approach to the green economy can apply a stricter standard for qualifying firms as green, and can apply that standard consistently. In addition to assessing green jobs and businesses, this approach provides other useful green statistics that offer valuable insight. These may include information on venture capital funds, patents, and federal and state policies such as financial incentives, renewable energy portfolio standards, energy efficiency resource standards, and cap and trade programs.

The state-based surveys' major disadvantage is that interpretation of what constitutes a green job is partially left up to the survey respondent. For example, a survey question may ask the respondent to estimate the number of employees who have one of the study's core green job areas as their "primary focus." It is up to the respondent to determine if an employee's primary focus is "increasing energy efficiency" or simply turning off the lights at the end of the day. This calls the reliability of the results into

[138]https://cew.georgetown.edu/wp-content/uploads/2010/08/Literature-Review_Green.pdf.
[139]https://www.americanprogress.org/issues/green/reports/2013/12/10/80756/the-green-industrial-revolution-and-the-united-states/.

question. Some surveys, instead of asking for the "primary focus," instruct respondents to list jobs as green only if work in one of the green categories was essential to the job. However, this difference does not alleviate the problem of ambiguity.

The occupational (industry input) approach may have great potential. There may be emerging green occupations, but to date, most are without an SOC code.[140] Indeed, one might think that unambiguously green jobs would require special certifications that could clearly identify the position and its skill set as green. However, based on responses gathered from employer focus groups, some state surveys found that most new green jobs would require in-house training, in contrast to external certification. Employers predominantly desire employees with basic skills. Accordingly, a discussion of well-defined green skills might be somewhat unproductive, since the main skills employers are seeking are not unambiguously green.

Whatever the case, devoting significant federal analytical resources to rigorous, consistent analysis of the scope and growth of the green economy and green jobs is required.[141] One potentially useful method could likely be a "green economy satellite account" produced by BEA, in collaboration with other federal statistical agencies. BEA currently releases economic statistics for several satellite accounts.

For example, the Commerce Department's Travel and Tourism Satellite Account (TTSA) measures the size of the travel and tourism "industry."[142] Producing the TTSA requires some analytical refinements similar to what would be required to define and measure the green economy. There really is not a travel and tourism industry as such. Industries are defined in terms of their production. Travel and tourism, on the other hand, is based on the consumer.[143]

The same experience that BEA has gained developing the TTSA and other satellite accounts could also be applied to measuring the green economy. Thus, green economic activity -- the dollar-value and the number of jobs -- would be defined rigorously and measured consistently over time.

A green economy satellite account does not preclude or replace an occupational survey. BLS currently conducts the Occupational Employment Statistics (OES) Survey. The data from the OES help to evaluate many elements of labor dynamics. Further, because occupations can be linked with educational and training needs, these data can help inform training programs that develop the skill and knowledge sets needed for the future.[144] The green jobs surveys conducted by several states are similar to the OES survey.

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[140]See the discussion in Bezdek, "The Hydrogen Economy and Jobs of the Future," op. cit.

[141]Industries that qualify as green can serve as a benchmark for the current size of the green economy and as a benchmark to measure the rate by which the economy becomes "greener."

[142]https://www.trade.gov/travel-and-tourism-satellite-account-ttsa-program.

[143]For example, on a weekend trip, a tourist may eat at a restaurant, sleep at a hotel, golf, rent a car, and take a guided tour. In this example, the tourist consumed the output of five distinct industries with five distinct production processes.

[144]See the discussion in Bezdek, "The Hydrogen Economy and Jobs of the Future," op. cit.

While conventional debate on the environment, climate change, and alternative energy has focused on applying new technology to offset traditional energy sources. Increasingly, however, advances and breakthroughs in the green economy will come from all areas of the economy, and may not necessarily be captured by traditional industry sources of energy/green technologies or current job classifications. This represents both a challenge and an opportunity. The opportunity is to get ahead of the curve on how and where the jobs of the future are being created as the economy rebuilds from COVID-19, determine which are the best green industries to target, assist companies and communities seeking solutions to their own workforce issues, and identify for workers and job seekers where the jobs of the future will be. Thus, the challenge is to identify where these industries, companies, and jobs currently are and where they will be in the near future.

Nevertheless, it is important to realize that the overwhelming majority of green jobs will be existing conventional jobs. For example:

- Electricians will be installing solar panels.
- Plumbers will be installing low-flush toilets.
- Drywall installers will be needed to increase the energy efficiency of buildings.
- Insulation workers will be increasing the R-values of buildings.
- HVAC technicians will be installing energy efficient HVAC systems.
- Autoworkers will be building ZEVs (zero emission vehicles).
- Etc.

How “green” an occupation or skill is does not necessarily depend on the occupational definition. Rather, it is also determined by the product, process, or service involved. Further, neither federal nor state occupational classifications exist for occupations such as “Green Welder,” “Green Computer Analyst,” “Green Accountant,” “Green Carpenter,” etc. Thus, for example, the employees of a wind turbine manufacturing company include standard occupations such as Assemblers, Mechanical Engineers, Maintenance and Repair Workers, Machinists, Purchasing Agents, Customer Service Representatives, Industrial Machinery Mechanics, Shipping and Receiving Clerks, etc. All of these should be considered “green” employees.

Similarly, the employees of an environmental remediation services company include standard occupations such as General and Operations Managers, Construction Laborers, Truck Drivers, Office Clerks, Maintenance and Repair Workers, Janitors and Cleaners, Dispatchers, Security Guards, Operating Engineers, Receptionists, etc. All of these should also be considered “green” employees.

Thus, the green economy and green jobs are significantly determined by the product – such as wind turbines, or service – such as environmental remediation, that a company or a worker is associated with. This leads to at least two concepts of green jobs. First, the usual and obvious ones, such as Ecologist, Wind Turbine Technician, Environmental Engineer, Solar Energy Specialist, Hydrogen Fuel Cell Researcher, Hazardous Materials Removal Worker, Environmental Lawyer, and so forth. In this case it is the occupational classification that determines the green job.

The second classification involves workers in standard jobs in "green" firms. In this case it is the company and the product or service being furnished that determines the green job.

There are thus at least two approaches to estimating green jobs: an industry approach and an occupational approach:

- The industry approach estimates the number of employees at a firm that, based on the firm's output, makes the economy "greener."
- The occupational approach estimates the number of employees at all types of firms with work activities that can be defined as green, no matter what the output of the firm.

However, even these two taxonomies still include only a portion of the green jobs in the economy. Most green jobs generated in the green economy are indirect, induced, or supporting and this is rarely recognized or estimated in the green jobs literature. This is discussed further in Chapter V.

II.C. Defining Green Jobs as the Null Set?

Numerous organizations, advocates, and politicians have significantly tightened the criteria for defining and characterizing green jobs and have, paradoxically, greatly reduced the number of jobs that can according to these criteria or characteristics be legitimately defined as being "green." The more stringent the criteria, the fewer the jobs that are defined as green. For example:

President Biden in his Presidential election campaign identified green jobs as:[145]

- Stable well-paying jobs.
- Good jobs offering good wages, benefits, and worker protections.
- Jobs that defend workers' rights to form unions and collectively bargain.
- Incorporating skills training.
- Worker-centered and driven in collaboration with the communities they will affect.

Senator Elizabeth Warren in her Presidential campaign defined the specifics of green jobs as those:[146]

- Committed to investments in retraining, joint labor management apprenticeships, and strong career pipelines to ensure a continuous supply of skilled, available workers.
- Jobs with good wages and strong benefits for every worker.
- Jobs available to those who have traditionally been excluded -- especially women and communities of color.
- Jobs with expanded worker safety protections and strengthened anti-discrimination protections for workers from all backgrounds.

[145]https://joebiden.com/climate-labor-fact-sheet/.
[146]https://elizabethwarren.com/plans/green-jobs.

The Century Foundation identifies green jobs as:[147]

- Family-sustaining jobs that promote racial, economic, environmental, and intergenerational justice.
- Jobs that contribute to preserving or enhancing the well-being, culture, and governance of both current and future generations.
- Good, living-wage jobs.
- Decent, family-supporting jobs with fair and equitable wages and benefits, including the right to collectively bargain without retaliation, access to sick and family leave, vacation, full-time hours for those who want them, safe working conditions, health insurance, retirement, and advancement opportunities.
- Jobs that are inclusive of all workers across locations, genders, races, and ethnicities, and offer special support, training, and recruitment for workers from low-income, minority, under-employed communities, as well as communities most impacted by climate change.
- Jobs that ensure gender and racial equity.

Other advocacy organizations have also identified stringent green jobs criteria, for example:

- According to the Apollo Alliance, green jobs are well paid, career track jobs that contribute directly to preserving or enhancing environmental quality and include opportunities for advancement in both skills and wages.[148]
- The Sunrise Movement defines green jobs as guaranteed jobs to build a just, sustainable, and people-centered economy to anyone who wants one.[149]
- Good Jobs First defines two essential characteristics of a good green job: If the job is unionized or if it is covered by a Job Quality Standard (that is, a state rule attached to an economic development subsidy; as a quid pro quo for the subsidy, the company must pay a certain wage -- and sometimes benefit -- level).[150]
- Xprize specified green jobs as decent jobs paying a living wage and that offer the dual benefits of both good jobs and new ways to tackle climate change and nature crises.[151]
- The Green Economy Coalition states that green jobs must be good jobs, offering equal access to women and men, providing workers with social protection, and ensuring that workers are safe.[152]
- The Green Alliance defines green jobs as attractive jobs that provide job security and positive working conditions -- positive in the sense of decent pay, predictable hours, adequate breaks and holidays, and are guaranteed jobs of the future.[153]

[147]https://tcf.org/content/report/redefining-green-jobs-sustainable-economy/?agreed=1.
[148]https://cdn.americanprogress.org/wp-content/uploads/issues/2008/03/pdf/green_collar_jobs.pdf.
[149]https://www.sunrisemovement.org/campaign/good-jobs-for-all/.
[150]https://www.goodjobsfirst.org/green-jobs.
[151]https://www.xprize.org/prizes/rapidreskilling/articles/reskilling-workers-for-the-green-economy.
[152]https://www.greeneconomycoalition.org/news-and-resources/the-future-of-work-is-green.
[153]https://green-alliance.org.uk/resources/Public_First_research_good_green_jobs.pdf.

- The UNEP defines green jobs as those that result in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities and create decent employment opportunities, promote sustainable trade, and reduce poverty.[154]
- The ILO defines green jobs as those that are decent jobs providing decent employment and income opportunities, are socially inclusive, facilitate improved human well-being and social equity, and facilitate retraining of workers and upgrading of skills.[155]

Thus, it would seem that that to qualify as a green job, the job must, at a minimum:

- Result in improved human well-being and social equity.
- Be a well-paid career track job.
- Be a "decent job" providing decent employment and income opportunities.
- Be socially inclusive, facilitate improved human well-being and social equity, and facilitate retraining of workers and upgrading of skills.
- Be unionized or covered by a Job Quality Standard.
- Offer equal access to women and men, providing workers with social protection and ensuring that workers are safe.
- Provide job security and positive working conditions -- decent pay, predictable hours, adequate breaks and holidays, and is a guaranteed job of the future.
- Be family-sustaining and promote racial, economic, environmental, and intergenerational justice.
- Contribute to preserving or enhancing the well-being, culture, and governance of both current and future generations,
- Be a decent, family-supporting job with fair and equitable wages and benefits, including the right to collectively bargain without retaliation, access to sick and family leave, vacation, full-time hours, safe working conditions, health insurance, retirement, and advancement opportunities.
- Be inclusive of all workers across locations, genders, races, and ethnicities, and offer special support, training, and recruitment for workers from low-income, minority, under-employed communities.
- Ensure gender and racial equity.
- Be committed to investments in retraining, joint labor management apprenticeships, and strong career pipelines.
- Have good wages and strong benefits for every worker.
- Be available to those who have traditionally been excluded -- especially women and communities of color.
- Have expanded worker safety protections and strengthened anti-discrimination protections for workers from all backgrounds.
- Be stable and well-paying.
- Incorporate skills training
- Be worker-centered and driven in collaboration with the communities affected.

[154]Hussein Abaza, "Green Economy: A Tool For Transitioning to Sustainable Development," https://www.readkong.com/page/green-economy-in-action-articles-and-excerpts-that-4087406
[155]https://www.ilo.org/global/topics/green-jobs/WCMS_214247_EN/lang--en/index.htm.

In reality, some, but not all, of these criteria may apply to a very small subset of ideal or idealized green jobs, such as Ecologist, Environmental Lawyer, Solar Energy Engineer, Fuel Cell Researcher, Hydrologist, Environmental Compliance Manager, Sustainable Building Consultant, Geoscientist, Hydrogen System Designer, etc. Nevertheless, while perhaps commendable and aspirational, adhering to these criteria would greatly reduce estimates of the number of jobs in the U.S. identified as being green. Further, in some respects achievement of these criteria are impossible to achieve. For example, it is mathematically impossible for all green jobs – or any large category of jobs – to pay "above average wages," just as it is laughably impossible for all of the children in Lake Wobegon, to be "above average."[156]

In addition, many jobs universally classified as green would not meet these criteria. Consider an obvious example. As discussed at length in the MISI Colorado and Pennsylvania reports for,[157] BLS forecasts that wind turbine technicians will be the most rapidly growing occupation in percent terms over the next decade, increasing 61% by 2029 (although from a very low base of jobs).[158] Accordingly, a wind turbine technician is highly publicized and promoted by advocates as a dream green job of the future. However, does this job adhere to the criteria listed above? It may or may not be unionized, pay good wages, have good benefits, etc., but the working conditions may certainly not be commendable. For example, consider a wind turbine technician working on servicing and maintaining a wind turbine 300 feet high in North Dakota in February where the wind may be blowing strongly and the wind chill factor is -30^{o} Fahrenheit.[159] This is not anyone's definition of good, safe, or healthy working conditions. Thus, this job would not be classified as a green job according to the criteria listed above.

Similarly, BLS forecasts that solar photovoltaic installers will be the third most rapidly growing occupation over the next decade, increasing 51% by 2029 (but again from a very low base).[160] The job may or may not be unionized, pay good wages, have good benefits, etc., but the working conditions may certainly not be commendable. Consider a solar photovoltaic installer who is installing, maintaining, or cleaning photovoltaic panels for a solar power station in the Arizona desert (which has a very favorable insolation factor) in August with the temperature at 120^{o} Fahrenheit. This is also not anyone's definition of good, safe, or healthy working conditions. Thus, this job would also not be classified as a green job according to the criteria listed above.

Similar considerations are applicable to many jobs otherwise classified as being green, such as, for example:

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[156]https://www.oxfordreference.com/view/10.1093/oi/authority.20110810105237549.

[157]Management Information Services, Inc., "The Green Economy, Green Jobs, and Green Companies in Colorado," op. cit. and Management Information Services, Inc., "The Green Economy, Green Jobs, and Green Companies in Pennsylvania," op. cit.

[158]U.S. Bureau of Labor Statistics, "Fastest Growing Occupations: 20 Occupations With the Highest Percent Change of Employment Between 2019-29," https://www.bls.gov/ooh/fastest-growing.htm.

[159]Vestas is currently building wind turbines 850 feet in height; Building the World's Largest Wind Turbine |OilPrice.com.

[160]U.S. Bureau of Labor Statistics, "Fastest Growing Occupations: 20 Occupations With the Highest Percent Change of Employment Between 2019-29," https://www.bls.gov/ooh/fastest-growing.htm.

- Hazardous Materials Removal Worker
- Asbestos Disposal Worker
- Recycling Plant Employee
- Insulation Installer
- Environmental Field Laborer
- Waste Management, Treatment, and Disposal Facilities Worker
- Emergency Response Services Technician
- Oil And Gas Well Capping Worker
- Mold Remediation Worker
- Medical Waste Disposal Worker
- Frac Tank Cleaning Roustabout
- Class B Hazmat Driver
- Decontamination & Disinfecting Technician
- Septic Tank Cleaner
- Trash Collector
- Etc.

More generally, most current green jobs in the U.S. may not be relatively well paying, have generous benefits, or be unionized. There is considerable evidence that many green jobs may pay substantially less than the jobs they are displacing and that unionization rates for green jobs are relatively low. Further, many labor union officials are concerned with potential discrepancies in green jobs salaries and those in the fossil fuel industries and the implications of a "just transition."[161]

The USEER studies found that energy industry workers employed by solar and wind power companies earn significantly less than those who mine coal or drill for natural gas.[162] For example, the median wage for solar workers is $24.48 an hour compared with $30.33 for those employed by the natural gas sector, which amounts to a roughly $12,000 annual wage gap.[163] Such wage disparities threaten to undermine green energy advocates' contention that the U.S. can initiate a multitrillion-dollar assault on climate change while growing its economy and transitioning workers to well-paying green jobs.

Energy workers on the whole earn more than the typical U.S. worker, but the highest-paying positions are skewed heavily toward nuclear, utility, natural gas, and coal industry workers. Wind, solar, and "green" jobs were well below them on the median pay

[161]Organized labor abhors the term "just transition," but most green energy advocates and their allies continue to use it. Too often, though, the message gets subsumed in a broader culture war that paints Washington-conceived solutions as at best fools' gold, at worst a death sentence. According to Phil Smith, spokesman for the United Mine Workers, "They've got a long way to go to convince people that what could happen will actually be positive for them. Because right now, they don't believe that. There's never been such a thing as a just transition. Now, at least people are talking about the need for it, which is a step in the right direction. But there's been no example in this country of how to do that."[161] UMW president Cecil Roberts stated "We believe that the Second Coming of the Lord is gonna get here before a just transition makes it our way." "Bracing For Life After Coal," *Bloomberg Businessweek*, May 10, 2021.
[162]https://www.usenergyjobs.org/.
[163]Kelsey Tamborrino, "The Wage Gap That Threatens Biden's Climate Plan, *Politico*, April 6, 2021.

scale. According to former DOE Secretary Ernest Moniz, "The big message is that the energy industry has a significantly higher median wage than does the economy as a whole. There's clearly a distribution of wages -- as there is in any other sector -- because of the level at which specialized skills are needed."[164]

The median hourly wage for all U.S. energy workers is $25.60 -- 34 percent higher than the national median hourly wage of $19.14. And, while the energy sector has suffered during the COVID-19 pandemic, it has lost fewer jobs than other parts of the economy. Utility employees were the highest paid among energy industry segments, with a median wage of $41.08 per hour, which would amount to nearly $85,500 per year, while mining and fossil fuel extraction workers followed at $36.32 per hour, or more than $75,500 a year. The high concentration of utility jobs in the electric power generation and transmission, distribution, and storage sectors also means that workers in those positions earn higher than average wages.

Jobs in energy-specific construction, which would increase significantly under green initiatives, pay about $25.53 per hour, or just above $53,000 annually. Manufacturing jobs earned a median wage of $23.02, or nearly $48,000 per year. Many fossil fuel jobs pay very well. For example, Rotary Drill Operators, Oil and Gas, earn about 28.35 per hour, or $60,000 per year, and coal miners earn about $25.80 per hour, or $52,500 per year.[165]

It is difficult to compare wages across energy technology sectors because of factors such as accessibility, skill, experience, education and training requirements, and geographic distribution.[166] Jobs that pay significantly higher than the national median wage are also likely to require more experience, education, training, and certifications.

Workers in the nuclear industry receive a median hourly wage of $39.19, equivalent to $81,515 a year -- more than double the national median, although the industry accounts for less than one percent of total energy jobs. Nuclear industry workers tend to need advanced training and other requirements, increasing their earning power. However, they face a wave of nuclear plant retirements, with five nuclear reactors scheduled to close during 2021.[167] Shutdowns of nuclear plants could also threaten the U.S. effort to address climate change: According to Moniz, "Without the nuclear fleet carrying on, our carbon goals just become all that much more difficult because nuclear remains the single highest zero-carbon electricity source."[168]

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[164]Ibid.
[165]U.S. Bureau of Labor Statistics, https://www.bls.gov/oes/.
[166]https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf.
[167]Rebecca Rainey and Eric Wolff, “Biden's Green Energy Plans Clash With Pledge to Create Union Jobs,” *Politico*, April 2, 2021.
[168]Kelsey Tamborrino, op. cit.; U.S. Energy Employment Report: Colorado Energy and Employment – 2019, op. cit.

Energy efficiency workers, including those engaged in building efficiency improvements such as weatherization, comprised 28.4 percent of total energy employment in 2019. However, workers in that sector have a median wage of $24.44 an hour -- significantly lower than nuclear industry workers and nearly $6 lower per hour than natural gas workers, who make $30.33/hr. Fast-growing sectors in the renewable energy sector, solar and wind, also have median wages below that of fossil fuel workers: $24.48 for solar and $25.95 for wind.[169] The green jobs salaries issue is discussed in more detail in Chapter VI.

The bottom line here is that, ironically, in terms of some of the key criteria listed above, including wages, benefits, working conditions, and unionization, many "non-green jobs" score higher than green jobs. In any case, it is clear that a very strict list of necessary criteria will greatly reduce the estimate of the number of green jobs in the economy.

Finally, and perhaps most significant and as discussed in Chapter V, MISI estimates the total number of jobs generated (direct, indirect, and induced) by the green economy:[170]

- 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 or all of the jobs created.
- For simplicity, MISI includes induced jobs in the indirect category.

Thus, for example, as discussed in Section II.B, most of the employees of a wind turbine factory include standard occupations such as Assemblers, Mechanical Engineers, Maintenance and Repair Workers, Machinists, Purchasing Agents, Customer Service Representatives, Janitors, Industrial Machinery Mechanics, Shipping and Receiving Clerks, Welders, Accountants, Electricians, etc. MISI classifies all of these as "green" employees because they work in for a firm producing RE equipment.

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[169]Ibid.

[170]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.greenenergytimes.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=66046.

Production of wind turbines also creates a large number of indirect jobs: Jobs that are generated in the supply train and supporting industries. These include jobs that produce the inputs required by the turbine factory, the inputs required by these inputs, and so forth -- the classic input-output/interindustry concept. Most of these indirect jobs probably do not meet the criteria listed above. Nevertheless, MISI classifies them as "green" – jobs that are created by the green economy.

Further, production of wind turbines also creates a large number of induced jobs: Jobs generated by the re-spending of income received from direct and indirect job creation. For example, these include jobs located near the turbine factory such as fast food, restaurant, and bar jobs, retail sales employees, a plethora of various service and support jobs, etc. To paraphrase Gene Sperling, "If a ZEV plant or a wind turbine factory opens up, a Wal-Mart can be expected to follow. But the converse does not hold: A Wal-Mart opening definitely does not bring a ZEV plant or wind turbine factory with it."[171] Most of these induced jobs almost certainly do not meet the criteria listed above. Nevertheless, MISI also classifies them as "green" – jobs created by the green economy.

Thus, the reality is that the overwhelming majority of jobs created in and by the green economy may not adhere to the stringent criteria listed above. It is desirable that the wages, benefits, working conditions, and unionization rates of these jobs be improved. Nevertheless, they are green and must be counted as such. To do otherwise would be unrealistic and, most ominously, would very seriously underestimate the size, importance, and rates of growth of the U.S. green economy and the jobs created by the green economy. Since the jobs issue is critical, this will hinder efforts to address pressing environmental, climate, and energy issues and to expand the green economy.

[171]https://obamawhitehouse.archives.gov/sites/default/files/administration-official/sperling_-_renaissance_of_american_manufacturing_-_03_27_12.pdf.

III. THE ISSUE OF NET JOBS

The issue of net jobs is critical, but is rarely addressed in green jobs studies. There are at least two different concepts of net green jobs:

- First, there is the issue of when investing a specified amount of funds in a green jobs initiative or program, how many jobs in total would be created compared to investing the same amount of funds in other programs or initiatives.
- Second, there is the question of whether environmental regulations or the creation of green jobs via green initiatives destroys "non-green" jobs, and if so, how many compared to the green jobs created.

These issues are discussed at length here, since they are of obvious importance to the current policy debates.

III.A. Comparative Jobs Per Dollar Invested

A number of studies have assessed the issue of when investing a specified amount of funds in a green jobs initiative or program, how many jobs in total would be created compared to investing the same amount of funds in other programs or initiatives – that is, comparative jobs per dollar invested. Several of the more significant of these are summarized below.

The American Council For an Energy Efficient Economy

The American Council For an Energy Efficient Economy (ACEEE) contends that energy efficiency creates net gains in employment which extend well beyond the jobs that shift among industries. It does so in two ways. First, an initial effort or investment will create opportunities for workers (e.g., an investment in infrastructure improvements). This stimulates opportunities for the construction sector and industries that support it. Second, energy bill savings that stem from the initial effort or investment will free up the funds to support additional employment throughout the economy. In other words, energy efficiency investments not only inject funds into the economy to stimulate job creation, but they also have the potential to alleviate systemic unemployment by reducing energy bills and making those dollars available to support broader economic activity.[172]

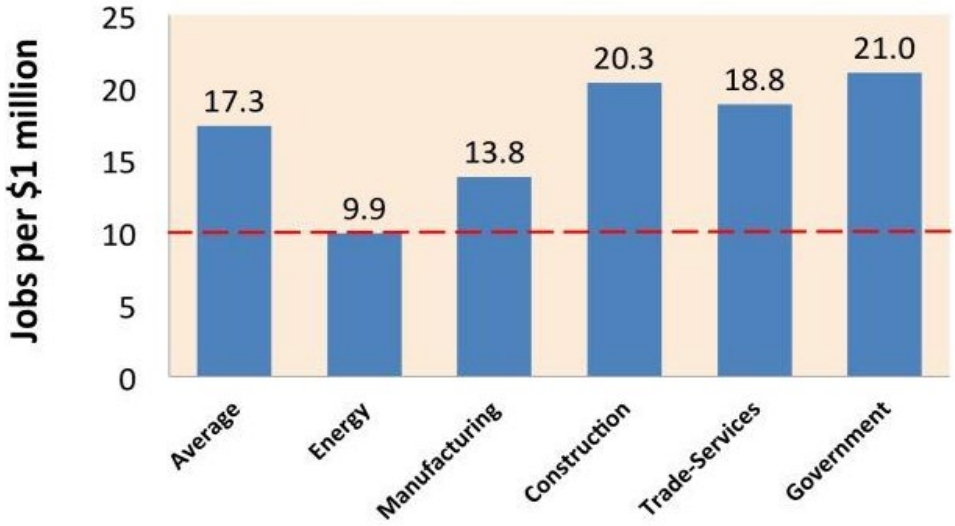
ACEEE contends that analysts often opt to report job creation in terms of gross jobs without assessing impacts relative to a business-as-usual case -- in other words, the number of jobs that would have been supported on average across all sectors of the economy by that same investment amount. This approach ultimately inflates the estimates by neglecting to provide context (i.e., a power plant may support 100 jobs, but the economy might be able to support 170 jobs if funds were not required to keep the

[172]American Council for an Energy Efficient Economy, "How Does Energy Efficiency Create Jobs?" https://www.aceee.org/sites/default/files/pdf/fact-sheet/ee-job-creation.pdf.

plant running). Thus, according to ACEEE, in this scenario, saying that the power plant creates 100 jobs is misleading.

To understand how a cost-effective energy efficiency investment can create net jobs, ACEEE states argues that it is important to consider how efficiency diverts funds away from less labor-intensive sectors of the economy in order to support greater overall employment. On average, $1 million spent in the U.S. economy supports approximately 17 total jobs, including direct, indirect, and induced jobs – Figure III-1. It is important to note that the $1 million expenditure does not divide neatly into workers' salaries (17 people are not making $59,000 a year as a result of this investment). Investments directed towards a specific industry may support greater or fewer jobs depending on the industry. As illustrated in Figure III-1, manufacturing supports approximately 14 jobs per $1 million investment, while the trade-services sector supports just under 19 jobs.[173]

Figure III-1
Jobs Per Million Dollars of Revenue by Key Sectors of the U.S. Economy



Source: American Council For an Energy Efficient Economy.

Thus, an investment in energy efficiency will first create opportunities for workers in industries that are more labor intensive than average. For example, a retrofit project will create jobs in the construction sector, which supports approximately 20 jobs per $1 million, compared to the all-sector average of 17. Then, it will continue to support jobs year after year by saving energy. The energy savings generated by the investment diverts spending away from power generation and distribution, which supports just under 10 total jobs per $1 million (Figure III-1) back into the overall economy (which supports 17 jobs per $1 million).

[173] Ibid.

ACEEE cites the following example. A city decides to use $15 million of its revenue to improve energy efficiency in public buildings. These improvements will save the city $3 million a year for the next 20 years. Three types of jobs are created from this investment. First, a construction contractor will have to hire workers to install the desired energy efficiency measures. These contractor jobs are the direct jobs resulting from the investment. In addition, the workers will require materials that they have to purchase from other companies (e.g., insulation, tools). These purchases create jobs throughout the economy for manufacturers and service providers who supply the building industry. These supply-chain jobs are the indirect jobs resulting from the investment. Finally, workers in these direct and indirectly created jobs may choose to spend their earnings on goods and services in the local economy, creating induced jobs.

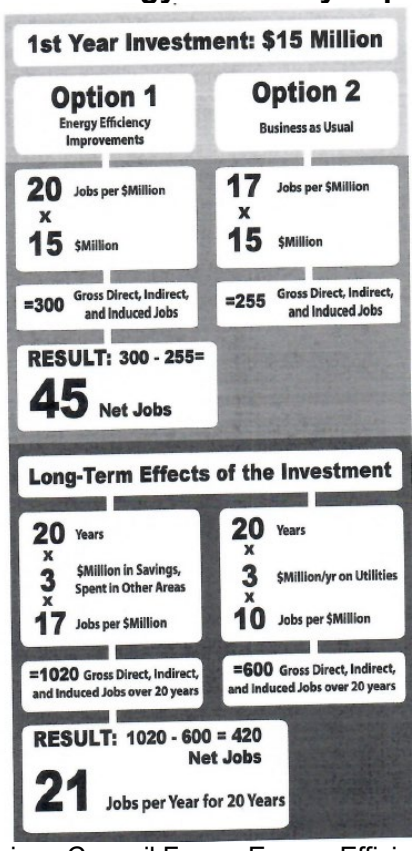
In this example, ACEEE assumes that funds will be redirected from their business-as-usual spending pattern and channeled into the construction industry, which is more labor intensive than the average sector of the economy. This will support approximately 20 (direct, indirect, and induced) jobs per $1 million investment. In this case, the trade-off (from spending that supports 17 jobs per $1 million to spending that supports 20 jobs per $1 million) results in an additional 45 jobs in the year the upgrade occurs.

In addition, energy efficiency generates energy bill savings over the life of the investment, which frees up funds to support more jobs in the economy by shifting jobs in the energy generation and distribution industries (lower labor intensity: 10 jobs per $1 million) to jobs in all other industries (higher labor intensity: 17 jobs per $1 million on average). ACEEE assumes that the investment will save $3 million a year for 20 years and thus achieve a net gain of 22 jobs per year.[174]

As shown in Figure III-2, the business-as-usual (pre-efficiency) scenario supports 860 gross jobs (260 + 600) in the first year, and 600 gross jobs year after year for the next 19 years. However, the efficiency scenario supports 1,343 gross jobs (305 + 1038) in the first year (and 1,038 gross jobs year after year for the next 19 years), which is greater than the number of jobs supported by business-as-usual. Therefore, energy efficiency creates 67 net jobs in the first year, and continues to support an additional 22 net jobs year after year for the 20-year life of the investment.[175]

[174]To simplify the calculations in this demonstrative example ACEEE assumed that energy savings would be recognized immediately in the first year of the investment, which is often not the case. For many of their analyses, ACEEE assumed that energy savings are recognized at least six months to one year after the efficiency measures are implemented.
[175]American Council for an Energy Efficient Economy, op. cit.

Figure III-2
$15 Million For Energy Efficiency Improvements



Source: American Council For an Energy Efficient Economy.

The Institute for Governance & Sustainable Development

The Institute for Governance & Sustainable Development (IGSD) noted that stimulating investments in the upgrade of the workforce and U.S. infrastructure that increase resource productivity will build new opportunities for millions of new jobs and careers over the next two decades. It estimated the job creation that can be stimulated by new investments in end-use energy efficiency, decarbonization, and clean renewable energy systems compared to new investments in traditional fossil fuel technologies.[176]

IGSD identified a number of critical steps which promote greater employment prospects, as each of those many steps support a series of direct jobs from on-site activities and indirect jobs from the off-site supply of goods and services which support those direct jobs. And as the wages and earnings are spent within American communities, they sustain further induced jobs which support a range of community activities such as education, entertainment, food, health, and a quality of life. Investments

[176]Institute for Governance & Sustainable Development, "Investing in US Energy Efficiency and Infrastructure Creates More Nationally-Distributed Jobs while Saving Money and Protecting the Climate," http://www.igsd.org/wp-content/uploads/2021/03/Investing-in-US-Energy-Efficiency-and-Infrastructure-Creates-More-Nationally-Distributed-Jobs-while-Saving-Money-and-Protecting-the-Climate.pdf

in energy efficiency and clean renewable energy technologies have far lower social, economic and environmental costs, while increasing the disposable incomes of families.

This is in part due to the fact that the delivered cost of electricity from new wind, solar, and other clean renewable energy systems is less expensive than from fossil fuel technologies. Energy efficiency and solar, in particular, can be ubiquitously built or sited at individual homes and businesses or neighborhoods. In short, these investments contribute to improving community prosperity while avoiding the human health and productivity costs, and agricultural and ecosystem damages associated with the consumption of fossil fuels.

IGSD characterized the job and the scale of economic benefits of a 40 percent savings in the cost of the nation's retail electricity bills. It then utilized the subsequent insights from that detailed assessment and asked the question: What if we imagine a much larger opportunity if we were to transform the nation's entire energy structure. The analysis found that mobilizing a cumulative investment of $1.2 trillion over the years 2021 through 2040 can reduce electricity end-use costs by 40 percent in the year 2040.[177] This stimulates an average net employment benefit of 2.8 million new jobs per year even as the nation's GDP might increase more than $580 billion (in constant 2012 dollars) by the year 2040. The resulting reduction of greenhouse gas emissions and air pollution would result in an average annual benefit of a further $112 billion in avoided air pollution and health costs (expressed in 2020 dollars). The cumulative benefit of this economic reboot would be on the order of $2.1 trillion through 2040 (also in constant 2020 dollars).

If business leaders and policy makers agree to reduce costs by 40 percent across the stream of the nation's entire energy expenditures -- including all agricultural, industrial, building and transportation energy uses -- IGSD estimated that the economic reboot would generate an average of 8.7 million net new jobs per year through the year 2040. Further, a complete 100 percent transformation of the overall energy system within the U.S. away from conventional fossil fuels and nuclear energy power plants to clean renewable energy would result in an average of 20 million new net jobs per year by 2040.[178]

IGSD noted that the job growth in induced jobs from investments in clean renewable energy and energy efficiency is far larger than the more conspicuous direct and indirect jobs. More critically, these induced jobs, as well as the many other benefits of the productive investments, are more equitably distributed geographically among the population and with higher employment over a wider range of skill levels and wages. Thus, the high rates of return on clean renewable energy and energy efficiency can

[177]A reduction in electricity costs can be achieved through energy efficiency, or by switching to a more productive means of electricity generation and distribution; for example, switching from fossil-fuel based to clean renewable forms of electricity generation and reducing losses that occur in the generation and transmission process. Thus a 40% reduction in electricity costs does not necessarily mean that consumers or businesses consume 40% less electricity at their homes or businesses. Rather, that 40% reduction in electricity costs could be achieved through a combination of factors, including more efficient and less wasteful production, generation, transmission, distribution and consumption of energy.

[178]Institute for Governance & Sustainable Development, op. cit.

accrue to the citizen taxpayers making the investment possible, and the avoided environmental and social costs of fossil fuel exploitation can similarly benefit all citizens, but particularly in lower income communities that would otherwise be located near fossil fuel extraction, combustion, and waste management activities.[179]

IGSD concluded that the larger lesson is that the economy is not any one isolated element, or even an array of investments and expenditures; rather the economy is a system of many highly interdependent connections. This permits understanding the many possible interactions by exploring seven different interactive drivers that can positively or negatively shape the nation's long-term social and economic well-being, as well as the nation's future job markets -- Table III-3. Each of these drivers has unique direct, indirect, and induced jobs per stream of expenditures. How they both scale and converge to a more energy and resource productive economy can have a significant impact on the total number of good paying jobs available to communities.[180]

Table III-3
The Seven Major Drivers of Employment and Economic Benefits

Driver	Primary Impact
Intensity Shift	Moving away from capital-intensive to labor-intensive activities
Supply Chain Build Up	Building up greater local production and local services
Energy Cost Reduction	Both unit cost and total cost savings for efficiency and non-efficiency
Productivity Boost	Expanding non-energy benefits
Managing Volatility	Smoothing out price shocks
Minimizing Disruption	Avoiding the inconvenient interruption of supply
Innovating Plus	Cost and services breakthroughs in the delivery of energy and other services

Source: Institute for Governance & Sustainable Development.

The International Monetary Fund

The International Monetary Fund (IMF) estimated output multipliers for spending in clean energy and biodiversity conservation, as well as for spending on non-ecofriendly energy and land use activities. Using a new international dataset, IMF found that every dollar spent on key carbon-neutral or carbon-sink activities can generate more than a dollar's worth of economic activity – Table III-4. Although not all green and non-ecofriendly expenditures in the dataset are strictly comparable due to data limitations, estimated multipliers associated with spending on renewable and fossil fuel energy investment are comparable, and the former (1.1-1.5) are larger than the latter (0.5-0.6) with over 90 percent probability. These findings survive several robustness checks and lend support to bottom-up analyses arguing that stabilizing climate and reversing biodiversity loss are not at odds with continuing economic advances.[181]

[179]Ibid.
[180]Ibid.
[181]International Monetary Fund, "Building Back Better: How Big Are Green Spending Multipliers?" https://www.elibrary.imf.org/view/journals/001/2021/087/article-A001-en.xml#:~:text=The%20estimated%20multipliers%20associated%20with.on%20sectors%2C%20technologies%20and%20horizons.

Table III-4
Cumulated Multipliers associated to Green (Renewable) and Non-Eco-Friendly (Non-Renewable) Energy Investment Spending

Horizon	Green (Renewable) Energy Investments Multiplier	Non-Eco-Friendly Energy Investments Multiplier
Impact	1.19*	0.65*
1 Year	1.20*	0.64*
2 Years	1.19*	0.62*
3 Years	1.17*	0.59*
4 Years	1.14*	0.55
5 Years	1.11	0.52

*Denotes multipliers with credible intervals, delimited by the 16th and the 84th percentiles that exclude zero.
Source: International Monetary Fund

IMF stated that these results are intuitive on three grounds. First, clean energy is more labor intensive than carbon-based fuels spending. In relation to spending within the fossil fuel industries, spending on clean energy -- including the direct spending on specific projects plus the indirect spending of purchasing supplies -- uses far more of its overall investment budget on hiring people, and relatively less on acquiring land (either on- or offshore), machines, and supplies and energy itself.[182] In addition to the jobs directly created in the renewable energy industry, growth in clean energy can create positive economic "ripple" effects. For example, both industries in the renewable energy supply chain and unrelated local businesses will benefit from increased household and business incomes.[183]

Second, clean energy implies a higher domestic content. Considering direct plus indirect spending -- clean energy spending relies much more on economic activities taking place within the domestic economy, such as retrofitting homes or upgrading the electrical grid system locally, and less on imports than spending within conventional fossil fuel sectors.[184]

Third, clean-energy investments produce far more jobs at all pay levels -- higher as well as lower-paying jobs -- than the fossil fuel industry.[185] For the U.S., workers in clean energy earn mean hourly wages that are between 10 and 20 percent above the national average; and their wages are more equitable, with workers at lower ends of the income spectrum earning up to U.S. $10 more per hour than other jobs.[186] At the same

[182]Seehttps://www.energy.gov/sites/default/files/2017/08/f35/2016%20Wind%20Technologies%20Market%20Report%20Presentation_1.pdf; https://www.iea.org/reports/renewable-energy-market-update-2021; https://www.irena.org/media/Files/IRENA/Agency/Publication/2016/IRENA_Measuring-the-Economics_2016.pdf; https://www.wri.org/blog/2020/07/economic-benefits-climate-action-us.
[183]https://www.epa.gov/statelocalenergy/quantifying-multiple-benefits-energy-efficiency-and-renewable-energy-guide-state.
[184]Ibid and https://www.irena.org/media/Files/IRENA/Agency/Publication/2016/IRENA_Measuring-the-Economics_2016.pdf.
[185]https://e2.org/reports/clean-jobs-better-jobs/.
[186]https://www.brookings.edu/research/advancing-inclusion-through-clean-energy-jobs/.

time, clean-energy investments also produce more jobs for a given dollar of expenditure due to the larger number of entry-level jobs relative to the fossil fuel industry. Jobs spread across three major industrial sectors (clean energy production, energy efficiency, and environmental management) and include all levels of skills including many electricians, carpenters, and plumbers. These considerations help rationalize the much stronger multiplier effect of clean spending than that of non-eco-friendly spending on the larger economy.[187]

The National Resources Defense Council

The National Resources Defense Council (NRDC) found that clean-energy investments create more job opportunities than spending on fossil fuels, across all levels of skill and education, and that the largest benefits will accrue to workers with relatively low educational credentials.[188] It also concluded that a high proportion of the jobs generated by clean-energy investments should offer good opportunities for advancement through training programs, and more generally, that newly employed low-income workers will see new opportunities to lift themselves and their families out of poverty.

NRDC analyzed a $150 billion annual level of clean-energy investments in the U.S. economy. It found that out of the 1.7 million net increase in job creation, about 870,000 of the newly available jobs would be accessible to workers with high school degrees or less.189 Approximately 614,000 of the newly expanded number of jobs available for workers with high school degrees or less will offer decent opportunities for promotions and rising wages over time. The job creation within this category is seven times larger than the number of jobs that would be created in this category by spending the same amount of money within the fossil fuel industry. However, to maximize opportunities for decent job opportunities, clean-energy investment policies need to operate in tandem with high-quality and widely-accessible training pro-grams; minimum wage laws that set a 'living wage' standard throughout the country; and a more favorable environment for union organizing among low-wage workers.

NRDC estimated that the net increase of 1.7 million jobs will generate about a one percentage point reduction in the unemployment rate. This in turn should raise earnings for low-income workers by about 2%. Thus, NRDC found that this investment would create more jobs across all educational levels: 3.2 times more jobs overall than fossil-fuel in-vestments; 3.6 times more jobs requiring high school degrees or less; 2.6 times more jobs requiring college degrees or more; 3.0 times more jobs requiring some college.

[187]International Monetary Fund, "Building Back Better: How Big Are Green Spending Multipliers?" op. cit.
[188]National Resources Defense Council, "Green Prosperity: How Clean-Energy Policies Can Fight Poverty and Raise Living Standards in the United States," https://www.nrdc.org/resources/green-prosperity-how-clean-energy-policies-can-fight-poverty-and-raise-living-standards.
[189]Ibid.

NRDC found that energy efficiency retrofits lower home heating and utility bills and that retrofits could reduce living costs by an average of 3-4 percent for low-income households.[190] However, achieving these benefits will require well-designed policies to expand the market for retrofits, and the markets to provide retrofitting services must be targeted to benefit low-income renters as well as homeowners.

NRDC also found that improving public transit reduces transportation expenses. Specifically, improving public transportation in urban centers to about 25–50 percent of total transportation could lower costs and raise living standards for low-income households by an average of 1–4 percent. The largest benefits would accrue to households that can replace a car with public transit. These households would see their annual transportation expenditures fall by roughly $2,000. This would represent a reduction in total expenditures for these families of about 10 percent.[191]

These findings are particularly significant in the context of the current energy debate because they turn upside-down a common objection from opponents of clean-energy policies: That environmental policies will be harmful for the poor. NRDC found that, to the contrary, with effective policies in place, investing in clean energy can provide significant new opportunities at all levels of the U.S. economy, and especially for families who are poor or near-poor.

Heidi Peltier

Heidi Peltier noted that nature's restorative power is particularly important at a time of rapidly growing unemployment and financial hardship. Further, the U.S. has important decisions to make regarding how to use national funds -- it is important that budgetary decisions be made that not only improve quality of life, but also that create jobs.[192] She noted that in the month of April 2020 alone, more than 20 million people lost their jobs in the U.S., resulting in an unemployment rate of 14.7 percent, the highest seen since the Great Depression.[193]

She also noted that conservation of land and water is generally an area with broad support, as nature appeals not only to lovers of natural beauty but also recreational enthusiasts, including hikers, park-goers, hunters, and anglers. In addition, conservation creates jobs. For each $1 million spent in conservation activities, between 17 and 31 jobs are supported depending on the industry where the investment is made, as shown in Table III-5. Alternative uses of the funds would, in many cases, created fewer jobs, as shown in Table III-6. For example, she estimated Oil and Gas supports 8 jobs per $1 million spending, while Aviation supports 8.4 jobs per $1 million spending.[194]

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[190]Ibid.
[191]Ibid.
[192]https://www.bu.edu/pardee/files/2020/06/Employment_Impacts_of_Conservation_Spending-Peltier2020.pdf.
[193]https://www.bls.gov/news.release/pdf/empsit.pdf.
[194]https://www.bu.edu/pardee/files/2020/06/Employment_Impacts_of_Conservation_Spending-Peltier2020.pdf.

Table III-5
Conservation and related jobs per $1 million spending

	Direct	Indirect	Induced	Total
Support Activities for Forestry[5]	21.7	1.0	8.0	**30.8**
Forestry[6]	11.1	4.4	7.7	**23.1**
Conservation lands (including parks and conservation areas)[7]	10.9	3.7	6.0	**20.6**
Environmental and Technical Consulting[8]	9.0	2.8	8.0	**19.8**
Hunting-Trapping[9]	13.9	1.6	3.8	**19.3**
Fishing[10]	11.5	1.4	3.9	**16.8**

Source: Heidi Peltier.

Table III-6
Job creation potential of other areas, per $1 million spending

	Direct	Indirect	Induced	Total
Road and Bridge Repair[11]	9.7	3.9	7.5	**21.1**
Finance[12]	4.2	4.5	5.7	**14.4**
Solar power - design, manufacture, and install[13]	4.5	3.2	5.2	**12.9**
Oil and Gas[14]	1.7	3.1	3.6	**8.4**
Aviation[15]	2.4	2.0	3.6	**8.0**

Source: Heidi Peltier.

The Land and Water Conservation Fund (LWCF) is the primary federal grant program to conserve land and invest in state, local, and national parks, trails, and natural areas. LWCF funds purchase of land, and directly invests in development of parks, trails, boat launches and campgrounds at the state and local level.[195] Peltier contends that LWCF has the potential to support thousands of jobs in communities throughout the country, and that for each $100 million of LWCF funding, between 1,680 and 3,080 jobs could be supported.[196]

To estimate the number of jobs created by economic activities such as conservation and park she used an input-output (I-O) model, which captures production, sales, and supply chains throughout the economy. In assessing the impacts of additional LWCF funding, the I-O model can be used to estimate the increased number of jobs needed to meet the increased spending in impacted industries. The LWCF leads to job creation through both purchases of land that can then be used for conservation or recreational activities and development of state and local park infrastructure. For example, as spending increases to develop parks – for resurfacing fields, building trailheads, creating parking areas – jobs are created in construction as well as in the manufacturing industries that supply construction materials and the service industries used by parks and construction industries, such as food services, trucking, and accounting. More generally, she noted that "direct jobs" are created as funds are used to

[195]https://www.lwcfcoalition.com/lwcf-programs.
[196]https://www.bu.edu/pardee/files/2020/06/Employment_Impacts_of_Conservation_Spending-Peltier2020.pdf.

hire employees in the parks, conservation areas, or construction firms, and "indirect jobs" are created through the supply chain. "Induced jobs" are those that are created as the workers in direct and indirect jobs spend their earnings on housing, food, healthcare, education, and other industries.[197]

She thus concluded that preserving land for conservation, reforestation, continued and enhanced biodiversity, as well as for various outdoor recreational activities, not only ensures continued access to nature for various species, including human nature enthusiasts, but also supports a variety of jobs. Accordingly, funding conservation of land and water is one of the many solutions the U.S. requires to recover the economy and enhance quality of life in the coming years.[198]

The Rockefeller Foundation

The Rockefeller Foundation (RF) noted that access to power has become central and indispensable to modern life, yet progress towards achieving universal electrification was reversed in 2020 for the first time in decades, undermining a key pillar of development progress. Over the past decade, renewable power generation technologies have rapidly displaced fossil fuels as the most cost-effective building block for economic development. Distributed renewable energy technologies (DREs), in particular, have become a faster, nimbler, and more cost-effective solution for driving inclusive growth and reaching underserved populations. Nevertheless, RF estimated that approximately 3.6 billion people still live in energy poverty today in 63 countries across Asia and Africa. The time is ripe for a global alliance of partners to come together with a plan to greatly expand the climate-friendly use of DREs.[199]

This RF report explored a "what if" scenario – what if the world took action to harness the full potential of DREs to end energy poverty, setting in motion a green power transition across the energy poor world? It combined qualitative case studies with predictive economic modelling to explore the job creation potential that would flow from a steep and rapid increase in investment in DREs across 63 energy-poor countries in Asia and Africa. RF estimated that this would require $130 billion per annum of capital investment over the coming decade. It would result in 25 million new jobs created globally in the power sector itself, which is more than 30 times the number of jobs that would be created by a comparable investment in fossil fuels. Given the potential to rapidly deploy DREs close to the end-user, RF estimated that 491 million additional new jobs can be created in an array of downstream applications across agriculture, enterprises of various sizes, health, education etc. Further, hundreds of millions of existing jobs would be improved by the availability of clean, reliable power.[200]

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[197]Ibid.
[198]Ibid.
[199]https://www.rockefellerfoundation.org/report/transforming-a-billion-lives-the-job-creation-potential-from-a-green-power-transition-in-the-energy-poor-world/.
[200]Ibid.

The report estimated that more than 4 billion tons of CO_2 would be saved in the clean energy scenario compared to a fossil fuel dependent development pathway. Thus, "Ending energy poverty with a focus on DREs emerges as a uniquely job-creating agenda with transformative potential for more than a billion people."[201]

RF determined that 19 million permanent jobs and almost 6 million temporary jobs are created in designing, building, operating, and maintaining new DRE power generating facilities. Almost half of these jobs are located in South Asia, the majority in India; a quarter are located in the Sub-Saharan Africa region, and a quarter in the East Asia & Pacific region. Modest grid-tied systems that could service a medium-sized business or a cluster of small enterprises engaged in activities such as milling, carpentry, or tailoring, represent 46% of these direct jobs. Installing off-grid solar systems for individual households and micro enterprises accounts for another 20% of total direct jobs created. By comparison, investing in large, centralized fossil fuel assets would create less than half a million jobs, the great majority of which are temporary, focused on the construction of power plants.[202]

RF found that direct jobs are dwarfed by the unique potential for DREs to grow employment throughout the economy by the utilization of the new electricity generated for so-called "productive uses." The proximity to the end user, speed of deployment and reliability of DREs compared to traditional fossil assets means that these technologies are potentially transformative for local economies. Based on a detailed assessment of 75 productive uses across 8 key economic sectors, RF estimated that:[203]

- Almost 500 million new jobs could be created in these downstream applications.
- Close to 700 million jobs could be improved.

Nearly half of total downstream jobs created or improved are located in South Asia; the Sub-Saharan Africa Region accounts for one third of the total; and East-Asia Pacific the remaining 18%. Slightly more than half of downstream jobs are created in enterprises of varying sizes, while 35% are in the agricultural sector. RF case studies illustrated that DREs can be used to power ice making factories or solar lanterns used by fishermen in Uganda, irrigation pumps in Ethiopia, or milk chillers in Nigeria. However, it is important to note that the availability of reliable power alone will not spur increased demand for energy services. Significant additional investments will be needed in downstream machinery to ensure that new clean, reliable power from DREs boosts economic growth and improves lives.

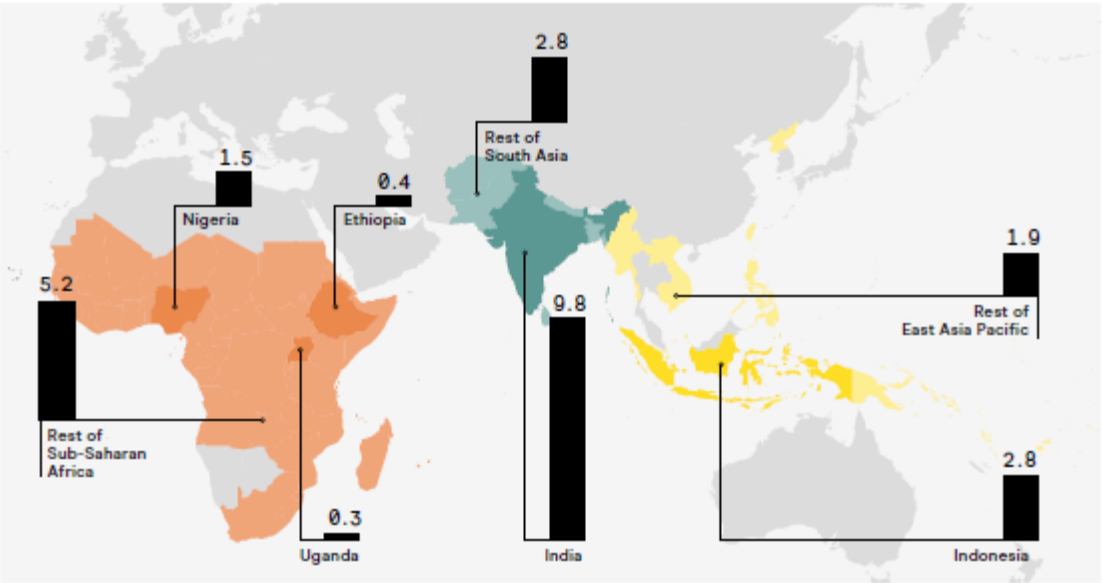
In total, nearly 25 million direct jobs are created, of which 19 million are permanent. These jobs are created in deploying DRE projects, which typically encompasses roles such as design and engineering work, providing financial and legal services, business development, sales and marketing, procurement, constructions and balance of systems. Furthermore, operating and maintaining these systems requires plant managers, guards, maintenance personnel, accountants, administrators and customer service providers.

[201] Ibid.
[202] Ibid.
[203] Ibid.

RF developed a simplified fossil-fuel scenario as a benchmark to compare the outputs from the DRE jobs model. The comparable fossil fuel portfolio contains 101 GW of coal generation, 141 GW of natural gas generation, and 39 GW of oil generation. Based on job multipliers for fossil resources from published reports,[204] RF estimated that this comparable investment in fossil fuels would create 378,000 construction and installation jobs in 2030. Just over 42,100 additional jobs in ongoing plant operations and maintenance would also be supported. Taking account for the lower capital expenditure in the fossil fuel scenario, this means that the DRE pathway creates 41 times more direct jobs.[205]

RF estimated the jobs impacts for the DRE scenario across three regions: Sub-Saharan Africa, South Asia, East Asia. In addition, the RF model included specific country-level carve-outs for Ethiopia; Nigeria; Uganda; India; and Indonesia. By geography, the South Asia region, including India, accounts for 54% of all direct jobs created; the Sub-Saharan African region accounts for 27% of the total; while East Asia Pacific accounts for the remaining 19% -- Figure III-3.

Figure III-3
Direct Jobs Created by Region and Selected Countries
(Million Jobs)



Source: Rockefeller Foundation.

[204]Other literature reviews highlight similar ranges for renewable energy vs. fossil fuels: "on average, $1 million of demand for RE generates 7.49 FTE jobs (4.50 direct plus 2.99 indirect). That same level of demand generates 7.72 FTE jobs in EE (4.59 direct, 3.13 indirect). These averages are nearly three times the level of job creation in FF, which averages a total of 2.65 FTE jobs per $1 million demand (0.94 direct, 1.71 indirect)." It is important to note, however, that these estimates do not include distribution and transmission jobs which will likely be higher with a centralized fossil fuel systems.

[205]https://www.rockefellerfoundation.org/report/transforming-a-billion-lives-the-job-creation-potential-from-a -green-power-transition-in-the-energy-poor-world/.

When RF refers to the productive use of power, it means electricity that is aimed at enhancing income generation opportunities and productivity in key sectors of the economy that would not have been possible without electricity. Typically, the focus is on power use in SMEs, agriculture, essential services, mobility and industry.

Power generated from DREs can be uniquely transformative for downstream sectors of the economy. This is because DRE projects are generally deployed in closer proximity to the end user, offering unique opportunities for innovative linkages with the local economy. Furthermore, DREs have considerably shorter project development cycles compared to centralized assets. For example, a typical 50 kilowatt solar mini grid serving a single village up to three kilometers in radius can now be installed in under two months. With more plug-and play components, sophisticated procurement systems, and experienced contractors, project timelines are declining every year. Finally, DREs often provide a more reliable service than traditional centralized grids.

Distributed renewables therefore quickly simulate local economic activity, which is a particularly important characteristic during an economic downturn. For these reasons, DRE power that is used productively has the potential to create an enormous number of downstream jobs. To model this downstream job-creation potential, RF first estimated how much of new electricity generation is consumed for so-called productive uses, compared to other non-productive uses (such as air conditioning or residential appliances), based on an evaluation of current electricity consumption trends in key regions and countries. It then allocated electricity consumption for productive uses across eight key economic sectors (Table III-7), and then to 72 sub-activities within each of these sectors, based on factors including GDP contribution, employment, current electricity consumption, trends and projections. Finally, within each of the 72 individual sub-activities a jobs multiplier was estimated based on a literature review covering reports, journal articles, case studies, company disclosures and engineering manuals.[206] These jobs multipliers estimate the number of jobs created per additional MWh of electricity consumed for each of the eight key economic sectors.[207]

[206]Ibid.

[207]For example, the Food and Agricultural Processing sector has the highest multiplier at around 8.25 jobs created or improved per MWh of electricity consumed, whereas the Heavy Industry sector had the lowest multiplier at around 0.01 jobs per MWh.

Table III-7
Power Allocated and Jobs Multiplier by Sector

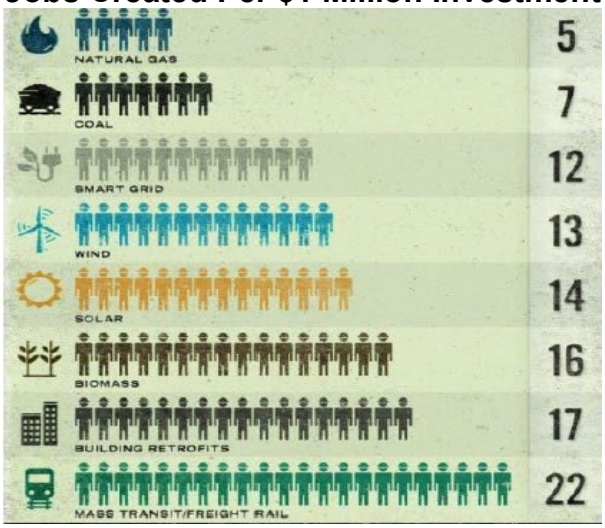
PUE SECTOR	DESCRIPTION	GENERAL PROPORTION OF PUE POWER ALLOCATED TO SECTOR	ESTIMATED JOBS MULTIPLIER (CREATED AND IMPROVED JOBS / MWH)
 AGRICULTURAL PRODUCTION	Agricultural crop production including activities like irrigation (small and large), pest management, maize production, rice production, sugarcane production, rubber production, etc.	5% – 10%	2.85
 ANIMAL PRODUCTION AND PRESERVATION	Production and preservation of animal products including activities like egg incubation, poultry farming, milk production and preservation, fish farming and aquaculture, cold storage (various scales), slaughterhouses, etc.	1.3% – 3.5%	4.60
 FOOD AND AGRICULTURAL PROCESSING	Processing of animal and crop production including activities like milling, grinding, threshing, husking, pressing, drying, etc. for a variety of crops for both small-scale and larger commercial scale applications.	2.5% – 5%	8.25
 ESSENTIAL GOODS AND SERVICES PROVISION	Essential goods and services provision including activities like education, healthcare, water and sanitation, streetlighting, etc.	5% – 10%	2.28
 MOBILITY	Electrification of transport including electric motorcycles, electric tuk-tuks/3-wheelers, electric boats, electric passenger vehicles, and electric bus rapid transit, as well as associated charging infrastructure	5% – 12.5%	0.71
 HEAVY INDUSTRY	Heavy industry including a variety of activities like mining, oil refining, wastewater treatment, data centers, desalination, cement production, chemicals, plastics, vehicle manufacturing, etc.	29% – 56.3%	0.01
 LARGE AND MEDIUM ENTERPRISES	Large and medium enterprises including activities like brewing/distilling, gas stations, telecommunications, trade hubs, banks, textiles, light manufacturing, hospitality, etc.	10% – 22.5%	2.62
 SMALL AND MICRO ENTERPRISES	Small and micro enterprises including activities like metalworking, carpentry, clothing alteration, vehicle maintenance and repair, visual entertainment, digital services, bakery, general retail, barbershop, nightlife, etc.	10% – 22.5%	4.00

Source: Rockefeller Foundation.

Zachary Shahan

Zachary Shahan estimated that if the U.S. national goal is to create jobs, investing in clean energy is several times more effective than investing in fossil fuel or nuclear jobs.[208] Thus, as shown in Figure III-4, "The basic facts are simple. When we invest, say, $1 million in building the green economy, this creates about 17 jobs within the United States. By comparison, if we continue to spend as we do on fossil fuels and nuclear energy, you create only about 5 jobs per $1 million in spending. That is, we create about 12 more jobs for every $1 million in spending -- 300 percent more jobs -- every time we spend on building the green economy as opposed to maintaining our dependence on dirty and dangerous oil, coal, natural gas, and nuclear power."[209]

Figure III-4
Jobs Created Per $1 Million Investment



Source: Zachary Shahan.

UNEP SEF Alliance

The UNEP/Sustainable Energy Finance Initiative (SEFI) conducted a comprehensive analysis of the jobs impact of green initiatives compared to other programs.[210] UNEP/SEFI noted that there is a large and growing interest in many nations in using "green" spending programs (renewable energy, energy efficiency, environmental initiatives, etc.) as economic stimulus and job creation programs. Nevertheless, there remains substantial controversy and uncertainty about the desirability and effectiveness of such initiatives, and the following questions must be addressed:

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[208]Zachary Shahan, "Over 3 Times More Green Jobs Per $1 Invested Than Fossil Fuel or Nuclear Jobs," https://cleantechnica.com/2013/03/20/over-3-times-more-green-jobs-per-million-than-fossil-fuel-or-nuclear-jobs/.

[209]Ibid.

[210]*Why Clean Energy Public Investment Makes Economic Sense – The Evidence Base*, https://wedocs.unep.org/handle/20.500.11822/8016;jsessionid=E3B084484C4FC925E53E4CC92455BCD4.

1. Do green programs facilitate economic growth and job creation?
2. Do green programs create more or fewer jobs than other types of economic stimulus programs, per dollar of spending?
3. How do the stimulus effects of green spending programs compare to those of tax cuts?

Issue 1: Do Green Programs Facilitate Economic Growth and Job Creation?

This is a timely and important issue:

- There has been substantial controversy over the years as to whether green programs act as a driver or a drag on nations' economies and job markets.
- Current worldwide economic conditions make it imperative to determine if such investments are fostering economic recovery and job growth.
- Many nations are rapidly increasing their investments in green stimulus programs and it is important to know whether these investments are compatible with economic growth and job creation.

UNEP/SEFI found that the answer to this question is "Yes:" Green programs facilitate economic growth and job creation. Government investments in these programs stimulate economic growth and job creation, as well as providing various other economic and environmental benefits. It thus concluded that there is a strong positive relationship between clean energy/energy efficiency/environmental investments and economic prosperity and job growth. For example:

- Figure III-5 shows that the relationship between economic efficiency and economic prosperity is positive: The more energy efficient the economy, the more prosperous it is.
- Figure III-6 shows the net job creation in California over the past three decades from investments in green energy programs – total job gains in excess of the jobs lost in the fossil fuel industries and the carbon fuel supply chain. By 2007, annual net job creation totaled nearly 450,000 in the state.

Thus, investments in clean energy and energy efficiency programs increase GDP, incomes, and jobs, reduce pollution and greenhouse gas (GHG) emissions, save energy, reduce energy costs, and reduce energy price fluctuations. Further, the relationship between i) clean energy, energy efficiency, and environmental programs and ii) economic growth and job creation is positive, not negative.

Issue 2: Do Green Programs Create More Jobs Than Other Types of Economic Stimulus Programs, Per Dollar of Spending?

UNEP/SEFI found that the answer to this question is "Yes:" government spending on green stimulus programs is, dollar for dollar, more effective in creating jobs as is equivalent spending on more traditional alternatives, such as road construction or fossil fuel energy programs. These findings are summarized in Figure III-7, which illustrates the relative job creation of different types of government spending programs. For example, it shows that per dollar of spending:

- Photovoltaics create more than 50 percent more jobs than highway construction.
- Biomass creates nearly twice as many jobs as does health care
- Insulation programs create nearly three times as many jobs as municipal infrastructure.
- Mass transit creates more than four times as many jobs as utility programs.

Figure III-5:
Energy Efficiency and Economic Prosperity - 2006

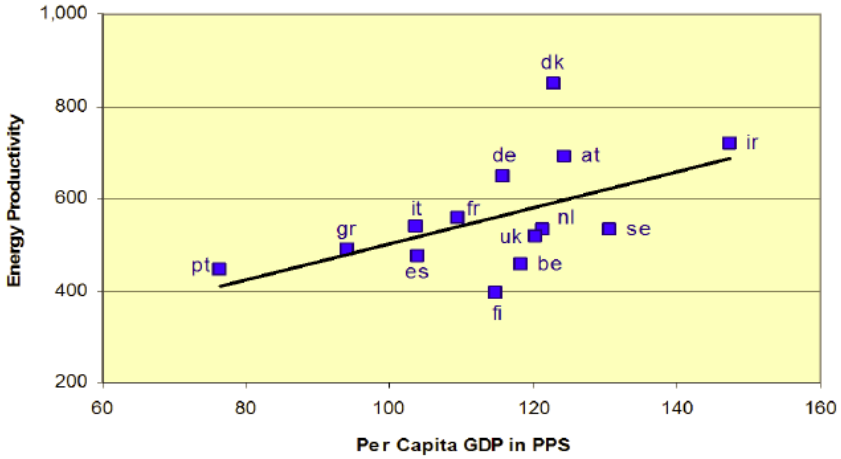
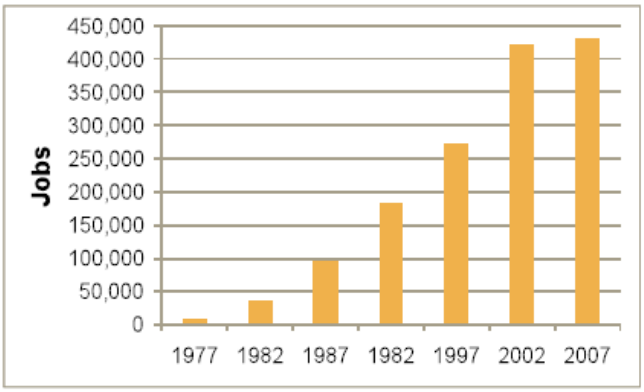


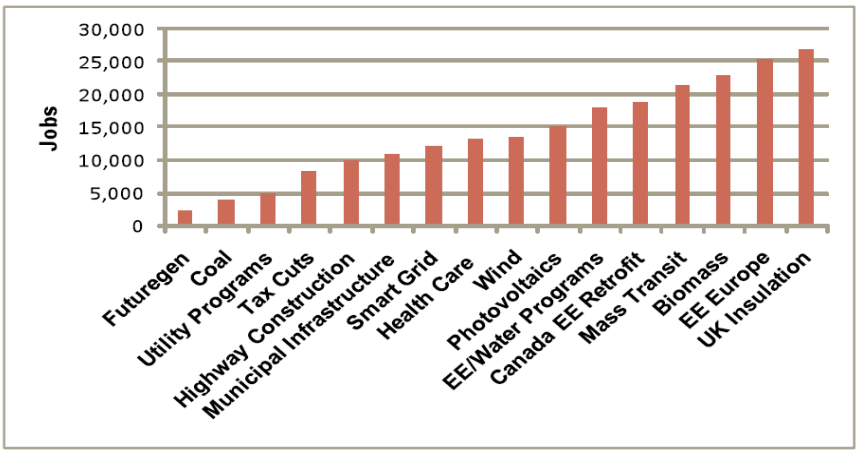
Figure III-6:
Net Job Growth in California Resulting From Green Program Investments



More generally, this figure shows that investments in green stimulus and infrastructure programs usually generate, per dollar of expenditure, more jobs than most alternatives. Investments in energy efficiency programs are especially beneficial and cost effective, and often have negative net economic costs. Clean energy programs are powerful job creators, but the job creation effects depend importantly on the specific clean energy program and technology. UNEP/SEFI thus concluded that the green stimulus

programs being implemented in many nations will likely act as expeditious and effective job creation mechanisms.

Figure III-7
Jobs Generated Per Billion Dollars of Expenditure on Selected Programs
(billion constant 2008 U.S. dollars)



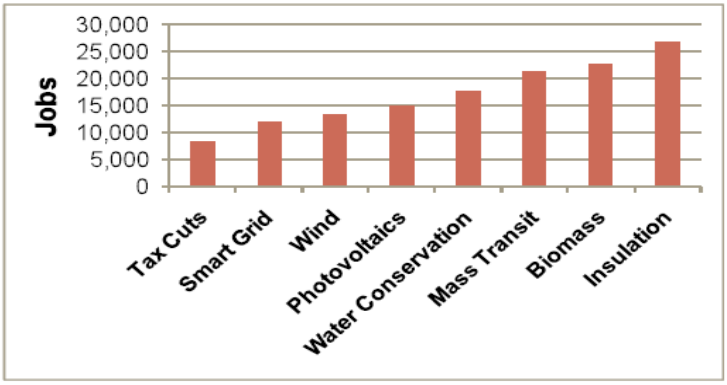
Source: UNEP/SEFI.

Issue 3. Do the Stimulus Effects of Green Spending Programs Have Greater Impacts Than Tax Cuts?

UNEP/SEFI found that the answer to this question is "Yes:" Green stimulus programs generate about three or four times as many jobs, per dollar, as do tax cuts. This is illustrated in Figure III-7 and emphasized in Figure III-8. Figure III-7 shows that, per billion dollars:

- Smart grid investments create 50 percent more jobs than tax cuts.
- Wind programs create 60 percent more jobs than tax cuts.
- Photovoltaics creates nearly twice as many jobs as tax cuts.
- Water conservation programs create more than twice as many jobs as tax cuts.
- Mass transit creates nearly three times as many jobs as tax cuts.
- Biomass creates nearly three times as many jobs as tax cuts.
- Insulation programs create more than three times as many jobs as tax cuts.

Figure III-8: Jobs Generated Per Billion Dollars of Expenditure on Tax Cuts and Selected Green Programs
(billion constant 2008 U.S. dollars)



Source: UNEP/SEFI.

World Resources Institute, New Climate Economy, and International Trade Union Confederation

The World Resources Institute (WRI), the New Climate Economy (NCE), and the International Trade Union Confederation (ITUC) conducted a literature review to compare the number of jobs created per $1 million in a variety of types of green infrastructure versus unsustainable infrastructure.[211] Analyzing 12 studies that met their criteria, WRI/NCE/ITCU compared the near-term job effects from clean energy versus fossil fuels, public transportation versus roads, electric vehicles versus internal combustion engine vehicles, and nature-based solutions versus fossil fuels. For each of these investment types they also investigated other literature on job quality, focusing on wages and benefits, work security, opportunities for growth, work safety, opportunities for social dialogue, and inclusivity of marginalized communities.

WRI/NCE/ITCU determined that $1 million in green investments often creates more near term jobs than an equivalent amount of unsustainable investments, and sometimes significantly more -- Figure III-9. They concluded that, from a jobs perspective, green investments should generally take precedence over unsustainable investments when there is a choice between the two.[212]

WRI/NCE/ITCU found that renewable energy and energy efficiency investments generally create more near-term jobs than fossil fuel investments, but efforts are needed to strengthen job quality. It is labor intensive to retrofit a home with energy-efficient technologies or to install solar panels. By contrast, the fossil fuel industry is highly automated.

[211]https://www.wri.org/research/green-jobs-advantage-how-climate-friendly-investments-are-better-job-creators.
[212]Ibid.

Figure III-9
Green Investments Can Create More Jobs in the Near Term than Unsustainable Investments

SECTOR	# COUNTRIES/ REGIONS ACROSS STUDIES	TYPE OF GREEN INVESTMENT	MEDIAN RATIO ACROSS STUDIES	COMPARISON TO UNSUSTAINABLE INVESTMENT
Energy	7	Building efficiency creates...	2.8	
	7	Industrial efficiency creates...	1.8	
	6	Geothermal energy creates...	1.7	
	8	Solar photovoltaic energy creates...	1.5	
	7	Upgrades to existing grids create...	1.5	
	8	Wind energy creates...	1.2	...times as many jobs as fossil fuels per $1 million
	7	Hydropower creates...	1.2	
	1	New grids create...	1.1	
	1	Reducing methane emissions creates...	0.8	
	1	Carbon capture, utilization, and storage creates...	0.5	
	1	Nuclear energy creates...	0.3	
Public and non-motorized transport	1	Pedestrian-only infrastructure creates...	1.3	
	1	Bicycle-only infrastructure creates...	1.4	
	1	Roads with pedestrian and cycling infrastructure create...	1.1	...times as many jobs as road construction per $1 million
	2	Mass transit creates...	1.4	
	2	Railways create...	0.8	
Vehicles	2	Electric vehicle manufacturing creates...	0.9	
	1	Battery cell manufacturing creates...	1.2	...times as many jobs as internal combustion engine vehicle manufacturing per $1 million
	1	Electric vehicle charging infrastructure creates	2.0	
Nature	1	Ecosystem restoration creates...	3.7	...times as many jobs as oil and gas production per $1 million

Note: A ratio >1 (colored in green) means that green investments create more jobs than an equivalent amount of unsustainable investments. A ratio <1 (colored in red) means that green investments create fewer jobs than an equivalent amount of unsustainable investments.

Source: WRI/NCE/ITCU.

Clean energy supports middle-class jobs, including for workers with less formal education, but there are concerns that the wages are not as high as those for fossil fuel jobs. Governments can design clean energy projects with agreements that mandate high wages and benefits comparable to union work, promote work training, and target disadvantaged workers for hiring. Putting in place strong labor standards for clean energy workers could have only a minimal effect on the cost and speed of reaching net-zero emissions.

Investments in mass transit, walking infrastructure, and cycling infrastructure generally create more jobs than investments in roads, and increase the productivity and inclusivity of the economy. Government investment needs to shift from building new roads to maintaining existing roads while expanding public and non-motorized transportation options. In addition to creating near-term jobs, public transportation investments have a long-term positive impact on jobs for everyone in the economy by lowering travel costs, reducing traffic, and improving job accessibility.

Rail investments may create relatively fewer near-term jobs per unit of investment in the U.S., but railways and mass transit both create more long-term operations and maintenance jobs than roads do. Strong labor standards, unions, and training can increase the quality of construction jobs.

WRI/NCE/ITCU found that the transition to electric vehicles (EVs) will lead to net job gains in the overall economy, but jobs are expected to be lost in the manufacturing sector.[213] EVs create jobs in the electricity sector, which is more labor intensive than the oil sector. Because EV owners save money on gasoline, they inject the savings into the overall economy, which is also more labor intensive than the oil sector. Investments in EV charging infrastructure could also be a strong job creator. However, investing in EVs is expected to create fewer manufacturing and maintenance jobs than investing in internal combustion engine vehicles because EVs are comprised of fewer and less complex parts.

WRI/NCE/ITCU determined that nature-based solutions like ecosystem restoration and sustainable agriculture can create many more jobs than investments in fossil fuels, reduce emissions, improve resilience to climate impacts, and benefit marginalized communities -- but the jobs are often informal.[214] Most jobs needed for restoration and nature-based solutions require little training and provide an opportunity to quickly hire low-skilled workers. However, these types of jobs are often lower paid and temporary.

WRI/NCE/ITCU recommended that green investments should be a core part of stimulus spending and longer-term economic strategies. They are necessary to meet climate goals and are often effective job creators compared with unsustainable alternatives.[215]

WRI/NCE/ITCU concluded that with the right policies, it is possible to improve job quality in climate-friendly sectors and the wider economy and enable a just transition. Governments should work with unions and employers to advance policies and practices that ensure fair wages and working conditions and target hiring of excluded social groups as conditions for public investment and procurement. They should invest in job training to help current workers build new skills and apprenticeship programs to ensure workers can move up the training and career ladder. They should invest in and help renew communities going through job transition or displacement. Governments should support job quality across the entire economy by implementing regulations like minimum wages

[213]Ibid.
[214]Ibid.
[215]Ibid.

and labor standards; strengthening social safety nets to support workers when emergencies like COVID-19 arise; and investing in the care economy, public health, and education to build a healthy and skilled workforce.[216]

III.B. Do Green Jobs Create or Displace Jobs?

III.B.1. Does the Green Economy Create Jobs?

Numerous studies have addressed the question of whether environmental regulations or the creation of green jobs via green initiatives destroys "non-green" jobs, and if so, how many compared to the green jobs created. The studies concluded that these regulations, initiatives, and climate policies actually would result in a net gain in jobs. For example:

- The Apollo Alliance's New Apollo Program proposed an investment of $500 billion over ten years to create five million green-collar jobs in a range of industries including renewable energy, energy efficiency, transit and transportation, and research, development and deployment of cutting-edge clean energy technologies.[217]
- Arnold, Forrest, and Dujack examined claims about the costs of environment regulations by reviewing the available research.[218] They found that, while the claims about damage to the economy can mostly be attributed to misinformed advocates or exaggeration, the majority of the fault lies in a lack of accurate communication of economists' findings about the effect of environmental regulation to the general public. Worst-case economic impact scenarios for a regulation – such as potential increases in unemployment and plant closures -- are reported not as low probabilities, but as serious threats. They concluded that the view that environmental regulation seriously harms the U.S. economy is not supported by the data.
- Barret and Heorner assessed the impact of policies designed to provide steady increases in energy efficiency and reductions in carbon emissions, while improving overall economic efficiency.[219] They analyzed the impact of these policies and estimated that an additional 660,000 net jobs would be created in 2010 and 1.4 million in 2020. This would increase employment in the service sector and reduce the rate of decline in manufacturing employment.
- John Bliese reviewed dozens of well-designed studies that tested the assertion that environmental protection harms the economy.[220] The results of these studies indicate that environmental protection normally has no negative impact on the economy overall, and often has a positive effect. He noted that the studies only searched for economic impacts of environmental policies -- and found none; they

[216]Ibid.
[217]http://apolloalliance.org/apollo-14/the-full-report/.
[218]https://www.scribd.com/document/296634230/EE-0422-01.
[219]https://www.epi.org/publication/studies_cleanenergyandjobs/.
[220]https://www.taylorfrancis.com/chapters/mono/10.4324/9780429496486-3/environment-versus-economy-myth-john-bliese.

did not estimate environmental or public health benefits. He concluded that the "environment vs. the economy trade-off" is a myth, even in narrowly economic terms.

- Bernow, Cory, Dougherty, Duckworth, Kartha, and Ruth examined the impact of implementing a set of integrated policies designed to bring the U.S. in compliance with the Kyoto Protocol.[221] They found that the U.S. could reduce its carbon emissions to its Kyoto target and that the prescribed policies would produce net economic savings. Specifically, they estimated that by 2010 almost 900,000 net new jobs would be created, relative to the baseline.
- The Center for American Progress and the Political Economy Research Institute, with the support of the Blue Green Alliance and the Green Jobs for America Campaign, estimated that spending $100 billion over two years would create two million jobs in building retrofitting, expansion of the transit and freight rail grids, construction of a "smart" electrical grid, wind and solar power, and next-generation biofuels.[222]
- The Environmental Policy Research Centre found that there are indications that many environmentally friendly technologies are associated with higher work intensity and as such, lead to an increase in employment compared to conventional technologies. Higher capital intensity is indicated for other technologies, with the result that the employment effects are negative. It found that employment effects of energy price increases are low unless the energy tax income is used to relieve labor costs. In this case, positive effects are to be expected.[223]
- A report prepared by Global Insight for the United States Conference of Mayors forecast that renewable power generation, building retrofitting, and renewable transportation fuels will would generate 1.7 million new jobs and another 846,000 related engineering, legal, research and consulting positions. That total would increase to 3.5 million by 2028 and 4.2 million by 2038.[224]
- Stephen Meyer analyzed the impact of environmental legislation on differential interstate rates of economic performance and tested the hypothesis that pursuit of environmental quality hinders economic growth and job creation.[225] He ranked the 50 states on the basis of the stringency of their environmental laws and then compared the environmental rankings with measures of economic growth and job creation between 1973 and 1989. He found no evidence to support a negative relationship between environmental regulation and economic performance, and his results showed the opposite. Meyer found that the states with the most ambitious environmental programs had the highest levels of economic growth and job creation over the period.

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[221]Stephen Bernow, W. Dougherty, M. Duckworth, S. Kartha, M. Lazams, and M. Ruth. *America's Global Warming Solutions*. Boston, Massachusetts: Tellus Institute and Stockholm Environment Institute, 1999.
[222]http://www.americanprogress.org/issues/2008/09/pdf/green_recovery.pdf.
[223]https://energypedia.info/images/f/fc/Green_Jobs_-_Impacts_of_a_Green_Economy_on_employment.pdf.
[224]http://www.usmayors.org/pressreleases/uploads/GreenJobsReport.pdf.
[225]Stephen S. Meyer. "Environmentalism and Economic Prosperity: Testing the Environmental Impact Hypothesis." Massachusetts Institute of Technology Project on Environmental Policies and Policy, Cambridge, Massachusetts, October 1992.

- The New Apollo Initiative proposed an economic development plan for the U.S. based on diversifying energy sources, making the U.S. less dependent on foreign oil, investing in green industries, promoting energy efficient buildings, and investing in cities and communities. It estimated that an annual $30 billion investment for 10 years would add more than 3.3 million jobs to the economy and stimulate $1.4 trillion in new GDP.[226]
- The Political Economy Research Institute (PERI) of the University of Massachusetts noted that transitioning to lower-carbon energy will entail a contraction of the fossil fuel sector along with a loss of jobs and that an important question is whether clean energy will create more jobs than will be lost in fossil fuels. It used Input-Output (I-O) tables to evaluate public and private spending in clean energy and compare it to the effects of spending on fossil fuels.[227] The research focused on employment impacts in the short-to-medium term, and did not estimate the long-term comparison of operations and maintenance employment. PERI found that on average, 2.65 full-time-equivalent (FTE) jobs are created from $1 million spending in fossil fuels, while that same amount of spending would create 7.49 or 7.72 FTE jobs in renewables or energy efficiency. "Thus each $1 million shifted from fossil to green energy will create a net increase of five jobs."[228]
- Michael Renner found that creating an environmentally sustainable economy has already generated an estimated 14 million jobs worldwide.[229] He reported that many new opportunities for job creation are emerging, ranging from recycling and remanufacturing of goods, to greater energy and materials efficiency and the development of renewable energy. Jobs are more likely to be at risk where environmental standards are low. He concluded that investing in the environment, in renewable energy, and energy efficiency will generate more jobs than investing in extractive industries and fossil fuels.
- University of California, Berkeley researchers found that California's efforts to reduce emissions have bolstered the state's economy and created more than 37,000 jobs.[230]
- The Union of Concerned Scientists analyzed the effects of implementing a national renewable electricity standard (RES) that would require electric utilities to supply a set percentage of their electricity from renewable sources. It found that under a national RES of 20% by 2020, the USA would increase its total renewable power capacity 11-fold and create more than 355,000 new jobs.[231]
- University of Illinois research staff analyzed the Midwest's Clean Energy Development Plan, which advocated energy efficient technologies and development of renewable energy resources, especially wind power and biomass

[226]https://cows.org/wp-content/uploads/sites/1368/2021/01/2004_New-Energy-for-America-The-Apollo-Jobs-Report.pdf
[227]https://www.sciencedirect.com/science/article/abs/pii/S026499931630709X.
[228]Ibid.
[229]http://link.sandiego.edu/portal/Working-for-the-environment--a-growing-source-of/FGksbID8Wec/.
[230]https://escholarship.org/uc/item/14p0h9mp.
[231]https://www.ucsusa.org/resources/renewable-electricity-standard.

energy. They estimated that implementing the plan would create more than 200,000 new jobs across the 10-state Midwest region by 2020.[232]

- Constantine Yapijakis found that widespread fears of job losses from environmental protection are unfounded and that, when job creation aspects of pollution control policies are factored in, environmental protection has increased net employment in the U.S.[233] Further, actual layoffs due to regulation have been extremely small. Environmental protection raises employment levels and provides some recession-proof stimulus to aggregate demand. Government data reveal that few manufacturing plants are shut down as a result of environmental or safety regulations.

Several other examples are discussed in more detail below.

Bezdek, Wendling, and DiPerna

Bezdek, Wendling, and DiPerna analyzed the relationship between environmental protection, the economy, and jobs in the U.S.[234] They noted that the relationship between environmental protection, the economy, and jobs has been an issue of harsh contention for decades. Does environmental protection harm the economy and destroy jobs or facilitate economic growth and create jobs? They addressed this issue by summarizing the results of the Jobs and the Environment Initiative, research funded by nonprofit foundations to quantify the relationship between environmental protection, the economy, and jobs.

They estimated the size of the U.S. environmental industry and the numbers of environment-related jobs at the national level and in the states of Florida, Michigan, Minnesota, North Carolina, Ohio, and Wisconsin. This was the first time that such comprehensive, detailed estimates have been developed. They found that, contrary to conventional wisdom, environmental protection, economic growth, and jobs creation are complementary and compatible: Investments in environmental protection create jobs and displace jobs, but the net effect on employment is positive.

They derived five major findings:

1. Their major finding was that, contrary to conventional wisdom, environmental protection, economic growth, and jobs creation are complementary and compatible: Investments in environmental protection create jobs and displace jobs, but the net effect on employment is positive.
2. Environment protection has grown rapidly to become a major sales-generating, job-creating industry – $300 billion/yr. and 5 million jobs in 2003.

[232]https://www.michigan.gov/documents/nwlb/Job_Jolt_RepoweringMidwest_235553_7.pdf.
[233]Constantine Yapijakis. "The Myth of 'Jobs Versus the Environment.'" Environmental Research Laboratory, Cooper Union School of Engineering, New York, 1999.
[234]https://www.researchgate.net/publication/6569002_Environmental_Protection_the_Economy_and_Jobs_National_and_Regional_Analyses.

3. Most of the 5 million jobs created are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, etc., and the classic environmental job (environmental engineer, ecologist, etc.) constitutes only a small portion of the jobs created. Most of the persons employed in the jobs created may not even realize that they owe their livelihood to protecting the environment.
4. At the state level, the relationship between environmental policies and economic/job growth is positive, not negative – Tables III-8 and III-9. Thus, states can have strong economies and simultaneously protect the environment.
5. Environmental jobs are concentrated in manufacturing and professional, information, scientific, and technical services, and are thus disproportionately the types of jobs all states seek to attract.

Table III-8
Summary of the Environmental Industries in Six States in 2003

	Environmental industry (billions) ($)	Environmental jobs	Environmental industry as a percent of		State environmental industry as a percent of		Private sector environmental jobs	
			State GDP (%)	State jobs (%)	Total US environmental industry (%)	Total US environmental jobs (%)	Manufacturing (%)	Professional, scientific, technical (%)
Florida	15.4	220,000	3.1	3.0	5.0	4.4	7	22
Michigan	12.9	217,000	3.9	4.9	4.3	4.4	29	29
Minnesota	5.1	92,000	2.6	3.5	1.7	1.8	21	23
North Carolina	9.1	112,000	3.1	2.9	3.0	2.9	24	20
Ohio	12.2	176,000	3.2	3.3	4.1	3.5	29	25
Wisconsin	5.4	97,000	2.9	3.5	1.8	2.0	31	16

Source: Bezdek, Wendling, and DiPerna

Table III-9
Environmental-related Jobs in Each State, by Industry

Industry	Florida employment		Michigan employment		Minnesota employment		N. Carolina employment		Ohio employment		Wisconsin employment	
	Total	Environmental	Total	Environmental	Total	Environmental	Total	Environmental	Total	Environmental	Total	Environmental
Agriculture, forestry, fishing and hunting	2300	192	3515	216	800	86	3700	120	1564	129	2500	208
Mining	4900	459	5226	627	5200	515	4000	293	10,505	678	1300	145
Utilities	26,800	4973	24,136	6914	12,000	2902	14,000	2114	26,109	5949	11,600	2782
Construction	445,900	9966	173,244	8633	125,200	4497	211,800	4732	212,409	7061	123,500	4295
Manufacturing	388,800	9849	659,736	38,895	344,300	11,974	604,300	14,013	805,716	28,149	506,500	17,400
Wholesale trade	313,200	3692	178,545	4021	127,800	2151	163,600	1827	243,493	3634	113,000	1752
Retail trade	920,400	5833	503,576	351	301,700	1778	432,500	2582	591,557	322	319,000	1962
Transportation and warehousing	202,100	1300	90,412	544	80,100	507	110,700	632	130,002	516	94,600	555
Information	171,800	4278	86,397	170	62,600	1751	75,600	1797	103,334	148	49,700	1382
Finance and insurance	330,900	1962	168,065	202	138,100	1062	143,700	855	248,897	209	129,800	861
Real estate and rental and leasing	153,400	1680	61,676	278	37,900	527	47,800	577	66,212	248	27,900	416
Professional, scientific, and technical services	384,400	28,606	195,553	39,432	118,200	12,922	146,300	11,616	221,765	24,657	89,000	9341
Management of companies and enterprises	65,600	1032	152,641	2188	59,000	1385	61,200	971	134,502	1848	37,600	861
Administrative/support/waste management/ remediation services	807,500	41,971	294,857	25,287	117,300	7622	213,700	10,001	319,058	17,242	118,200	7586
Educational services	108,400	3198	70,286	2537	48,400	1676	61,600	1753	97,489	3186	46,100	1807
Health care and social assistance	777,200	4364	516,974	1269	318,300	2099	366,600	1848	678,618	1205	320,500	2330
Arts, entertainment, and recreation	157,200	1030	53,009	449	36,900	247	44,000	240	58,265	399	35,500	229
Accommodation and food services	651,300	5286	327,545	188	196,200	1525	291,000	1837	410,303	187	209,500	1641
Other services	317,800	3107	175,892	2676	118,900	1330	162,400	1335	229,701	2465	131,300	1310
Public administration	1,055,500	86,723	670,515	81,624	402,400	35,545	644,600	52,865	801,500	77,877	411,800	40,337
State total	7,285,400	219,500	4,411,800	216,500	2,651,300	92,100	3,803,100	112,007	5,390,999	176,109	2,778,900	97,200

Source: Bezdek, Wendling, and DiPerna

Consoli, Marin, Marzucchi, and Vona

Consoli, Marin, Marzucchi, and Vona conducted an empirical analysis of labor force characteristics associated to environmental sustainability.[235] Using U.S. data, they compared green and non-green occupations to detect differences in terms of skill content and of human capital. Their empirical profiling found that green jobs use high-level abstract skills significantly more than non-green jobs. Further, they found that green occupations exhibit higher levels of education, work experience, and on-the-job training. Their analysis emphasized an underdeveloped theme, namely the labor market implications associated with the transition towards green growth.

Their major finding is that green occupations exhibit significant differences from non-green occupations. In particular, green jobs are characterized by higher levels of non-routine cognitive skills and higher dependence on formal education, work experience and on-the-job training. The empirical evidence also indicates that the greening of the economy is in progress, and that work activities are not characterized by a high degree of routinization. This resonates with the remark that environmental technologies are still at early stages of the life cycle wherein cognitive skills such as design and problem solving are essential in guiding future developments. Their findings indicated that formal

[235]https://www.sciencedirect.com/science/article/abs/pii/S0048733316300208.

education, work experience and on-the-job training are more prominent among existing occupations that are undergoing qualitative change due to the greening of the economy compared to similar non-green jobs. Parallel to this, on-the-job training emerges as very important among new green occupations.

The main implication is that educational policy per se may not be sufficient to support green human capital formation, and that learning by doing should be kept in strong consideration when formulating policies that favor the adaptation of workforce skills to the demands of a changing production paradigm. Likewise, we envisage actors such as industry and sector *consortia* and interfirm associations to be well positioned for mitigating the risk of free-riding and favoring positive externalities in the creation of green human capital.

Donald Vial Center on the Green Economy

The University of California, Berkeley, Donald Vial Center on the Green Economy (DVC) noted that the San Joaquin Valley,[236] plays a critical role in shaping California's climate policy and is worthy of study due to its function as a bellwether of the state's transition to a low-carbon economy.[237] Reducing emissions is vitally important for the region, as the Valley's topography traps pollution, resulting in worse air quality and related health conditions than other regions of the state. The region also faces more socioeconomic challenges than California as a whole. Thus the Valley is vulnerable to both climate change and to climate policy. Further, "If policymakers can make climate policy work for the Valley, it will work for the state and demonstrate that these policies and programs can work for vulnerable communities around the country."[238]

DVC noted that in the California Legislature, some San Joaquin Valley representatives have raised concerns about the impact the state's climate policy and programs could have on jobs. However, claims and counter-claims about the economic impact of climate policies have been wielded in an informational vacuum, and no comprehensive independent study has sought to calculate and analyze economic impacts of state climate policies within the San Joaquin Valley.

DVC conducted a quantitative assessment of the economic impacts of three of California's major climate programs and policies in the San Joaquin Valley: Cap and trade, the renewables portfolio standard, and investor-owned utility (IOU) energy efficiency programs. Analysis from this report suggests that total net economic benefits thus far for the three programs investigated is more than $13.4 billion. In short, the findings indicate that despite the heightened fears of job loss, California's major climate policies have been a net economic boon to the San Joaquin Valley. Strengthening and

[236]The San Joaquin Valley is comprised of the eight California counties of Fresno, Madera, Merced, Kern, Kings, San Joaquin, Stanislaus, and Tulare.
[237]The Donald Vial Center on the Green Economy is a program of the Labor Center and the Center for Law, Energy, and the Environment at UC Berkeley School of Law.
[238]https://laborcenter.berkeley.edu/the-economic-impacts-of-californias-major-climate-programs-on-the-san-joaquin-valley/.

refining those policies, not backtracking on them, is likely to continue that success and accentuate the positive effects in the region. After accounting for the costs and benefits, the net impacts were estimated as:[239]

- Net economic impacts from the cap-and-trade program through December 2016 include $200 million in total economic impact, including $4.7 million in state and local tax revenue. These programs have created 1,612 total jobs in the Valley, including 709 direct jobs. When one includes expected benefits based on funds for projects approved but not yet spent (with funds to be disbursed on a yet-to-be-determined date), this figure increases to nearly $1.5 billion when accounting for total impact on the economy. These projects will create 10,500 total jobs, including 3,000 direct jobs.
- The state's Renewables Portfolio Standard (RPS) has had a substantial economic impact on the Valley and is a key source of job creation. Construction on RPS-related projects resulted in a total economic impact of $11.6 billion in the Valley. Between 2002-15, the RPS created 88,000 total jobs, including 31,000 direct jobs.
- Energy efficiency projects in the Valley have had a net economic benefit of $1.18 billion. Energy efficiency is also a significant job creator, particularly in the construction sector, and was responsible for creating a total of 17,400 jobs in the Valley between 2006-2015, including 6,700 direct jobs. Benefits from efficiency programs include lower electricity costs, consumer savings from reduced energy use, jobs created to implement energy upgrades and jobs flowing from the boost in local economies that results from lower utility bills.

Hilliard Hunnington

Hilliard Huntington noted that green energy has some important advantages over conventional fossil fuels. Improving energy efficiency or expanding renewable energy sources reduces the risks of both combusting carbon-based fossil fuels and relying too much on potentially vulnerable oil and natural gas supplies, and green energy is also widely promoted for its ability to create jobs. If green energy power projects provide more new jobs than conventional energy projects, they may stimulate more additional jobs as incomes expand. This possibility provides green energy with a "two-for-one" possibility. Governments should advance these technologies, because they stimulate the economy as well as protect against global climate change and energy insecurity.[240] He analyzed some widely quoted estimates supporting the substantial benefits of renewable energy jobs, placed them in the context of other possible government responses, and provided a framework for comparing claims for job-creation on a consistent basis.

He derived job-creation estimates for power generation options and compared two estimates each for solar photovoltaic (PV), wind and biomass with single estimates for coal and natural gas – Table III-10. The job estimates included only the direct, first-round employment impacts. These direct impacts included additional employment from construction, manufacturing and installation of new facilities as well as the operations and

[239]Ibid.
[240]https://web.stanford.edu/group/emf-research/docs/occasional_papers/OP64.pdf.

management as well as fuel-processing costs of generating power. They excluded the indirect, inter-industry impacts where new facilities may require additional inputs (e.g., more steel), which may be important for many renewable options, except biomass. It is difficult to distinguish these inter-industry effects for each generation option (solar versus wind) from simulations reported by input-output models of the economy. Even ignoring these effects, however, the estimates show renewable energy sources to be major job-generators.[241]

The job-creation effects were standardized on megawatts of capacity, adjusted for the percent of time each option was used over a typical year -- megawatts averaged (MWa). These conversions were made to emphasize how much each option was used to generate electricity rather than how much capacity was available. Their estimates of the jobs per MWa are reported in the first column of Table III-10.

The top four entries for renewable energy sources look extremely attractive relative to those for natural gas and coal. The job ratios shown in column (5) are the ratio of job creation for each technology relative to that for natural gas. These estimates suggest that solar PV may be about 8-11 times more effective in creating jobs than either coal or natural gas.[242]

Table III-10
Job Creation Associated with Different Generation Technologies

	(1)	(2)	(3)	(4)	(5)	(6)
					---Job Ratio---	
	Jobs/MWa	Jobs/GWh	Jobs/$MM	$/KWh	MWh	$
Solar PV	7.41	0.846	3.18	$0.2664	7.80	1.55
Solar PV	10.56	1.205	4.53	$0.2664	11.12	2.21
Wind	0.71	0.081	1.64	$0.0495	0.75	0.80
Wind	2.79	0.318	6.43	$0.0495	2.94	3.14
Biomass	0.78	0.089	1.80	$0.0496	0.82	0.88
Biomass	2.84	0.324	6.54	$0.0496	2.99	3.19
Coal	1.01	0.115	3.72	$0.0310	1.06	1.81
Natural Gas	0.95	0.108	2.05	$0.0529	1.00	1.00

Explanation:
Column (1), source: Kammen, Kapadia & Fripp (2006).
Column (2) = column (1) * (10^6) / 8760.
Column (3) = column (2) / column (4).
Column (4), source: Metcalf (2005), converted from cents per KWh.
Columns (5) & (6): Jobs Index (where natural gas equals 1.00).

MW = megawatts = capacity.
MWa = used capacity averaged over the year = (% capacity factor) x (capacity).
GWh = 1000 * megawatt hours = (1000) x (24 hours) x (365 days) x (% capacity factor) x (capacity).
GWh = MWa x 1000 x 8760.

Source: Hilliard Huntington

[241]The estimates excluded the indirect impacts from additional spending from the higher direct earnings (the economy's multiplier effect). Excluding the expenditure multiplier effects is appropriate for comparing the options if the multipliers are similar for clean and conventional energy sources, which Hunnington found to be reasonable.
[242]https://web.stanford.edu/group/emf-research/docs/occasional_papers/OP64.pdf.

However, Hunnington cautioned that while the normalization on MWa makes sense if it is important to compare options based upon their generation of power, the argument about jobs has very little to do with equating energy use across generation options. Instead, it is an economic argument and should be related to the foregone opportunities associated with selecting a particular generation type.[243]

Tom Konrad

Tom Konrad noted that not all green policies improve economic efficiency. For example, subsidies for not-yet-economic types of renewable energy like wave power and solar installations may be justifiable on the grounds that they are helping to promote needed future technologies, but they probably come at a net cost to near-term jobs (even if they may create more jobs in the long term by allowing the creation of new types of businesses).[244]

On the other hand, he contends that policies to promote energy efficiency will be strong net creators of jobs, because the cost of energy efficiency is typically only a fraction of the cost of the energy saved. The very existence of opportunities to save significantly on energy bills at modest cost is proof that the energy market is inefficient. In an efficient market, all such opportunities would have already been taken. Further, "After the energy efficiency measure has been installed, the cost savings can be used for useful economic activity, rather than wasted on unneeded fuel. This money will then spur additional activity and stimulate jobs."[245]

MISI: The Tackling Climate Change Initiative

MISI estimated the economic and jobs impact of the USA displacing 1.2 billion tons of carbon emissions annually by 2030 using energy efficiency and renewable energy -- Tackling Climate Change (TCC) initiative. MISI:[246]

- Assessed the technologies deployed, their costs, and the necessary time frames.
- Estimated the job impacts of the policy.
- Determined that it would generate more than 4.5 million *net jobs*.
- Disaggregate the jobs created by industry, occupation, skill, and salary.
- Discussed the policy implications of the findings.
- Concluded that climate mitigation initiatives can be a major net job creator for the U.S.

[243]Ibid.
[244]https://www.renewableenergyworld.com/storage/the-microeconomics-of-green-jobs/#gref.
[245]Ibid.
[246]https://www.researchgate.net/publication/344240794_The_jobs_impact_of_GHG_redction_strategies_in_the_USA.

Table III-11 summarizes the net costs and jobs impact of the TCC initiative in 2020 and 2030. This table illustrates that the net costs of the EE and RE components of the TCC initiative differ dramatically among technologies and over time. For example, in 2020, the net costs are –$67 billion; in 2030, the net costs are +$4 billion; in 2020, EE has net savings of $85 billion, while all of the RE technologies except biofuels have net costs; in 2030, EE has net savings of $17 billion, while all of the RE technologies except wind and biofuels have net costs. The net savings from EE decline significantly over the forecast period, from $85 billion in 2020 to $17 billion in 2030: Biofuels net savings increase from –1 billion in 2020 to –$8 billion in 2030; biomass costs increase from $3 billion in 2020 to $4 billion in 2030; PV costs increase nearly three-fold, from $5 billion in 2020 to $16 billion in 2030; concentrating solar costs decrease 60%, from $5 billion in 2020 to $2 billion in 2030; geothermal costs increase by over one-half, from $4 billion in 2020 to almost $7 billion in 2030. Annualized costs over the entire period also differ dramatically, from a –$108 billion for EE to more than $9 billion for biofuels and nearly $7 billion for concentrating solar.

Table III-11
Net costs and jobs resulting from the TCC initiative

	Net costs			*Net jobs*	
	Annualised	*2020*	*2030*	*2020*	*2030*
	Billion 2005 dollars			*Thousand FTE*	
Energy efficient	–$107.9	–$84.8	–$17.4	3,533	3,360
Wind	$0.0	$0.3	–$0.4	149	93
Biofuels	$9.2	–$0.5	–$7.6	261	257
Biomass	$2.6	$3.3	$4.5	122	172
Photovoltaics	$4.7	$5.3	$16.0	105	340
Concentrating solar	$6.6	$5.2	$2.2	156	147
Geothermal	$2.5	$4.0	$6.7	96	144
Total	–$82.3	–$67.2	$4.0	4,419	4,513

Source: MISI.

Examining the net jobs generated by industry from TCC initiative indicates that the impacts are well distributed throughout the U.S. economy. The industries involved are not surprising, and it is easy to understand the parts they will play in the evolving transformation to a new energy consumption structure and the subsequent economic growth.

The vast majority of the jobs created by EE&RE are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. and most of the persons employed in these jobs may not even realize that they owe their livelihood to renewable energy. This is illustrated in Table III-12, which shows the jobs

created by the TCC initiative in 2030 within selected occupations. These demonstrate that the TCC initiative will generate:

- More jobs for cashiers than for recyclable materials collectors.
- More jobs for order clerks than for architects.
- More jobs for executive secretaries than for waste treatment plant operators.
- More jobs for janitors than for civil engineers.
- More jobs for customer service representatives than HVAC mechanics and installers.
- More jobs for truck drivers than for plumbers.
- More jobs for stock clerks than for electrical and electronics engineers;
- More jobs for customer service representatives than for welders.
- More jobs for inspectors and testers than for sheet metal workers.
- More jobs for bookkeeping and accounting clerks than for mechanical engineers.

Thus, many workers will be dependent on the TCC initiative for their jobs, although they often would have no way of recognizing the connection unless it is brought to their attention. Occupational data demonstrate that the TCC initiative will create a variety of high-paying jobs, many of which take advantage of manufacturing skills currently going unused as U.S. manufacturing stagnates.

Table III-12
Net jobs by occupation generated by the TCC initiative in 2030
(Selected occupations)

Industry	*Jobs (thousands)*
Agricultural equipment operators	12
Architects	5
Bookkeeping and accounting clerks	66
Carpenters	73
Cashiers	44
Cement masons and concrete finishers	19
Compliance officers	8
Computer software engineers	20
Computer systems analysts	17
Cost estimators	16
Customer service representatives	64
Drywall installers	11
Electricians	49
Electric power line workers	13
Farm workers and labourers	142
Financial analysts	6
Hazardous materials removal workers	14
Human resource specialists	7
Industrial engineers	14
Industrial production managers	11
Operating engineers	34
Painters	19
Plumbers	35
Power plant operators	5
Purchasing agents	14
Refuse and recyclable material collectors	30
Security guards	22
Sewer pipe cleaners	6
Shipping and receiving clerks	30
Structural iron and steel workers	5
Tool and die makers	7
Waste treatment plant operators	8
Welders and solderers	28

Source: MISI.

III.B.2. Does The Green Economy Destroy Jobs?

Other studies have addressed the question of whether environmental regulations or the creation of green jobs via green initiatives destroys "non-green" jobs, and if so, how many compared to the green jobs created and have concluded that these regulations, initiatives, and climate policies actually would result in a net decrease in jobs. They make the argument that there are no sound economic arguments to support an assertion that green energy policies will increase the total level of employment in the medium or longer term when if macroeconomic conditions are held constant. For example, more people may be employed in manufacturing wind turbines and constructing wind farms, but this neglects the diversion of investment from the rest of the economy. Thus, it is necessary to assess macroeconomic and labor market policies to influence the level and composition of employment.[247]

A number of these studies are summarized below.

Beacon Hill Institute

The Beacon Hill Institute (BHI) contends that jobs, green or otherwise, are not benefits but are instead costs. The creation of a green job makes work for someone and it diverts resources from elsewhere in the economy. If the green job is a net benefit it has to be because the value the job produces for consumers is greater than the cost of performing the job. This argument is never made in any of these three green jobs studies. In fact the opposite, that it takes more work to provide the same amount of energy, is often argued as a benefit. The energy itself is the benefit, the work that goes into creating energy is a cost that we benefit by minimizing. The green jobs literature is riddled with this fundamental misunderstanding.[248]

According to BHI, green job subsidization will do nothing to help the U.S. recover from the current recession. Based on arbitrary assumptions or faulty methodologies, the forecasts of future green jobs are completely unreliable. When BHI applies its own general equilibrium model to a cap and trade proposal in the state of Indiana, it estimates net job losses rather than gains.[249] In viewing the creation of jobs as a benefit, green job studies and advocates all make a fundamental error. Jobs are a cost in the process of production; the services a job provides are the benefit. Green job advocates often claim that so-called sustainable technology for power generation, transport, or food production will require more labor per unit of output than do conventional methods. This is a major cost of their proposals – not a benefit as they claim. Decreased labor productivity is the path to poverty.

[247]http://www.windwatchni.com/uploads/1/6/4/9/16490250/green-jobs.pdf.
[248]https://www.beaconhill.org/BHIStudies/GreenJobs09/BHIGreen_Collar_Job_Critique090625.pdf.
[249]Ibid.

Alex Epstein

Alex Epstein argues that President Biden's contention that his policies to eliminate U.S. CO_2 emissions through a largely solar- and wind-based energy system will create millions of well-paying "green jobs" -- far more than will be destroyed in the fossil fuel industry – is false. Rather, a largely solar-and wind-based energy system will necessarily destroy far more well-paying U.S. jobs than it creates because the "green jobs" will be 1) far less productive, 2) largely in China, and 3) cause job losses in other industries via skyrocketing energy prices. Specifically:[250]

- Reason #1 why Biden's energy policies will destroy productive US jobs: "green jobs" are far less productive than the fossil fuel jobs that Biden is destroying–so they cannot possibly pay as well. The only way well-paying jobs are sustainable in the long-term is if they are highly productive. For example, the reason US oil-and-gas extractions jobs pay very well is that they produce an average of $2 million per worker annually. Nothing in wind or solar can compare. Workers involved in generating electricity from natural gas and coal produce nine times more electricity per person* than workers generating electricity from wind and solar. And the fossil fuel electricity, unlike solar and wind, is highly reliable.
- Reason #2 why Biden's energy policies will destroy productive US jobs: "green jobs" mostly exist in China, which has a huge competitive advantage in mining, processing, and manufacturing. The main jobs involved in solar and wind energy are mining jobs (to get the raw materials), processing jobs (to transform the raw materials into valuable form) and manufacturing jobs (to make solar panels and wind turbine components). Those jobs exist largely in China. China's dominance of "green energy" is due to a combination of vices (low environmental standards, human rights abuses) and virtues (lower energy costs, valuing mining and manufacturing). The anti-mining, anti-fossil fuel Biden administration will make us even less competitive.
- Reason #3 why Biden's energy policies will destroy productive US jobs: by making American energy unaffordable and unreliable, it will destroy American industry and with it, American jobs. The biggest cost of "green jobs" is unaffordable and unreliable energy. Because unreliable solar and wind can't replace our reliable power plants, they always add costs to the grid. And if we try, like CA and TX, to cut costs by closing reliable power plants, we get blackouts. Germany, which gets 1/3 of its electricity from solar and wind, provides a mild preview of the Biden Plan. Germans have seen their electricity prices double in 20 years thanks to wasteful, unreliable solar and wind. Their electricity prices are 3X our already-too-high prices. By driving up industrial energy costs, Biden's "green energy jobs" will make every American-made product more expensive and every American company less competitive. That means more productive jobs lost to other countries where energy costs less and is more reliable.

[250]https://energynow.com/2021/04/commentary-the-truth-about-green-energy-jobs-alex-epstein/.

Epstein thus concludes that Biden's "green energy jobs" will cause "green joblessness" throughout the economy, with those connected to the fossil fuel industry being hardest hit. The Global Energy Institute estimates that a fracking ban alone "would eliminate 19 million jobs."[251] He thus concludes "Biden's energy plan will create a handful of unproductive 'green energy jobs' that, by making American energy unreliable and unaffordable, will cause mass "green joblessness" in not just the fossil fuel industry but in every other industry as well."[252]

Marc Hafstead and Rob Williams

Marc Hafstead and Rob Williams concluded from their work on modeling the impact of environmental regulations on the labor market to demonstrate the strengths and weaknesses of current economic modeling related to jobs and environmental policy. They derived six key takeaway lessons for policy from the research:[253]

1. Policymakers should be very cautious about relying on empirical job estimates or simulation modeling of job effects when making policy decisions. Partial-equilibrium empirical studies are likely to be seriously biased. And most general-equilibrium studies use full-employment models, which cannot credibly model effects on jobs. They would argue for caution with the results from our own modeling and caution that it represents a substantial advance, but much more research is necessary, given important model sensitivities.
2. The effects of environmental policy on overall employment are likely to be small, especially in the long run. Even the short-run effects of economy-wide environmental policy are much smaller in magnitude and/or duration than typical business-cycle variation in employment and unemployment.
3. Environmental policy can cause substantial job reallocation: Fewer jobs in some industries and more jobs in others. In many cases, this reallocation will primarily involve reduced hiring in the industries that are negatively affected. But depending on the scale, scope, and speed of implementation of the policy, it may involve layoffs as well. This can have important effects on workers in industries that lose jobs, even if the overall employment effect is insignificant.
4. Different types of environmental policy have different impacts on the labor market. For a given level of emissions reductions, they found that emissions pricing (such as a carbon tax) has a lower overall cost and leads to higher long-run employment than intensity standards (such as renewable energy or clean energy standards). However, they also found that these intensity standards lead to less job reallocation, which may make them more appealing to policymakers. And, all else equal, less reallocation will generally imply lower short-term unemployment.

[251]https://www.globalenergyinstitute.org/sites/default/files/2019-12/hf_ban_report_final.pdf.
[252]https://energynow.com/2021/04/commentary-the-truth-about-green-energy-jobs-alex-epstein/.
[253]Jobs and Environmental Regulation (rff.org).

5. Both the scope and scale of environmental policy are an important determinant of short-term labor market effects (on unemployment, etc.), but are less important for long-term effects. Accommodating small amounts of job reallocation with minimal disruption is relatively easy due to normal job turnover, but that becomes more and more difficult as the amount of reallocation grows.
6. Preannouncements and phase-ins can substantially reduce short-term labor-market effects by allowing more time for the necessary reallocation to occur. While such preannouncements and phase-ins will often reduce overall economic efficiency, the reduced short-term labor-market disruption may have substantial distributional benefits.

They thus conclude that "Political conversations about whether environmental regulations kill or create jobs often miss the mark. Our paper sheds light on how environmental policies interact with the labor market, but our analysis is unable to address a broad range of questions often raised by policymakers: more economic research is necessary to build a better understanding about how new environmental policies will actually impact jobs and labor markets."[254]

Heritage Foundation

The Heritage Foundation analyzed the Waxman-Markey bill and estimated that it would cause a loss of 1,145,000 jobs. These are net job losses, after any "new" green jobs are taken into account.[255]

Heritage contended that real world experience confirms this: Governments that subsidize or mandate green jobs reap fewer overall jobs and a weaker economy. It noted that green job advocates once emphasized Spain's aggressive alternative energy policy as a model for the U.S. America. However, in reality, Spain's green-jobs program should serve as a warning.

Unemployment in Spain reached 18 percent, nearly twice that of the U.S. Gabriel Calzada, economics professor at Madrid's King Juan Carlos University, estimated that each green job Spain creates prevents 2.2 other jobs from being created.[256] The Danish think-tank CEPOS recently studied wind energy in Denmark, another oft-cited model for America. CEPOS found than each wind energy job there costs the government $90,000 to $140,000 annually -- much more than the jobs pay.[257] Nor are these jobs sustainable. Once the government handouts end, so do the jobs.

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[254]Ibid.
[255]https://www.heritage.org/environment/commentary/green-job-subsidies-will-destroy-far-more-jobs-they-create.
[256]https://instituteforenergyresearch.org/wp-content/uploads/2015/05/090327-employment-public-aid-renewable.pdf; http://www.windaction.org/posts/26329-gabriel-calzada-alvarez-speaks-to-the-u-s-congress- about -green-jobs#.YWWuwNrMK70.
[257]http://www.windaction.org/posts/22149-wind-energy-the-case-of-denmark#.YWWvutrMK70.

According to Heritage, the same lesson can be seen in the U.S. California has led the states in pursuing a green jobs agenda and environmentalists often cite it as a model for the rest of the nation. However, California also stands out as having higher unemployment and energy costs and a weaker economy than nearly every other state.

Thus, Heritage concluded "Waxman-Markey would take the nation down the same job-killing path. Some jobs would be destroyed entirely. Others would be outsourced to nations that don't drink the cap-and-trade Kool-Aid."[258]

Institute for Energy Research

The Institute for Energy Research contends that Europe's policy and strategy for supporting the so-called "green jobs" or renewable energy dates back to 1997, and has become one of the principal justifications for U.S. "green jobs" proposals. However, an examination of Europe's experience reveals these policies to be terribly economically counterproductive.[259] The Spanish experience is considered a leading example to be followed by many policy advocates and politicians. This study marks the very first time a critical analysis of the actual performance and impact has been made. Most important, it demonstrates that the Spanish/EU-style "green jobs" agenda now being promoted in the U.S. in fact destroys jobs, detailing this in terms of jobs destroyed per job created and the net destruction per installed MW. The study's results demonstrate how such "green jobs" policy clearly hinders Spain's way out of the current economic crisis, even while U.S. politicians insist that rushing into such a scheme will ease their own emergence from the turmoil. The following are key points from the study:[260]

1. Spain provides a reference for the establishment of government aid to renewable energy. No other country has given such broad support to the construction and production of electricity through renewable sources. The arguments for Spain's and Europe's "green jobs" schemes are the same arguments now made in the U.S., principally that massive public support would produce large numbers of green jobs. The question that this paper answers is "at what price?"

2. We find that for every renewable energy job that the State manages to finance, Spain's experience cited by President Obama as a model reveals with high confidence, by two different methods, that the U.S. should expect a loss of at least 2.2 jobs on average, or about 9 jobs lost for every 4 created, to which we have to add those jobs that non-subsidized investments with the same resources would have created.

[258]https://www.heritage.org/environment/commentary/green-job-subsidies-will-destroy-far-more-jobs-they-create.
[259]https://instituteforenergyresearch.org/wp-content/uploads/2015/05/090327-employment-public-aid-renewable.pdf.
[260]Ibid.

3. Therefore, while it is not possible to directly translate Spain's experience with exactitude to claim that the U.S. would lose at least 6.6 million to 11 million jobs, as a direct consequence were it to actually create 3 to 5 million "green jobs" as promised (in addition to the jobs lost due to the opportunity cost of private capital employed in renewable energy), the study clearly reveals the tendency that the U.S. should expect such an outcome.

4. At minimum, therefore, the study's evaluation of the Spanish model cited as one for the U.S. to replicate in quick pursuit of "green jobs" serves a note of caution, that the reality is far from what has typically been presented, and that such schemes also offer considerable employment consequences and implications for emerging from the economic crisis.

5. Despite its hyper-aggressive (expensive and extensive) "green jobs" policies it appears that Spain likely has created a surprisingly low number of jobs, two thirds of which came in construction, fabrication and installation, one quarter in administrative positions, marketing and projects engineering, and just one out of ten jobs has been created at the more permanent level of actual operation and maintenance of the renewable sources of electricity.

6. This came at great financial cost as well as cost in terms of jobs destroyed elsewhere in the economy.

7. The study calculates that since 2000 Spain spent €571,138 to create each "green job", including subsidies of more than €1 million per wind industry job.

8. The study calculates that the programs creating those jobs also resulted in the destruction of nearly 110,500 jobs elsewhere in the economy, or 2.2 jobs destroyed for every "green job" created.

9. Principally, the high cost of electricity affects costs of production and employment levels in metallurgy, non-metallic mining and food processing, beverage and tobacco industries.

10. Each "green" megawatt installed destroys 5.28 jobs on average elsewhere in the economy: 8.99 by photovoltaics, 4.27 by wind energy, and 5.05 by mini-hydro.

11. These costs do not appear to be unique to Spain's approach but instead are largely inherent in schemes to promote renewable energy sources.

Bjourn Lomborg

Bjourn Lomborg contends that the major problem in green jobs analyses is that they often fail to recognize the higher costs or job losses that these policies will cause. Alternative energy sources such as solar and wind create significantly more expensive

fuel and electricity than traditional energy sources.[261] Increasing the cost of electricity and fuel will hurt productivity, reduce overall employment, and reduce disposable income. Nevertheless, many studies used by advocates of green jobs have not addressed these costs at all -- overlooking both the cost of investment and the price hikes to be faced by end users.

He argues that the companies calling for political intervention to create green jobs tend to be those that stand to gain from subsidies and tariffs. But, because these policies increase the cost of fuel and electricity, they imply layoffs elsewhere, across many different economic sectors. Once these effects are taken into account, the purported increase in jobs is typically wiped out, and some economic models show lower overall employment. Despite a significant outlay, government efforts to create green jobs could end up resulting in net job losses.

Proponents might argue that even if that is true, investment in green jobs is nonetheless a good way to stimulate a sluggish economy. But there are many other economic sectors, such as health care, that could actually create more jobs for the same amount of government investment.

In addition to job creation, some researchers have claimed that all sorts of other economic benefits will accrue from investment in alternative energy, including increased productivity, higher disposable incomes, and lower operating costs for businesses. However, Lomborg concludes that the assertions are "not backed up by any evidence and are inconsistent with the realities of green technologies and energy markets."[262]

The fundamental problem is that green-energy technologies are still very inefficient and expensive compared to fossil fuels. Deploying less efficient, more expensive alternative-energy sources will hurt businesses and consumers, not help them. Lomborg states that in order for the whole planet to make a sustainable shift away from fossil fuels, we need to make low-carbon energy both cheaper and more efficient. That requires a substantial increase in research and development into next-generation green-energy alternatives. Current research budgets are tiny, and that desperately needs to change. In the meantime, he concludes that the public should be cautious of politicians' claims that deploying existing inefficient, expensive technology will result in windfall benefits at no cost.

Michael Lynch

Michael Lynch contends that, since green jobs proposals requires extensive expenditures and subsidies it seems counter-intuitive that argue that they might not create jobs. The answer usually involves the difference between microeconomics and macroeconomics or, more simply, gross versus net jobs. Spending money to hire workers

[261]https://economictimes.indiatimes.com/green-jobs-propaganda-fails-to-meet-economic-reality/articleshow/7512576.cms?from=mdr.
[262]Ibid.

creates jobs, but taking money out of the broader economy to pay for them destroys jobs.[263]

Spending taxpayer money to support, for example, the building of solar power farms will create the jobs involved in the manufacture and installation of the solar panels, which is what advocates of such policies typically focus on. These jobs are easy to measure after the fact, and can be estimated beforehand with a degree of confidence: X dollars spent on labor, divided by Y cost of labor, equals N jobs. But the impact on the broader economy of taking money from taxpayers and customers to pay for those jobs is less visible and the impact often ignored.

For all the talk of how cheap renewable energy is, the fact remains that government support has been vital in the growth of solar and wind in most instances, and investment in those energies has tended to fall sharply when support was reduced or ended. The implication is that the overall economy suffers from spending on renewables, as most projects create energy at above-market prices, something all too often glossed over or misrepresented. Simply put, it means less money in the economy.

And the net change can muddy the fact that there are losses as well as gains, plus costs related to the transition. "The simplistic view is that you can wipe out coal mining jobs but replace them with renewable energy (construction) jobs and we'll all be better off. But that assumes a seamless, frictionless transition from one industry and job to another. Life is not a video game, where a lost character just reappears at another site. There's a cost to move West Virginian miners to Montana to build wind turbines."[264]

In 2018, FTI consulting published a report trying to parse out the effects of such a program, and the results are illuminating.[265] It concluded that the first four years would see an employment loss of about 0.5%, several years of minimal impact, and three years of nearly 1% extra employment. This would seem a quite reasonable result, reflecting the costs of transition from such a program, and the Biden infrastructure proposal would probably have a similar impact.

He concludes that "Needless to say, there are many other complicating factors involved, but the general principles are sound even if the details are somewhat uncertain."[266]

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[263]https://www.forbes.com/sites/michaellynch/2021/04/06/the-bad-economics-beyond-green-job-creation/?sh=4daaac78551f.
[264]Ibid.
[265]https://www.remi.com/wp-content/uploads/2018/10/The-Economic-Fiscal-and-Emissions-Impacts-of-a-Revenue-Neutral-Carbon-Tax.pdf.
[266]https://www.forbes.com/sites/michaellynch/2021/04/06/the-bad-economics-beyond-green-job-creation/?sh=4daaac78551f.

Morriss, Bogart, Dorchak, and Meiners

Andrew Morriss, William Bogart, Andrew Dorchak, and Roger Meiners contended that the analysis provided in the green jobs literature is deeply flawed, resting on a series of myths about the economy, the environment, and technology. They assessed the problems in the green jobs analysis in depth and concluded by summarizing the mythologies of green jobs in seven myths about green jobs:[267]

- *Myth 1: There is such a thing as a "green job."* There is no coherent definition of a green job. Green jobs appear to be ones that pay well, are interesting to do, produce products that environmental groups prefer, and do so in a unionized workplace. Yet such criteria have little to do with the environmental impacts of the jobs. To build a coalition for a far reaching transformation of modern society, "green jobs" have become a mechanism to deliver something for every member of a real or imagined coalition to buy their support for a radical transformation of society.

- *Myth 2: Creating green jobs will boost productive employment.* Green jobs estimates include huge numbers of clerical, bureaucratic, and administrative positions that do not produce goods and services for consumption. Simply hiring people to write and enforce regulations, fill out forms, and process paperwork is not a recipe for creating wealth. Much of the promised boost in green employment turns out to be in non-productive (but costly) positions that raise costs for consumers.

- *Myth 3: Green jobs forecasts are reliable.* The forecasts for green employment optimistically predict an employment boom, which is welcome news. Unfortunately, the forecasts, which are sometimes amazingly detailed, are unreliable because they are based on questionable estimates by interest groups of tiny base numbers in employment, extrapolation of growth rates from those small base numbers, and a pervasive, biased, and highly selective optimism about which technologies will improve. Moreover, the estimates use a technique (input-output analysis) that is inappropriate to the conditions of technological change presumed by the green jobs literature itself. This yields seemingly precise estimates that give the illusion of scientific reliability to numbers that are simply the result of the assumptions made to begin the analysis.

- *Myth 4: Green jobs promote employment growth.* Green jobs estimates promise greatly expanded (and pleasant and well-paid) employment. This promise is false. The green jobs model is built on promoting inefficient use of labor, favoring technologies because they employ large numbers rather than because they make use of labor efficiently. In a competitive market, factors of production, including labor, earn a return based on productivity. By focusing on low labor productivity

[267]https://leeds-faculty.colorado.edu/bhagat/green-jobs-myth.pdf.

jobs, the green jobs literature dooms employees to low wages in a shrinking economy. Economic growth cannot be ordered by Congress or by the U.N. Interference in the economy by restricting successful technologies in favor of speculative technologies favored by special interests will generate stagnation.

- *Myth 5: The world economy can be remade based on local production and reduced consumption without dramatically decreasing human welfare.* The green jobs literature rejects the benefits of trade, ignores opportunity costs, and fails to include consumer surplus in welfare calculations to promote its vision. This is a recipe for an economic disaster, not an ecotopia. The twentieth century saw many experiments in creating societies that did not engage in trade and did not value personal welfare. The economic and human disasters that resulted should have conclusively settled the question of whether nations can withdraw into autarky. The global integration of wind turbine production, for example, illustrates that even green technology is not immune from economic reality.

- *Myth 6: Mandates are a substitute for markets.* Green jobs proponents assume that they can reorder society by mandating preferred technologies. But the responses to mandates are not the same as the responses to market incentives. There is powerful evidence that market incentives induce the resource conservation that green jobs advocates purport to desire. The cost of energy is a major incentive to redesign production processes and products to use less energy. People do not want energy; they want the benefits of energy. Those who can deliver more desired goods and services by reducing the energy cost of production will be rewarded. There is little evidence that successful command and control regimes accomplishing conservation.

- *Myth 7: Wishing for technological progress is sufficient.* The preferred technologies in the green jobs literature face significant problems in scaling up to the levels proposed. These problems are documented in readily available technical literatures, but resolutely ignored in the green jobs reports. At the same time, existing technologies that fail to meet the green jobs proponents political criteria are simply rejected out of hand. This selective technological optimism/pessimism is not a sufficient basis for remaking society to fit the dream of planners, politicians, patricians, or plutocrats who want others to live lives they think other people should be forced to lead.

They concluded that to transform modern society on the scale proposed by even the most modest bits of the green jobs literature is an effort of staggering complexity and scale. To do so based on the combination of wishful thinking and bad economics embodied in the green jobs literature would be the height of irresponsibility. Thus, “We have no doubt that there will be significant opportunities to develop new energy sources, new industries, and new jobs in the future. Just as has been true for all of human history thus far, we are equally confident that a market-based discovery process will do a far

better job of developing those energy sources, industries, and jobs than could a series of mandates based on imperfect information."[268]

III.C. Assessment: Net Jobs Increase or Decrease?

Extensive review of the literature reveals that there are a large number of studies contending both that environmental regulations and green initiatives create substantial numbers of jobs and just the opposite – that they destroy jobs or create negative net jobs. So, what is the reality? Several points are worth noting.

First, as usual in economic or policy debates, it is largely a case of whose study or research do we wish to cite. Many of the studies' results can be anticipated by the source or funder of the research. Thus:

- It is hardly surprising that research from organizations such as the Apollo Alliance, the Center for American Progress, PERI, the Blue Green Alliance, the Green Jobs for America Campaign, NRDC, IGSD, WRI, NCE, ITCU, UCS, and similar organizations find that environmental and green initiatives are net job creators.
- Similarly, it is not surprising that the Global Energy Institute, the Heritage Foundation, BHI, IER, the American Petroleum Institute, the Competitive Enterprise Institute, the American Enterprise Institute, and similar organizations conclude that environmental and green initiatives are net job destroyers.

Nevertheless, rigorous review of the existing research indicates that investments in environmental and green economy programs will likely have substantial net positive impacts on the economy, energy, jobs, and employment. There are important caveats:

- The jobs impacts of different types of green programs and initiatives vary markedly.
- Poorly designed or implemented green initiatives can have harmful economic, energy, and jobs impacts.
- It is not necessarily true that any single green program will have positive economic or jobs impacts compared to any alternative use of the funds – it depends critically on the types of programs being compared.

However, more basically the net jobs issue is largely a red herring. Very often environmental and green spending programs are given much more scrutiny with respect to net economic or jobs impacts than are other types of programs -- especially by those skeptical of such program. For example:

- Numerous studies of the economic and jobs impacts of DOD spending have been conducted. These find that DOD spending invariable creates huge positive local, state, and national benefits. However, very rarely if ever do any of these studies try to determine if equivalent expenditures on other programs – such as, for

[268] Ibid.

example, housing, health care, education, or environmental programs -- would have created larger benefits.[269]

- Numerous studies have found that government RD&D is a classic public good, that the benefit cost ratio of this RD&D is high, and that it creates very favorable economic and jobs benefits. However, very rarely if ever do any of these studies try to determine if equivalent expenditures on other programs – such as, for example, housing, health care, education, or environmental programs -- would have larger benefits.[270]
- When a local government wishes to build a new convention center, sports stadium, or commercial or industrial facility it invariably produces a study estimating the tremendous economic and employment benefits that would result from the project. However, very rarely if ever do any of these studies try to determine if equivalent expenditures on other programs – such as, for example, housing, health care, education, or environmental programs -- would have larger benefits.[271]
- During the 2021 U.S. Congressional debate over the infrastructure bill, the "Infrastructure Investment and Jobs Act," many competing estimates were quoted of the economic benefits and large numbers of jobs that would be created from such spending.[272] However, little discussion was given to whether, equivalent

[269]See, for example, https://www.ncsl.org/research/military-and-veterans-affairs/military-s-impact-on-state-economies.aspx; https://www.whiteman.af.mil/Portals/53/documents/Economic%20Impact%20Statements/FY19%20Economic%20Impact%20Report.pdf?ver=2020-07-22-134515-417; https://www.hrpdcva.gov/uploads/docs/Economic%20Impact%20of%20the%20DoD%20in%20Hampton%20Roads-%20DRAFT.pdf; https://www.rand.org/content/dam/rand/pubs/research_reports /RR1100/RR1119/RAND_RR1119.pdf.

[270]See, for example, Jeff Dowd, "Aggregate Economic Return on Investment in the U.S. DOE, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, October 2017; https://energy.gov/sites/prod/files/2015/05/f22/evaluatingrealized_rd_mpacts 9-22-14.pdf; Michael Gallaher, Troy Scott, Zachary Oliver, Kyle Clark-Sutton, and Benjamin Anderson, "Benefit-Cost Evaluation of U.S. Department of Energy Investment in HVAC, Water Heating, and Appliance Technologies," RTI International, September 2017; Albert N. Link, Alan C. O'Connor, Troy J. Scott, Sara E. Casey, Ross J. Loomis, and J. Lynn Davis, "Benefit-Cost Evaluation of U.S. DOE Investment in Energy Storage Technologies for Hybrid and Electric Cars and Trucks," RTI International, December 2013; A. O'Connor, R. Loomis, and F. Braun, "Retrospective Benefit-Cost Evaluation of DOE Investments in Photovoltaic Energy Systems," RTI International, August 2010; M. Gallaher, A. Rogozhin, and J. Petrusa, "Retrospective Benefit-Cost Analysis of U.S. DOE's Geothermal Technologies R&D Program Investments," RTI International, August 2010; Tom Pelsoci, "Retrospective Benefit-Cost Evaluation of U.S. DOE Wind Energy R&D Program: Impact of Selected Energy Technology Investments," Delta Research Co., June 2010; Al Link, "Retrospective Benefit-Cost Evaluation of U.S. DOE Vehicle Combustion Engine R&D Program: Impacts of a Cluster of Energy Technologies," prepared for the U.S. Department of Energy, May 2010; Jeffrey Rissman and Hallie Kennan, "Case Studies on the Government's Role in Energy Technology Innovation: Advanced Diesel Internal Combustion Engines," American Energy Innovation Council, March 2013; Chris Coons, "R&D is Essential For Boosting the American Economy," *The Hill*, July 11, 2017; Kimberly Amadeo, "NASA Budget, Current Funding, History, and Economic Impact, *The Balance*, February 27, 2020.

[271]See https://www.brookings.edu/articles/sports-jobs-taxes-are-new-stadiums-worth-the-cost/.

[272]https://www.reuters.com/world/us/democratic-divide-over-spending-priorities-tests-bidens-deal-making-skills-2021-10-19/; https://www.congress.gov/bill/117th-congress/house-bill/3684.

expenditures on other programs – such as, for example, housing, health care, education, or environmental programs -- would have larger benefits.[273]

Spending $1 billion, $100 billion, or $1 trillion on green initiatives will have large economic impacts and will create large numbers of jobs. Of course, investments of these magnitudes in almost anything will also create large numbers of jobs. Nevertheless, the bottom line is that the balance of research indicates that investments in environmental and green programs have favorable net positive economic and jobs benefits. At least as important though, the net positive economic and jobs impacts, while significant and powerful for policy purposes, should not blind us to the fact that the major purpose and rationale for these programs are the energy and environmental and benefits they will create. The cart should not be put before the horse: The energy and environmental and benefits are the reason these programs are necessary and desirable. Jobs benefits are an important secondary benefit, and should be evaluated as such.

[273]Upon passage of the bill, President Biden stated "Jobs will be created, the vast majority of which would not require a college degree. This is a blue-collar blueprint to rebuild America." https://www.washingtonpost.com/politics/2021/11/08/here-comes-biden-infrastructure-pr-blitz/.

IV. ESTIMATING THE U.S. GREEN ECONOMY AND GREEN JOBS

IV.A. Recent Estimates of U.S. Green Jobs

There are five recent estimates of U.S. green jobs available from:

- A. Bowen, K. Kuralbayeva, and E.L. Tipoec.
- E2/USEER.
- Environmental and Energy Study Institute.
- Lucien Georgeson and Mark Maslin.
- MISI.

These are summarized below.

IV.A.1. Bowen, Kuralbayeva, and Tipoec

In 2018, Bowen, Kuralbayeva, and Tipoec (BKT) estimated the share of U.S. jobs that would benefit from a transition to the green economy, and presented different measures for the ease with which workers are likely to be able to move from non-green to green jobs. They found that 19.4% of U.S. workers are currently part of the green economy in a broad sense, although a large proportion of green employment is indirectly green.[274] U.S. employment in 2018 was 155.8 million, and thus the BKT estimate implies that about 30.2 million of these jobs were green.

BKT contended that green jobs vary in "greenness," with few jobs consisting only of green tasks, suggesting that "green" should be considered a continuum rather than a binary characteristic. They found that while it is easier to transition to indirectly green rather than directly green jobs, greening is likely to involve transitions on a similar scale and scope of existing job transitions. Non-green jobs differ from their green counterparts in only a few skill-specific aspects, suggesting that most re-training can happen on-the-job. BKT found that the green economy offers a large potential for short-run growth.[275]

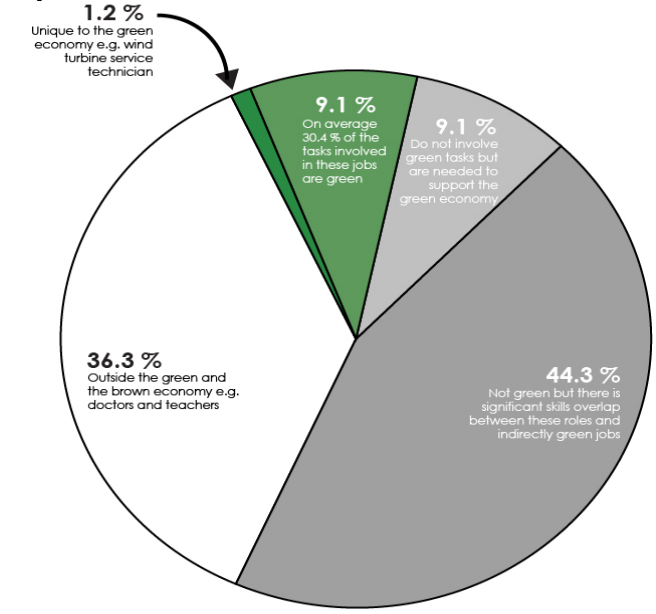
They used data on the U.S. job market to estimate how many green jobs there are in the U.S. workforce and, for those jobs which are not green, how the transition to a low-carbon economy could affect them. They noted that BLS estimated that in 2011 2.6% of the U.S. workforce was employed in the production of green goods and services. These jobs reduce fossil fuel usage, decrease pollution and greenhouse gas emissions, involve recycling materials, increasing energy efficiency, or the development of renewable energy sources.

[274]A. Bowen, K. Kuralbayeva, and E.L. Tipoec, "Characterising Green Employment: The Impacts of "Greening" on Workforce Composition," *Energy Economics*, https://doi.org/10.1016/j. eneco.2018.03. 015.
[275]Ibid.

However, BKT estimated that the actual number of workers in jobs already supporting the green economy is much higher. Using BLS data from 2014 and from the U.S. department of Labor's Occupational Network Database (O*NET), they found that there is a spectrum of green jobs. Most estimates of green jobs only include occupations which are unique to the green economy, for example wind turbine service technicians or solar photovoltaic installers. BKT analyzed the O*NET data and found that there are many occupations which involve some green tasks but are usually excluded from estimates of green jobs.

BKT estimated that 1.2% of U.S. jobs is unique to the green economy. On average, 59.4% of the tasks involved in these jobs are 'green tasks' as defined by data from the O*NET dataset, which assesses the types of tasks involved in 858 (out of 974) U.S. occupations and how often the tasks are carried out. An additional 9.1% of the workforce are performing green tasks in their jobs but less often: For example workers who are urban and regional planners or refuse and recyclable material collectors. On average, 30.4% of the tasks carried out in these jobs are green. When BKT included all jobs in which workers are currently undertaking at least one green task per year they estimated that 10.3% of current U.S. jobs are "green" – Figure IV-1.[276]

Figure IV-1
Proportion of the U.S. Workforce That is Green



Source: Bowen, Kuralbayeva, and Tipoec

Their analysis estimated that a further 9.1% of the U.S. workforce are in jobs which will be necessary to support the green economy but which do not directly support green tasks, and they labeled these "indirectly green jobs." For example, financial analysts

[276]Ibid.

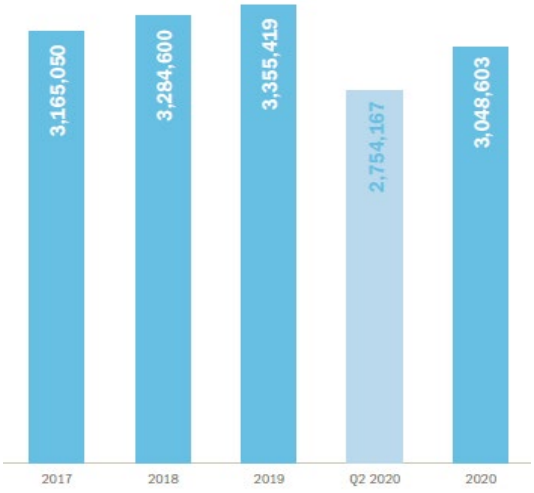
might forecast or analyze financial costs of climate change, identify environmentally-sound financial investments, and recommend environmentally-related financial products. These jobs do the behind-the-scenes work that contributes to green economic activity.

It is difficult to determine how many of the workers in this category are currently supporting the green economy. However, BKT concluded that these workers should be able to transition to working in jobs which support the green economy with little retraining since they will not need any new skills.[277]

IV.A.2. E2/USEER

E2, using primarily USEER data, estimated that in 2020, the number of clean energy jobs in the U.S. declined for the first time since it began tracking nationwide employment across the entire clean energy sector in 2015 – Figure IV-2.[278] Amid the COVID-19 pandemic and related economic contraction and the lingering impacts of policies from the previous administration that encouraged fossil fuels over clean energy, nearly 307,000 jobs were lost in wind, solar, energy efficiency and other clean energy sectors.

Figure IV-2
U.S. Clean Energy Employment by Year 2017–2020



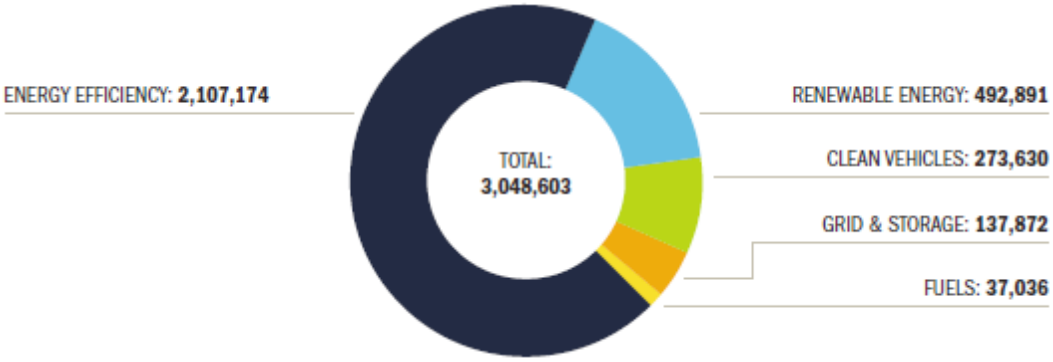
Source: E2.

E2 estimated that about 3 million Americans worked in clean energy at the end of 2020, down from 3.36 million the year before – Figure IV-3.[279] Further:

[277]Ibid.
[278]E2, "Clean Jobs America 2021," https://e2.org/reports/clean-jobs-america-2021/.
[279]Based on E2's analysis of BLS data and the findings of a national survey of more than 35,000 businesses across the U.S. economy.

- Jobs in energy efficiency, the largest part of the U.S. energy sector, decreased the most, falling more than 11 percent from 2019 as COVID-19 pandemic restrictions prevented energy efficiency workers from entering commercial and residential buildings.
- Wind energy employment increased slightly, while solar employment fell, driven by declines in residential solar sales and installation which were hit hard early in the pandemic and could not fully recover despite growth in the second part of the year.
- Overall, renewable energy jobs fell by nearly 6 percent.
- Jobs in grid modernization, battery, and storage occupations declined nearly 7 percent after two years of rapid growth driven by growing demand in batteries for electric vehicles and commercial and residential energy storage.
- Clean vehicle manufacturing jobs defied overall energy sector job loss patterns and grew nearly 3 percent as automakers increasingly shifted to cleaner and more efficient electric cars, trucks and buses. Electric and hybrid electric vehicle employment grew more than six percent adding over 12,000 new jobs in 2020, the largest increase of any clean energy category.

Figure IV-3
U.S. Clean Energy Employment by Sector 2020



Source: E2.

Despite the overall decline, E2 found that clean energy remains the largest job creator across America's energy sector, employing nearly three times as many workers as work in fossil fuel extraction and generation. More Americans still work in clean energy than work as middle and elementary school teachers, bankers, farmers or real estate agents. Median hourly wages for clean energy jobs also are about 25 percent higher than the national median wage, and also pay better than most fossil fuel extraction jobs.

California, Texas, New York, and Florida remain the nation's leaders for clean energy jobs, but smaller states such as Illinois, Massachusetts, Michigan, and Ohio all employed more than 100,000 clean energy workers each at the end of 2020.[280]

[280]"Clean Jobs America 2021," op. cit.

E2 includes jobs in solar energy, wind energy, combined heat and power, bioenergy, non-woody biomass, low-impact hydro power, geothermal, clean vehicle technologies, clean energy storage, smart grid, micro grid, grid modernization, advanced biofuels, and energy efficiency including ENERGYSTAR and high efficiency appliances, efficient lighting, HVAC, renewable heating and cooling, and advanced building materials. The clean energy occupations covered in this report span economic sectors including construction, manufacturing, wholesale trade, transmission and distribution, and professional services.[281]

E2 excludes jobs of workers who may spend some of their time in clean energy but a plurality in another energy sector. For example, workers employed by an excavation business might spend the majority of their time grading and preparing drilling pads for oil or gas rigs, but they also might spend a portion of their time preparing sites for wind turbines or large solar installations. If clean energy does not account for a plurality of their work, those workers would not be counted as being employed in the clean energy economy but would instead be counted as part of another energy sector. E2 also does not include jobs in corn ethanol, woody biomass, large hydropower, and nuclear because of environmental issues associated with those industries. Jobs in retail trade, repair services, water or waste management, and indirect employment or induced employment are also not included.

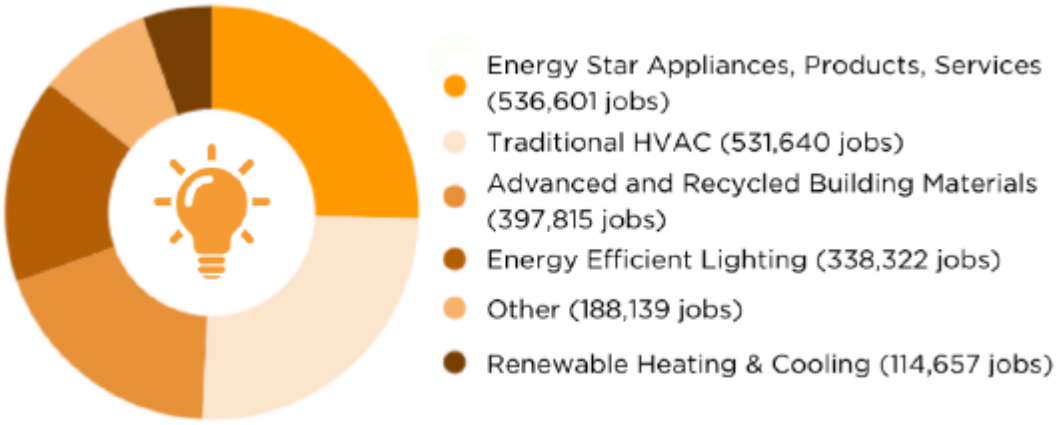
IV.A.3. Environmental and Energy Study Institute

The Environmental and Energy Study Institute (EESI) contends that responding to the climate crisis provides an immense opportunity for job creation and terms those jobs -- jobs that help mitigate and adapt to climate change -- are climate jobs.[282] It estimates that in recent years, climate jobs have been on the rise in the U.S. However, the economy-wide impacts of the COVID-19 pandemic affected climate employment and EESI estimated that 8% of climate jobs were lost in 2020.[283] Despite this, employment in some climate industries increased in 2020, and many climate jobs are expected to recover in 2021. ESSI estimates that, in total, there were over 4.1 million climate jobs in 2020.[284]

ESSI estimates that energy efficiency supported 2.1 million jobs in 2020 – Figure IV-4. This includes workers who design, install, distribute, and manufacture energy-efficient products and services. The states with the most energy efficiency jobs in 2020 were California (283,800 jobs), Texas (152,100), New York (121,000), and Florida (108,900). While energy efficiency jobs decreased 11.4 percent in 2020, they are forecast to increase 10% in 2021.

[281]Ibid.
[282]https://www.eesi.org/papers/view/fact-sheet-climate-jobs.
[283]ESSI relied on the USEER reports for most of the estimates.
[284]Ibid.

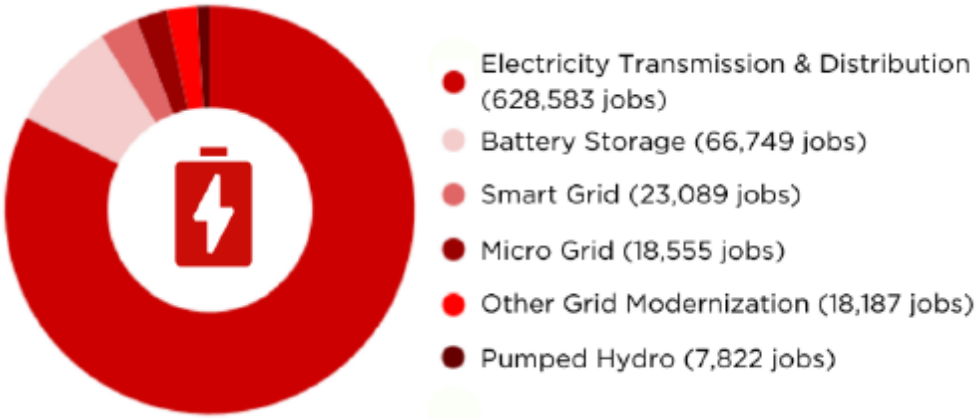
Figure IV-4
Energy Efficiency Jobs



Source: Environmental and Energy Study Institute.

ESSI estimates that energy transmission, distribution, and storage supported 763,000 jobs in 2020 – Figure IV-5. The sector overall lost three percent of its jobs in 2020, but battery storage added 800 jobs. California had the highest energy storage and grid employment (22,600 jobs), with Texas (12,400) and Nevada (9,200) following. In the coming years, transmission, distribution, and storage employment will likely grow to support increased renewable energy connecting to the electric grid.

Figure IV-5
Energy Transmission, Distribution, and Storage Jobs

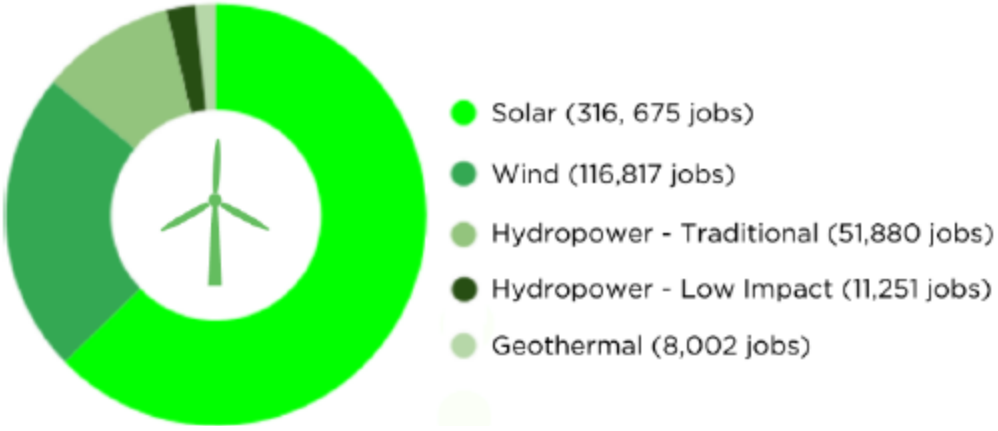


Source: Environmental and Energy Study Institute.

ESSI estimates that renewable energy supported 504,600 jobs in 2020 – Figure IV-6. Employment in the sector decreased by six percent in 2020, but wind energy added 2,000 jobs. EESI contends that significant job growth in renewable energy is anticipated, noting that wind turbine service technicians and solar photovoltaic installers are

projected to be the fastest and third-fastest growing occupations, respectively, across the entire economy in the coming decade.

Figure IV-6
Renewable Energy Jobs



Source: Environmental and Energy Study Institute.

ESSI estimates that clean vehicles supported 261,300 jobs in 2020. This includes about 119,700 jobs in hybrid electric vehicles, 83,700 jobs in electric vehicles, 47,800 jobs in plug-in hybrid vehicles, and 10,000 jobs in hydrogen/fuel cell vehicles. Despite the economic impacts of COVID-19, employment in the hybrid electric and electric vehicle industry increased six and eight percent, respectively, in 2020. Renewable fuels supported 103,000 jobs in 2020. This includes about 33,500 jobs in corn ethanol, 19,500 jobs in other ethanol fuels, 32,400 jobs in woody biomass, and 17,600 jobs in other biofuels. Public transportation agencies supported 435,000 direct jobs in 2018, and every $1 billion invested in public transportation can yield 50,000 jobs.[285]

IV.A.4. Georgeson and Maslin

Lucien Georgeson and Mark Maslin (G&M) estimated the share of jobs in the U.S. that would benefit from a transition to the green economy, and developed different measures for the ease with which workers are likely to be able to move from non-green to green jobs.[286] Using what they termed "transactional triangulation" they measured supply chain activity and full economic impact, but this approach it is not directly comparable to national statistics.

[285]https://www.apta.com/wp-content/uploads/APTA-2020-Fact-Book.pdf.
[286]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/ 22199 27-us-green-economy-has-10-times-more-jobs-than-the-fossil-fuel-industry/.

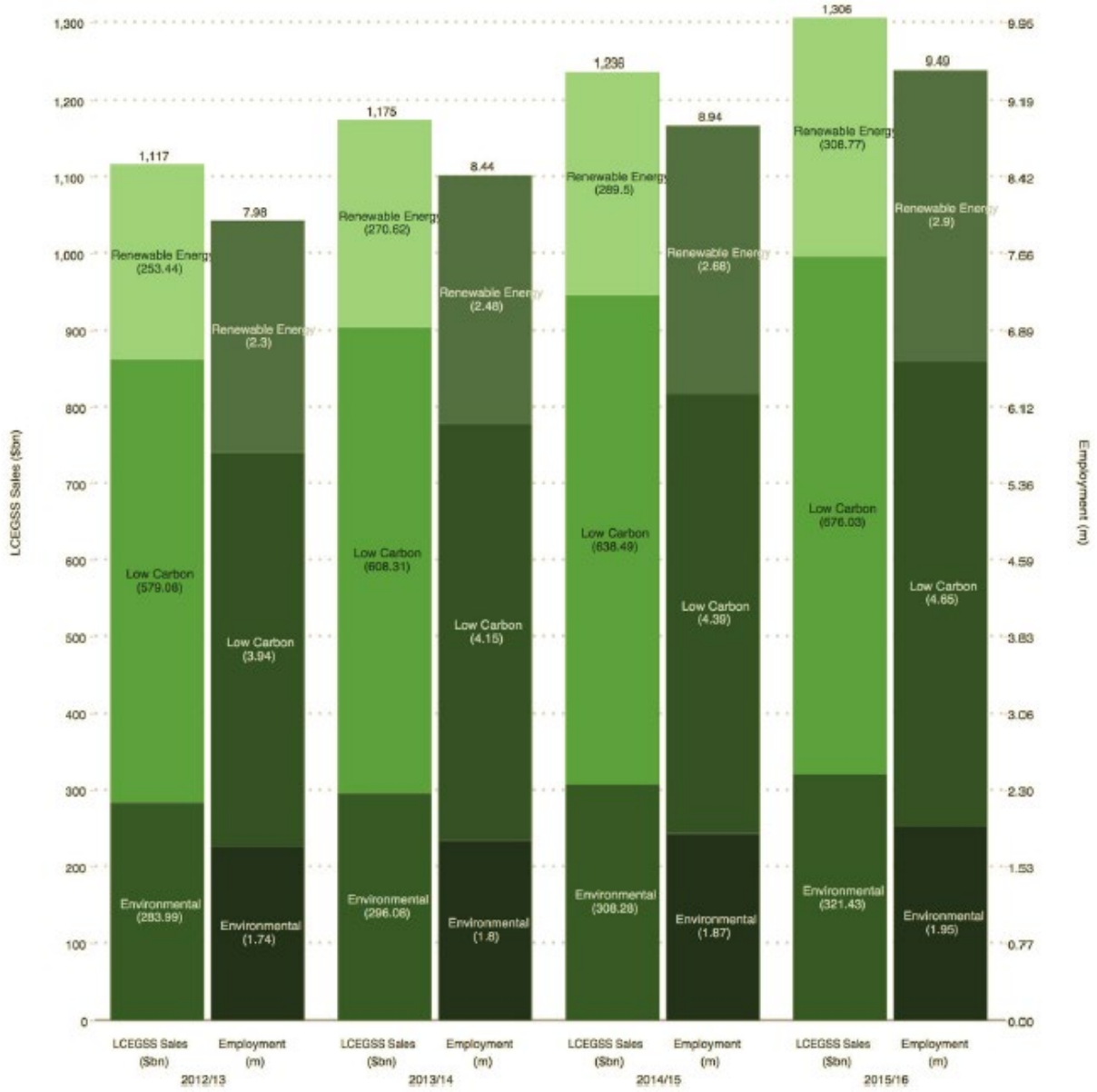
G&M utilized the U.S. O*NET database and its definition of green jobs, and estimated that 19.4% of U.S. workers could currently be part of the green economy in a broad sense, although a large proportion of green employment would be "indirectly" green, comprising existing jobs that are expected to be in high demand due to greening, but do not require significant changes in tasks, skills, or knowledge.[287] Their analysis of task content showed that green jobs vary in "greenness," with very few jobs only consisting of green tasks, suggesting that the term green should be considered a continuum rather than a binary characteristic. While it is easier to transition to indirectly green rather than directly green jobs, greening is likely to involve transitions on a similar scale and scope of existing job transitions. Non-green jobs generally appear to differ from their green counterparts in only a few skill-specific aspects, suggesting that most re-training can happen on-the-job. Network analysis shows that the green economy offers a large potential for short-run growth if job transitions are strategically managed. Their estimated components of the U.S. green economy is illustrated in Figure IV-7.

Using LCEGSS data, G&M estimated that the 2015/2016 U.S. green economy represented $1.3 trillion in annual sales revenue and employed nearly 9.5 million FTEs and that both have grown by over 20% over three years – Figure IV-7. This figure shows the estimation of the U.S. green economy using the LCEGSS definitions for Environmental, Low Carbon and Renewable Energy sectors, for both sales revenue, and jobs estimated in FTEs for the four financial years for which data are available. They estimated that a greater proportion of employment is taken up by Renewable Energy compared to Sales revenue, and this suggests that RE sectors are particularly important for green economy job creation. On the other hand, they concluded that the Environmental sectors, which may be more mature in many cases, deliver a greater amount of revenue per FTE.[288]

Their comparison with China, OECD members, and the G20 countries indicated that the U.S. has a greater proportion of the working age population employed (4%) and higher sales revenue per capita in the green economy. It also demonstrates that other countries have huge potential to develop their green economy and the US needs to develop energy, environmental and educational policies to remain competitive.

[287]Georgeson and Mark Maslin, Ibid.
[288]Ibid.

Figure IV-7
Sales ($ billions) and Employment (FTEs, m) in LCEGSS in the US for financial years 2012/2013 to 2015/16



Source: Georgeson and Maslin.

G&M estimated that LCEGSS in the U.S. increased from $1.1 trillion and 8 million FTEs in 2012/13 to $1.3 trillion and 9.5 million FTEs in 2015/16.[289] This represented about 7% of the U.S. annual GDP. The estimated scale of the green economy ($1.3 trillion and employing over 4% of the working age population) strongly suggests that it is a significant contributor to U.S. economic development and the economic well-being of millions of people across the U.S. It was also a key contributor to the U.S. recovery after

[289]Ibid.

the 2007 financial crisis.[290] Existing federal policies to support the private sector (including clean energy initiatives) have assisted U.S. businesses to grow and create jobs, and the data herein suggests that growth in jobs in the green economy may be faster than growth in estimated sales value in some sectors of the green economy. Economic initiatives and environmental regulations can, potentially, drive innovation and economic development, rather than inhibiting it.[291]

G&M's research indicated that many countries have huge potential to generate higher green employment and growth. Thus, "The economic case for driving economic growth and job creation through fossil fuels has weakened based on the employment estimates in fossil fuels, and there are genuine risks of stranded assets. To safeguard US economic development and job creation, we suggest that economic, environmental and education policies need to be developed to support the U.S. green economy in the context of global developments in the green economy."[292]

G&M contends that their research provides the basis to restart the previously fruitful and important debates regarding how to define and measure the green economy in the US, and the value of doing so to better assess claims made about the green economy and green jobs. They presented a newer, broader definition of the green economy, which includes data estimates of both sales and employment, which has data available for the various subsectors that are included in the LCEGSS taxonomy, and which measures value chain activities. The data therefore have a number of novel characteristics and benefits that give it significant potential to contribute to improving the understanding of how economies are changing and how economic policies could be designed based on alternative data collection processes such as this.[293]

IV.A.5. MISI

MISI estimated U.S. green jobs in 2019 and 2021 and estimated the jobs that would be created by the Green New Deal (GND).[294] The GND is a proposed package of U.S. legislation designed to address climate change, economic inequality, and other issues.[295] In recent years, various proposals for a "Green New Deal" have arisen both in the U.S. and internationally.

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[290]J.E. Aldy, "A Preliminary Assessment of the American Recovery and Reinvestment Act's Clean Energy Package," https://doi.org/10.1093/reep/res014.

[291]See Bezdek, DiPerna, and Wendling, op. cit.; S. Ambec S, M.A. Cohen, S. Elgie, and P. Lanoie, "The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?" https://doi.org/10.1093/reep/res016, and M.E. Porter and C. van der Linde C., "Toward a New Conception of the Environment-Competitiveness Relationship. *Journal of Economic Perspectives*, 9 (4): pp. 97-118."

[292]Georgeson and Mark Maslin, Ibid.

[293]Ibid.

[294]https://www.researchgate.net/publication/344228366_Journal_of_Environmental_Science_and_Renewable_Resources_The_USA_New_Green_Deal_Will_Create_Over_18_Million_Jobs; https://www.researchgate .net/publication/342044233_The_Jobs_Impact_of_the_USA_New_Green_Deal.

[295]The name is derived from the New Deal, a set of social and economic reforms and public works projects undertaken by USA President Franklin Roosevelt in response to the Great Depression of the 1930s. The GND combines Roosevelt's economic approach with contemporary proposals involving environmental

MISI noted that, contrary to general public perception and public policy understanding, in recent decades, green energy and environmental protection have grown rapidly to become a major sales-generating, profit-making, job-creating industry. The size and the job creating potential of the green industry is something that few people are aware of. MISI, estimated that in 2019, U.S. green jobs (direct plus indirect) totaled about 7.8 million and in 2021 totaled about 8.8 million.[296] MISI estimated that the green "industry" currently ranks above the top of the Fortune 500, and MISI estimates that in 2019 the green industry generated $640 billion in total industry sales (2019 dollars) and 7.8 million jobs. For perspective, compared the revenues generated by other industries, this is: About equal to all supermarkets and grocery stores; greater than the construction industry; more than twice the size of the mining industry; 25% greater than Walmart; twice the size of ExxonMobil; more than 2.5 times the size of Apple; 2.75 times the size of Amazon; and four times the size of Ford. Thus, the green industry is currently a major factor in the USA economy and job market.

MISI noted that the GND is not well defined and there are many different versions, and the GND cost has been estimated at anywhere from $2 trillion to $6 trillion and higher. MISI estimates that the GND would cost about cost about $2.5 trillion in expenditures (2019 dollars) and would generate more than 18.3 million jobs (direct plus indirect).[297] Thus, here MISI is using a relatively modest version of the GND costing about $2.5 trillion that is concerned primarily with energy and environmental programs. As noted, some versions of the GND also include a variety of health, education, and other social policies. Of course, the economic and job impacts of the GND will differ depending on the size, structure, and duration of the GND specified.

MISI also estimated the jobs in the manufacturing sector that would be generated by the GND and found that of the 18.3 million jobs, about 2.25 million would be "green" manufacturing jobs.[298]

IV.B. Comparison of the Estimates

Table IV-1 and Figure IV-9 show the different estimates of U.S. green jobs available from a variety of government and non-government sources over the past two decades. They illustrate the wide range of green jobs estimates available depending on

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programs, renewable energy, and energy efficiency, and its estimated costs run well into the trillions of dollars.

[296]https://www.researchgate.net/publication/344228366_Journal_of_Environmental_Science_and_Renewable_Resources_The_USA_New_Green_Deal_Will_Create_Over_18_Million_Jobs; https://www.researchgate.net/publication/342044233_The_Jobs_Impact_of_the_USA_New_Green_Deal.

[297]The 18.3 million jobs estimated is a very large number. However, it is sobering to note that in the eight week period from early March to early April 2020, about 36.5 million Americans filed for unemployment insurance, with weekly totals above three million a week. Thus, the 18.3 million jobs is only half as many jobs as were lost in an eight week period.

[298]https://www.researchgate.net/publication/344228366_Journal_of_Environmental_Science_and_Renewable_Resources_The_USA_New_Green_Deal_Will_Create_Over_18_Million_Jobs; https://www.researchgate.net/publication/342044233_The_Jobs_Impact_of_the_USA_New_Green_Deal.

the green job definition and the source of the estimate. For example, the lowest estimate is 750,000 green jobs from USME for 2008 and the highest estimate is 30.2 million green jobs from BKT for 2018 – a 40X difference.

Even for similar years, the estimates can vary greatly. For example:

- BLS estimates 3.4 million green jobs in 2011.
- BI estimates 2.7 million green jobs in 2010.
- G&M estimates 8 million green jobs in 2012.
- MISI/J&EI estimates 5.9 million green jobs in 2010
- These estimates differ by 3X.

Table IV-1
U.S. Green Jobs Estimates

Source and Year of Estimate	**Green Jobs** (millions)
BI, 2010	2.7
BI, 2016	6.6
BLS, 2011	3.4
BKT, 2018	30.2
DOC, 2010	1.8 - 2.4
E2/USEER, 2015	2.5
E2/USEER, 2019	3.4
E2/USEER, 2020	3.0
EBI, 2017	1.73
EDF, 2017	4.0 – 4.5
EESI, 2020	4.1
EI, 2014	3.8
G&M: 2012	8.0
G&M: 2016	9.4
GI, 2006	0.8
MISI/J&EI, 2010	5.9
MISI, 2021	8.8
Pew, 2007	0.77
USME, 2008	0.75

Source: MISI.

Legend for Table IV-1:

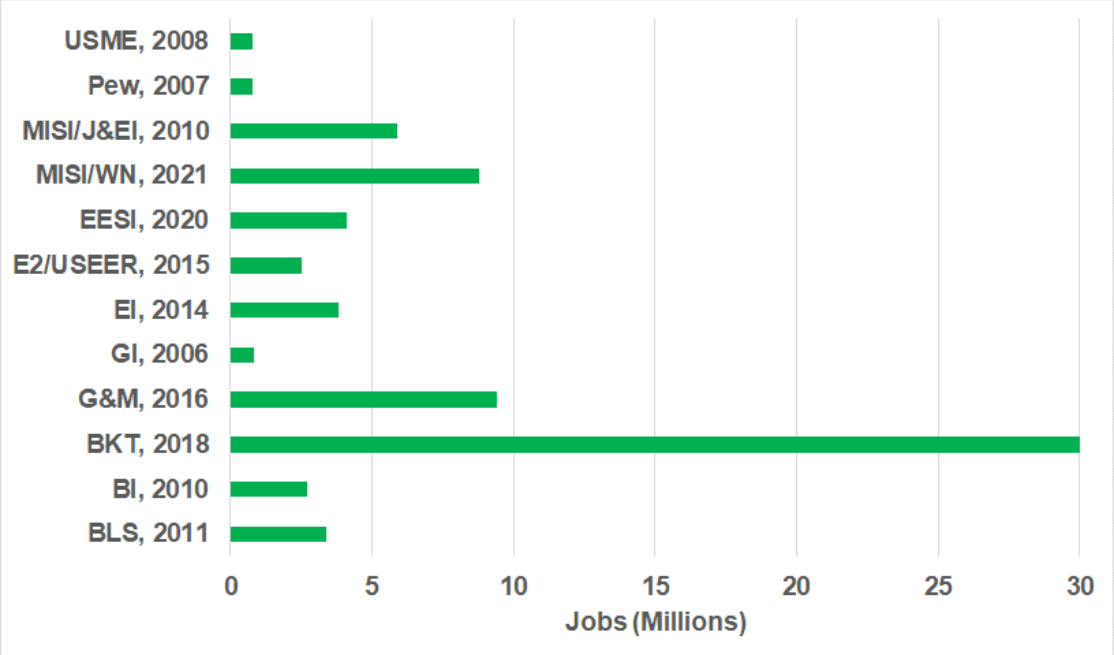
- BLS: U.S. Bureau of Labor Statistics
- BI: Brookings Institution
- BKT: Bowen, Kuralbayeva, & Tipoec
- E2: Environmental Entrepreneurs
- EBI: Environmental Business International, Inc.
- EDF: Environmental Defense Fund
- EESI: Environmental and Energy Study Institute
- EI: Echotech Institute
- DOC: U.S. Department of Commerce

- G&G: Georgeson and Maslin
- GI: Georgetown Institute
- J&EI: Jobs and Environment Initiative
- MISI: Management Information Services, Inc.
- Pew: Pew Charitable Trusts
- USEER: U.S. Energy Employment Report
- USME: U.S. Metro Economies

The most recent green jobs estimates also vary greatly:

- E2/USEER estimates 3.0 million green jobs in 2020.
- EESI estimates 4.1 million green jobs in 2020.
- BKT estimates 30.2 million green jobs in 2018.
- G&M estimates 9.4 million green jobs in 2016.
- MISI estimates 8.8 million green jobs in 2021.
- These estimates differ by a factor of 10.

Figure IV-9
Examples of the Variation in U.S. Green Jobs Estimates



Source: MISI.

Even estimates from the same organization can differ substantially. For example, BI estimated 2.7 million green jobs in 2010 and estimated 6.6 million green jobs in 2016 – a 2.5X difference.

State green jobs estimates also differ markedly. Table IV-2 and Figures IV-10 and IV-11 show the different estimates of green jobs available for a number of states from a variety of government and non-government sources over the past two decades.

Table IV-2
Estimates of Green Jobs For Selected States

State, Source, and Year of Estimate	Green Jobs Estimate (thousands)
Arizona: MISI/J&EI, 2005	91
Arizona: E2/USEER, 2020	57
California: MISI/J&EI, 2005	599
California: E2/USEER, 2020	485
California: E2/USEER, 2019	537
California: LIMD, 2009	433
California: AEEI, 2015	508
California: CCJE, 2015	332
Colorado: MISI/WN, 2019	266
Colorado: E2/USEER, 2020	58
Colorado: MISI/ASEA, 2007	91
Connecticut: MISI/J&EI, 2005	66
Connecticut: ECSU, 2009	42
Connecticut: MISI, 2009	165
Connecticut: E2/USEER, 2020	40
Connecticut: EC, 2019	44
Florida: MISI/J&EI, 2005	220
Florida: E2/USEER, 2020	150
Louisiana: E2/USEER, 2020	26
Louisiana: LSU, 2009	98
Maine: MDL, 2006	2.5
Maine: E2/USEER, 2020	11.9
Michigan: MISI/J&EI, 2005	202
Michigan: E2/USEER, 2020	113
Michigan: BLMISI, 2008	109
Michigan: Pew, 2007	23
Minnesota: MISI/J&EI, 2005	92
Minnesota: E2/USEER, 2020	55
Minnesota: MNGAT, 2014	15
Minnesota: NRDC, 2008	252
New York: MISI/NYSERDA, 2007	9*
New York: E2/USEER, 2020	153
New York: NYSERDA, 2019	164
Missouri: MGJR, 2009	131
Missouri: E2/USEER, 2020	47
North Carolina: MISI/J&EI, 2005	112
North Carolina: E2/USEER, 2020	100
Ohio: MISI/J&EI, 2005	176
Ohio: E2/USEER, 2020	103
Ohio: MISI/ASES, 2006	503
Ohio: ODJFS, 2011	89
Oregon; OED, 2010	43
Oregon: E2/USEER, 2020	52
Pennsylvania: MISI/WN 2019	376
Pennsylvania: E2/USEER, 2020	87
Pennsylvania: PDEP, 2019	97
Pennsylvania: PDLI, 2010	183
Washington: WESED, 2010	99
Washington: E2/USEER, 2020	76
Washington: Pew, 2007	17
Wisconsin: MISI/J&EI, 2005	97
Wisconsin: E2/USEER, 2020	69

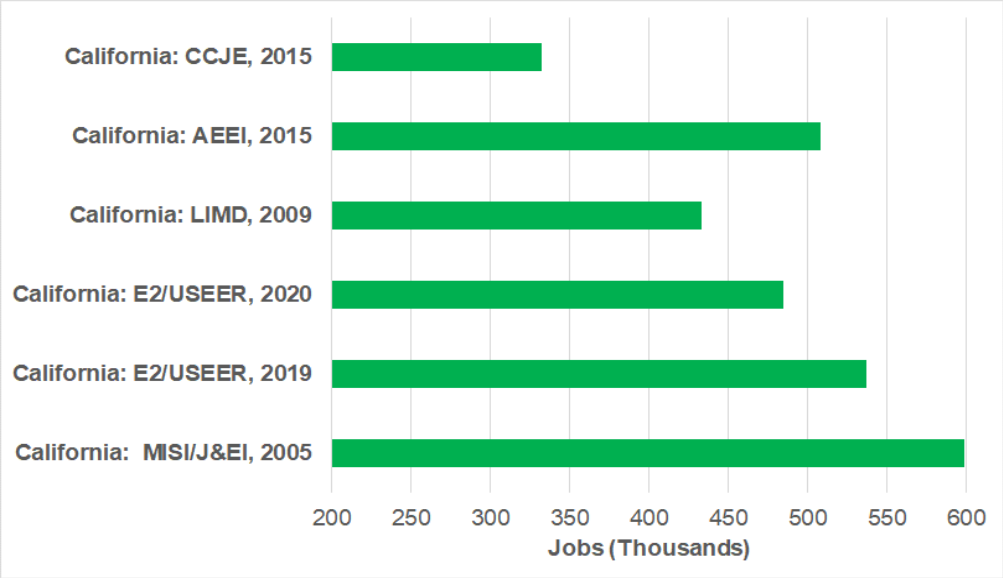
*RE jobs only

Source: MISI.

Legend for Table IV-2:

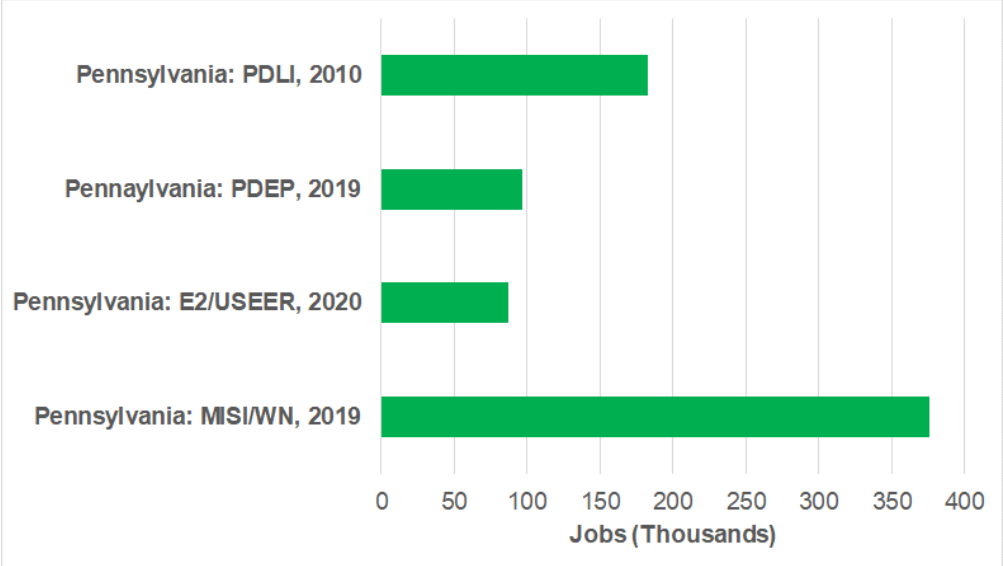
- AEEI: Advanced Energy Economy Institute
- ASEA: American Solar Energy Association
- BLMSI: Michigan Bureau of Labor Market Information and Strategic Initiatives
- CCJE: California Center for Jobs and the Economy
- E2: Environmental Entrepreneurs
- EC: Energize Connecticut
- ECSU: Eastern Connecticut State University
- J&EI: Jobs and Environment Initiative
- LIMD: California Employment Development Department's Labor Market Information Division
- LSU: Louisiana State University
- MDL: Maine Department of Labor
- MGJR: Missouri Green Jobs Report
- MNGAT: Minnesota NGA Policy Academy Team
- MISI: Management Information Services, Inc.
- NYSERDA: New York State Research and Development Authority
- NRDC: National Resources Defense Council
- ODJFS: Ohio Department of Jobs and Family Services
- OED: Oregon Employment Department
- PDEP: Pennsylvania Department of Environmental Protection
- PDLI: Pennsylvania Department of Labor & Industry
- Pew: Pew Charitable Trusts
- USEER: U.S. Energy Employment Report
- WESED: Washington State Employment Security Department
- WN: WorkingNation

Figure IV-10
California Green Jobs Estimates



Source: MISI.

Figure IV-11
Pennsylvania Green Jobs Estimates



Source: MISI.

They illustrate the enormous range of green jobs estimates among states and even for the same state depending on the green job definition and the source of the estimate. For example:

- For California, the green job estimates differ by a factor of nearly two.
- For Colorado, the green job estimates differ by a factor of nearly five.
- For Connecticut, the green job estimates differ by a factor of four.
- For Michigan, the green job estimates differ by a factor of nearly nine.
- For Minnesota, the green job estimates differ by a factor of 17.
- For Ohio, the green job estimates differ by a factor of nearly 12.
- For Pennsylvania, the green job estimates differ by a factor of more than four.
- For Washington, the green job estimates differ by a factor of nearly six.

IV.C. Analysis: Why do the Estimates Differ so Markedly?

It is thus clear that green jobs estimates for the U.S. and for individual states differ significantly. The national estimates differ by a factor of 40, and even the most recent estimates differ by a factor of 10.

To begin with, the differences cannot be attributed to any potential biases inherent in the source of the estimate. For example, EBI's estimate of 1.73 million green jobs in 2017 is among the lowest of the estimates. This is despite the fact the EBI is a for-profit corporation selling environmental data and consulting services, and it would seemingly be in EBI's interest to estimate a large number of green jobs. As another example, the Echotech Institute's estimate of 3.8 million green jobs in 2014 is far less than the larger

estimates. This is despite the fact the EI was a for-profit college specializing in renewable energy and environmental programs, and it would seemingly have been in EI's interest to estimate a large number of green jobs.

Rather, the major cause of the enormous differences in green jobs estimates is the definition of green jobs and the data sources used. Thus, for example:

- EBI has a narrow proprietary data base and a focus on revenues to business, and classifies spending into services (analytical, hazardous waste, consulting & engineering, etc.) equipment (air pollution control, waste management, instruments & information, etc.), and resources (water utilities, resource recovery, and clean energy & power). It estimated 1.73 million U.S. green jobs in 2017.
- Pew used an industry output approach to categorize and estimate the number of U.S. green jobs and estimated 770,000 U.S. green jobs in 2007.
- The Department of Commerce (DOC) estimated private sector green employment in the U.S. based on publically-available Economic Census data, defined green products or services as those whose predominant function serves one or both of conserving energy and other natural resources or reducing pollution, and estimated 1.8 - 2.4 million U.S. green jobs in 2010.
- BLS defined green jobs as "jobs involved in economic activities that help protect or restore the environment or conserve natural resources" and estimated 3.4 million U.S. green jobs in 2010.
- E2 used USEER data, defined green jobs solely as clean energy jobs – thus excluding environmental and pollution abatement jobs, and estimated 3.0 million U.S. green energy jobs in 2020.

At the other extreme are very large estimates of U.S. green jobs:

- BKT used a very expansive definition of green jobs including not only those involving production of green goods and services but also jobs in any way somehow supposedly supporting the green economy, and estimated 30.2 million U.S. green jobs in 2018.
- G&M used what they termed "transactional triangulation" to measure supply chain activity and full economic impact, and estimated that in 2016 there were about 9.4 million U.S. workers who could be generously defined as being part of the green economy in a broad sense.

We conclude that the low estimates of U.S. green jobs are too low because of restrictive definitions. For example, EBI has a very narrow definition of green jobs that corresponds to its data base of environmental companies, and E2's definition of green jobs is deficient because it pertains only to clean energy jobs and excludes environmental jobs.

However, the high estimates of U.S. green jobs are too high because of overly expansive definitions. For example:

- BKT essentially counts any job even remotely connected to clean energy or environmental activities as green, even if only a small portion of the job relates to anything tenuously characterized as green. It ignores the FTE concept and likely overestimates the actual number of FTE green jobs by a factor or two or three, or more.
- G&M used what they termed "transactional triangulation" to measure supply chain activity and full economic impact and counted green jobs that vary in "greenness," with very few jobs consisting only of green tasks. Their approach also ignores the FTE concept, is overly broad, and is not directly comparable job estimates derived from available national statistical data bases.

We prefer the MISI green job concept, which is discussed in more detail in Chapter V. Basically, MISI does not attempt to develop a unique green job definition based on industrial or occupational characteristics. Rather, MISI defines green jobs as those FTE jobs generated – directly, indirectly, or induced – by the activities of the green economy. This approach has at least five advantages:

1. It does not bog down into interminable debates over a specific green job definition.
2. It corresponds to interindustry job creation concepts that have been validated over the past half-century and utilized in many disparate economic and job impact analyses.
3. It provides a consistent national data base of estimates of jobs generated by the U.S. green economy over the past five decades.
4. It is viable and credible and produces neither the highest nor the lowest estimates of U.S. green jobs.
5. Importantly, it emphasizes that most of the jobs created by the green economy are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, etc., that the classic green job (solar energy engineer, ecologist, etc.) constitutes only a small portion of the jobs created, and that most of the persons employed in the jobs created may not even realize that they owe their livelihood to the green economy.

Most of the comments made above apply to the state green jobs estimates. These vary enormously among the states and for individual states for the same reasons: Widely different green job concepts, definitions, estimation methods, and sources. It is unfortunate that no consistent databases of state green jobs estimates exist. E2 produces estimates of clean energy jobs by state, are available on a consistent basis for only three years, exclude environmental jobs, and suffer from the deficiencies of the USEER data. MISI has produced consistent estimates of jobs generated by the U.S. green economy for 11 states. However, these are not available for all states and are not available on a time series basis.

V. FORECASTS OF THE U.S. GREEN ECONOMY AND GREEN JOBS

There is widespread agreement that the green economy, green industries, and green jobs will be a rapidly and consistently increasing portion of the U.S. economy and labor force. However, since there is currently no rigorous specification of the green economy or labor force, accurately forecasting of these is impossible. In Chapters II, III, and IV, MISI analyzed and estimated the U.S. green economy and green jobs. This facilitates robust forecasting of the jobs generated by the U.S. green economy. Thus, here MISI:

- Presents the basic MISI forecasting assumptions and parameters.
- Utilizes the existing BLS occupational data to forecast green jobs.
- Assesses the BLS green jobs data and forecasts.
- Analyzes the problems with BLS occupational data base.
- Discusses the MISI approach to forecasting the jobs created by the U.S. green economy.
- Forecasts over the coming decade the jobs generated by the U.S. green economy.
- Forecasts the jobs generated by the U.S. green economy in industry detail.
- Forecasts the jobs generated by the U.S. green economy by selected occupation.
- Derives an example of forecasts of emerging green occupations and education and skill requirements.

V.A. Forecasting Parameters, Assumptions, and Methodology

V.A.1. Constant Dollar Data

The only meaningful way to compare and analyze historical and forecast economic data over a long period is to use constant dollar data. Obviously, it would be misleading to equate a dollar expended in 2020 with one forecast to be spent in 2030, since the price level in the latter year will likely be much higher than that of the former year. Aside from the general distortions, use of current dollar data in the analysis would, for example, seriously undercount expenditures early in the forecast period relative to those later in the forecast period. Therefore, throughout this report, the constant dollar estimates given are stated in constant 2020 dollars. The base year dollar used was 2020 dollars, and estimates stated in nominal dollars or in other base year dollars were converted, where necessary, to 2020 constant dollars using the BEA Implicit GDP Deflator series.[299]

MISI derived the constant 2020 dollar data (2020 = 1.00), using the GDP deflators to convert dollar values into 2020 base year estimates. It is preferable in an analysis such as the one conducted here to use the GDP deflators – implicit price deflators (IPD) – instead of the more widely known consumer price index (CPI) deflators.[300]

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

[300]The IPD, compiled by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce, is a by-product of the deflation of GDP, and is derived as the ratio of current-to-constant-dollar GDP (multiplied by 100). It is the weighted average of the detailed price indices used in the deflation of GDP, but they are

V.A.2. The Jobs Concept

The jobs issue is a key focus of this report. The "jobs" concept can be subject to misinterpretation and misuse, and it is thus important that it be carefully defined.[301] 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 in a year's time, 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. Thus, for example, two wind turbine technicians each working six months of the year would be counted as one FTE job. An FTE job is the standard job concept used in these types of analyses and allows meaningful comparisons over time and across jurisdictions because it consistently measures the input of labor in the economy.

Thus, a "job" created is defined as one job created for one person for one year, and 50,000 jobs created will refer to 50,000 persons employed for one year. It is correct to state that "over a ten year period 500,000 cumulative jobs are created" as long as it is specified that this refers to 50,000 persons, each employed annually for 10 years. These distinctions may sound technical, but they are critical to a proper interpretation of the results.

In estimating the impacts on the entire 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. The inclusion (or exclusion) of jobs and output in industries with strong backward and forward linkages to other economic sectors can cause indirect and induced impacts. Employment multipliers measure how the creation

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combined using weights that reflect the composition of GDP in each period. Thus, changes in the implicit price deflator reflect not only changes in prices but also changes in the composition of GDP. It is issued quarterly by BEA. Conceptually, the IPD measures the general price level of all final goods and services (including government) produced during a specific period. Thus, the IPD is the only official index which attempts to measure overall price behavior of all goods and services in the nation. The CPI is restricted to a narrower universe. The implicit GDP deflators are the ones used in this study,

[301]For example, DOE has expended substantial resources on several annual versions of the *U.S. Energy and Employment Report* (USEER). The employment figures reported in the USEER are supposed to refer only to direct employment and not to indirect employment or induced employment. However, the report's employment figures do include some indirect jobs, although it is not clear how many. It is also not clear what "job" concept USEER utilized. There are repeated references to "employment," "workforce," "jobs," and "net jobs." However, these concepts are sometimes used interchangeably in a confusing manner. Further, the employment concept of a full time equivalent (FTE) job in the U.S. is the standard used in economic analyses and normalizes job creation among full time, part time, and seasonal employment. The USEER does not mention the FTE job concept. In addition, the methodologies used in the 2016 USEER, (which estimated 2015 employment) and the 2017 USEER (which estimated 2016 employment) are different. Thus, as noted in the 2017 USEER, "As a result, not all data points are directly comparable between 2016 and 2017." In other words, it is difficult to estimate employment trends between the two years. See *U.S. Energy and Employment Report,* https://www.energy.gov/downloads/2017-us-energy-and-employment-report.

or destruction of output or employment in a particular industry translates into wider employment changes throughout the economy.[302]

Accordingly, MISI estimated the total (direct, indirect, and induced) jobs created by the U.S. green economy: [303]

- 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.
- For simplicity, MISI includes induced jobs in the indirect category.

The total (direct, indirect, and induced) jobs concept is the accepted methodology widely used in studies of this nature and in the peer-reviewed literature.

V.A.3. Forecasting Conventions and Parameters

In the analysis and forecasting, MISI followed the conventions in the U.S. Energy Information Administration's *Annual Energy Outlook 2021* (*AEO 2021*) and *Annual Energy Outlook 2020* (*AEO 2020*), and dollar estimates are expressed in terms of constant 2020 dollars.[304] The other standard conventions of the EIA AEO reports were also adhered to. In addition, the conventions of the required U.S. Bureau of Labor Statistics, U.S. Bureau of Economic Analysis, and U.S. Census Bureau data bases were followed. This is essential to ensure that the forecasts are based on the gold standard publicly available information and are consistent, accurate, and dependable.

Table V-1 presents the basic parameters MISI used in developing the forecasts – data derived from the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor Statistics, and the U.S. Energy Information Administration.[305] 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%.[306]

[302]See, for example, "Understanding Multipliers," https://implanhelp.zendesk.com/hc/en-us/articles/115009505707-Understanding-Multipliers.
[303]See the discussion in Section V.D.
[304]U.S. Energy Information Administration, *Annual Energy Outlook 2021*, February, 2021; U.S. Energy Information Administration, *Annual Energy Outlook 2020*, January 2020.
[305]EIA forecast real U.S. GDP in 2012 dollars. MISI converted these data to constant 2020 dollars.
[306]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.

Table V-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: U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.

V.B. BLS Occupational Forecasts

BLS is the authoritative U.S. Federal agency for occupational data and forecasting and has forecast through 2030 employment, employment change, and average annual job openings for over 1,000 U.S. occupations.[307] BLS has also estimated the average 2020 salaries for these occupations.[308] MISI analyzed these data bases and identified 41 green or partially green occupations, and these are listed in Table V-2.

In this table, many of the occupations listed would be considered green under any definition of the term. For example, these include:

- Natural science managers.
- Environmental engineering technicians.
- Conservation scientists.
- Environmental scientists.
- Forest and conservation technicians.
- Environmental science technicians.
- Environmental science teachers.
- Insulation workers.
- Solar photovoltaic installers.
- Hazardous materials removal workers.
- Wind turbine technicians.
- Refuse and recycle workers.

[307]https://www.bls.gov/emp/tables/occupational-projections-and-characteristics.htm.
[308]U.S. Bureau of Labor Statistics, "Occupational Employment and Wage Estimates," https://www.bls.gov/oes/.

Table V-2
Employment by Detailed Green/Semi-green Occupations, 2020 and Projected 2030, and Average 2020 Salary

2020 National Employment Matrix title	2020 Employment (thousands)	2030 Employment (thousands)	Employment Change, 2020 - 2030 (thousands)	Percent Employment Change, 2020 - 2030	Average Annual Job Openings, 2020 - 2030 (thousands)	Average 2020 Salary (thousands)
Natural sciences managers	79.0	83.5	4.5	5.8	6.0	$154.9
Landscape architects	23.7	23.6	-0.1	-0.3	1.6	$75.4
Environmental engineers	52.3	54.3	1.9	3.7	4.0	$96.9
Health and safety engineers	24.1	25.6	1.5	6.1	1.7	$97.3
Mining and geological engineers, including mining safety engineers	6.3	6.6	0.2	3.9	0.4	$100.1
Nuclear engineers	17.2	15.8	-1.5	-8.4	0.9	$125.1
Architectural and civil drafters	99.9	99.0	-0.9	-0.9	9.3	$59.1
Environmental engineering technologists and technicians	17.3	18.6	1.3	7.8	1.8	$56.6
Soil and plant scientists	18.8	20.7	1.9	10.0	2.3	$73.0
Conservation scientists	25.3	26.8	1.5	6.1	2.5	$69.0
Foresters	13.7	15.1	1.4	10.0	1.4	$66.0
Environmental scientists and specialists, including health	87.1	94.4	7.3	8.4	9.4	$80.1
Geoscientists, except hydrologists and geographers	29.0	31.0	2.0	7.0	3.1	$112.1
Hydrologists	6.5	6.9	0.4	5.6	0.7	$90.2
Urban and regional planners	39.1	41.8	2.7	6.8	3.7	$79.4
Environmental science and protection technicians, including health	34.2	37.8	3.6	10.6	4.7	$51.0
Geological and hydrologic technicians	16.8	18.3	1.5	8.7	2.3	$61.1
Nuclear technicians	6.6	5.8	-0.8	-12.4	0.7	$83.8
Forest and conservation technicians	33.0	33.3	0.2	0.7	4.0	$42.8
Occupational health and safety specialists	98.0	104.8	6.8	7.0	7.8	$78.1
Occupational health and safety technicians	21.3	23.2	1.9	9.0	1.8	$57.9
Forestry and conservation science teachers, postsecondary	1.7	1.8	0.1	5.5	0.2	$92.4
Environmental science teachers, postsecondary	7.1	7.6	0.5	6.8	0.7	$94.5
Forest fire inspectors and prevention specialists	3.0	3.7	0.7	23.9	0.4	$52.1
Landscaping and groundskeeping workers	1,117.8	1,202.8	85.0	7.6	157.9	$33.8
Forest and conservation workers	12.6	11.6	-1.0	-8.0	1.8	$33.5
Drywall and ceiling tile installers	121.2	127.2	6.0	4.9	10.7	$51.9
Electricians	729.6	795.7	66.1	9.1	84.7	$61.6
Electrician Helpers	75.5	76.2	0.7	0.9	8.9	$35.4
Insulation workers, floor, ceiling, and wall	33.3	34.9	1.6	4.9	3.3	$46.9
Insulation workers, mechanical	28.2	29.6	1.4	5.1	2.8	$55.5
Plumbers, pipefitters, and steamfitters	469.9	493.2	23.4	5.0	51.0	$61.1
Solar photovoltaic installers	11.8	17.9	6.1	52.1	2.3	$48.0
Hazardous materials removal workers	44.5	47.4	2.9	6.6	5.8	$49.2
Seotic tank cleaners	30.4	34.8	4.4	14.3	4.2	$43.9
Heating, air conditioning, and refrigeration mechanics and installers	380.4	399.4	19.0	5.0	38.5	$53.4
Water and liquid waste treatment plant operators	122.1	119.1	-3.1	-2.5	10.5	$49.1
Electrical power-line installers and repairers	115.9	117.4	1.5	1.3	10.2	$74.4
Wind turbine service technicians	6.9	11.7	4.7	68.2	1.4	$59.3
Nuclear power reactor operators	5.3	3.6	-1.8	-32.9	0.2	$104.5
Refuse and recyclable material collectors	140.5	157.2	16.7	11.9	21.4	$42.6

Source: U.S. Bureau of Labor Statistics and MISI.

Other occupations are included in this table because they are essential to the green economy and green industries. For example, these include:

- Hydrologists, who will be needed for water conservation initiatives.
- Architects, who will be needed to design energy efficient buildings.
- Electricians, who will be installing solar panels.
- Plumbers, who will be installing low-flush toilets.
- Drywall installers, who will be needed to increase the energy efficiency of buildings.
- HVAC technicians, who will be needed to install energy efficient HVAC systems.
- Urban planners, who will be needed to design energy efficient real estate developments and smart cities.
- Electric power line workers, who will be needed to expand the capacity of the U.S. power grid to accommodate increased renewable energy generation.

Several nuclear occupations are included in this table because nuclear power generates no CO_2. However, many environmental organizations reject nuclear power as an acceptable alternative to fossil fuels.[309]

Green job definitions can be even more controversial. For example, in April 2021, Presidential climate adviser Gina McCarthy confirmed that White House plans for a clean electricity standard (CES) would allow carbon capture technologies – carbon capture and sequestration (CCS) and direct air capture (DAC).[310] However, many environmentalists and green energy groups have called on President Biden to abandon CCS, contending that it prolongs the use of fossil fuels.[311] Nevertheless, McCarthy stated that the CES would be "fairly robust, and it's going to be inclusive. Clearly, we think a CES is appropriate and advisable, and we think the industry itself sees it as one of the most flexible and most effective tools."[312] Thus, CCS jobs may or may not be considered "green."

It should be noted that even the jobs listed in Table V-2, which include many occupations in which most of the jobs are not "green," totaled 4.1 million in 2020. This comprises only 2.8% of total U.S. jobs in that year.

Figure V-1 shows the forecast average annual job openings, 2020 – 2030, for selected green/semi-green occupations. This figure illustrates that job openings for these occupations differ markedly, and over the period 2020 – 2030 there are forecast to be annual job openings for:

- 84,700 Electricians
- 51,000 Plumbers
- 38,500 HVAC Mechanics
- 21,400 Refuse & Recycle Workers
- 10,700 Drywall Installers

However, over the period 2020 – 2030 there are forecast to be annual job openings for only:

- 700 Hydrologists
- 1,600 Landscape Architects
- 1,400 Wind Turbine Technicians
- 2,300 Solar Photovoltaic Installers

[309]See, for example https://www.nationalgeographic.com/environment/article/nuclear-plants-are-closing-in-the-us-should-we-build-more.

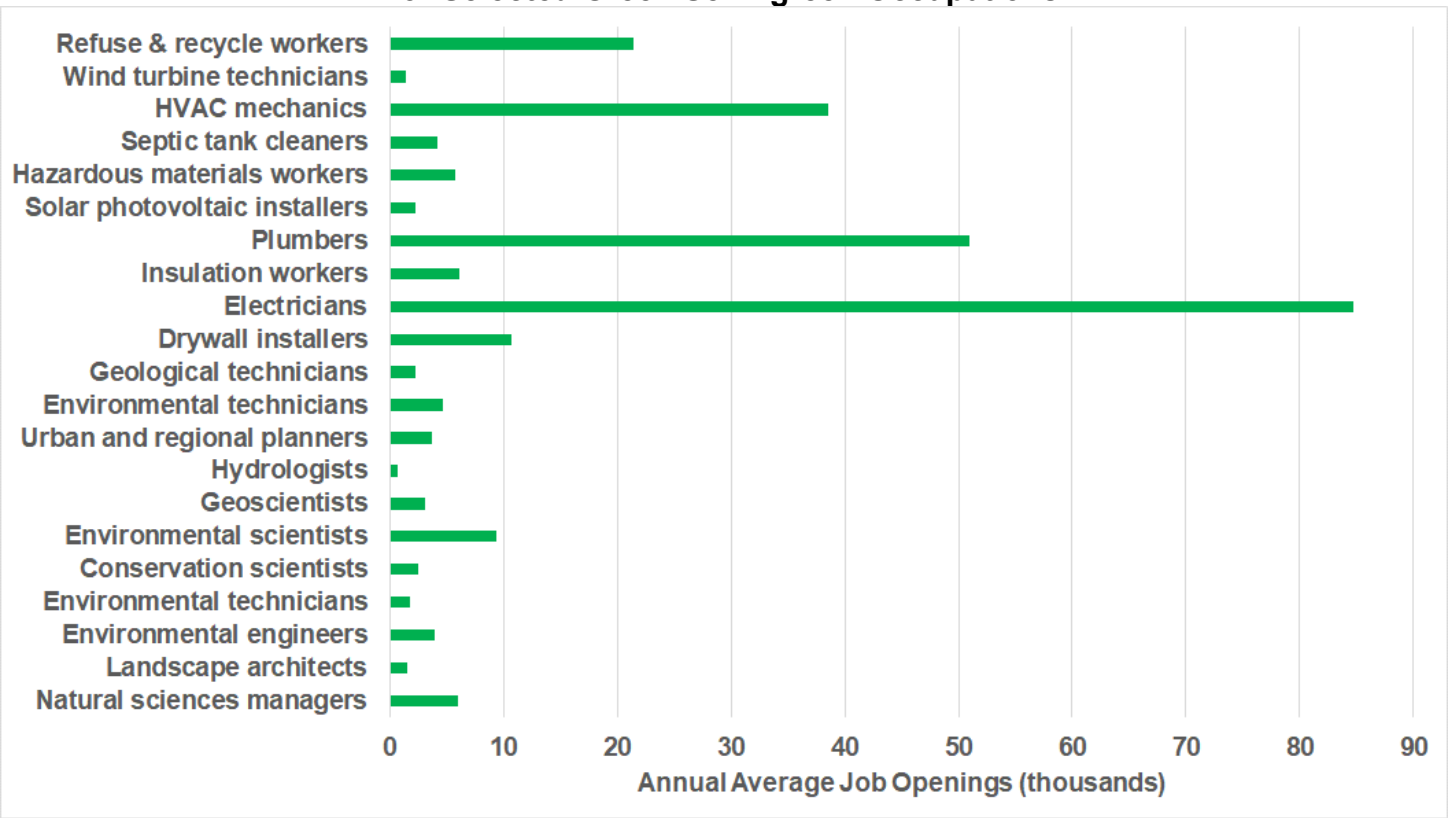
[310]McCarthy stated that the Administration considers a clean energy standard to be an integral part of its effort to achieve zero carbon emissions: "We think it's one of the best methods to actually get the reductions we're looking for with a level of certainty, and the energy sector seems to understand that." Lesley Clark, "Gina McCarthy: Clean Energy Standard to Include Nuclear, CCS," *E&E News*, April 2, 2021; Ari Natter, "White House Wants Nuclear in Clean Energy Mandate, McCarthy Says," April 2 2021, https://www.bloombergquint.com/business/white-house-wants-nuclear-in-clean-energy-mandate-mccarthy-says.

[311]For example, Greenpeace contends that "CCS is a false climate solution that bolsters big oil." Carbon-Capture-Scam.pdf (greenpeace.org).

[312]Ibid.

- 2,500 Conservation Scientists
- 4,700 Environmental Technicians

Figure V-1
Average Annual Job Openings, 2020 – 2030,
For Selected Green/Semi-green Occupations



Source: U.S. Bureau of Labor Statistics and MISI.

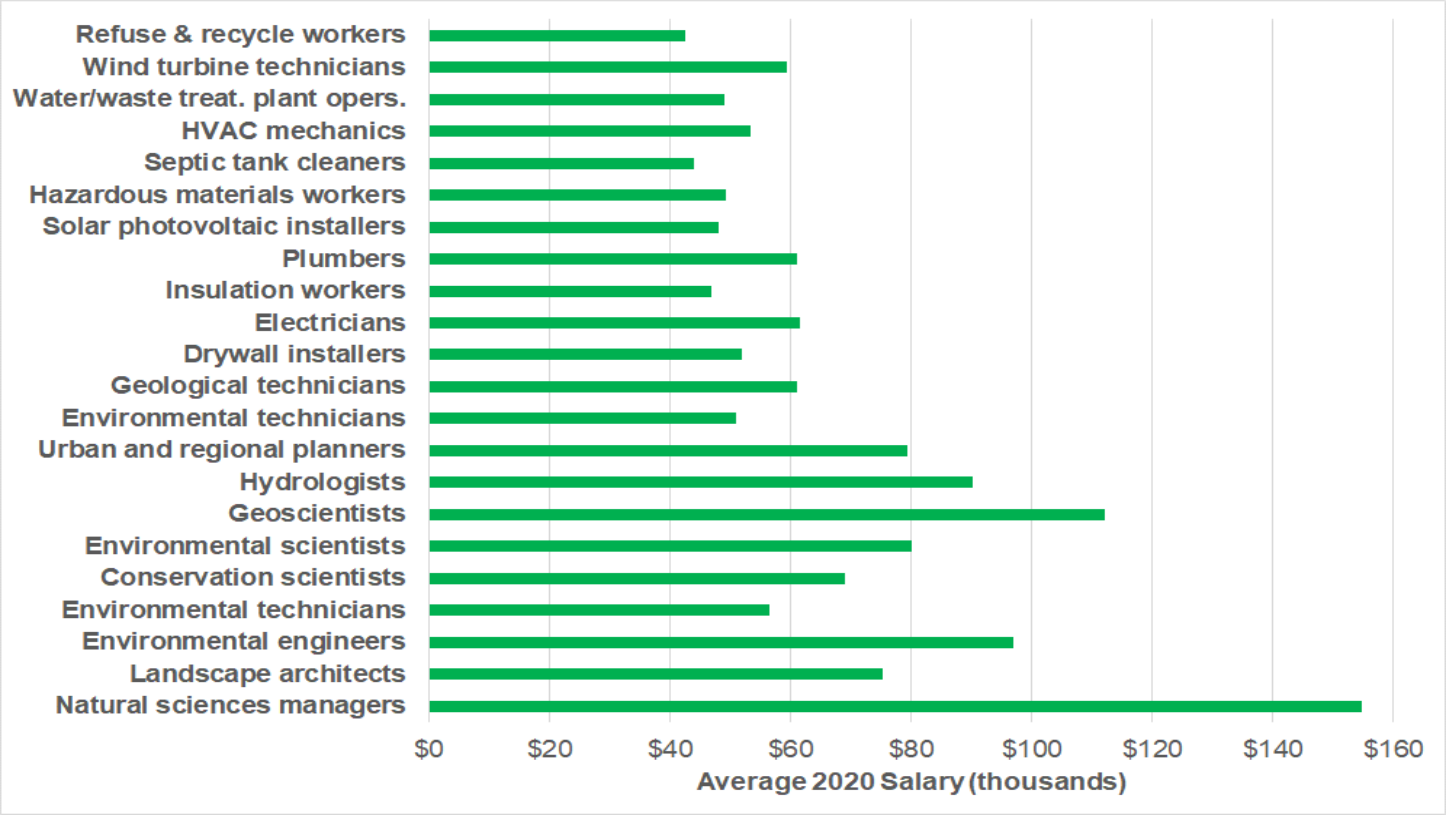
Thus, BLS forecasts that over the coming decade, there will be relatively few annual job openings for such iconic green jobs as Hydrologists, Wind Turbine Technicians, Solar Photovoltaic Installers, Conservation Scientists, and Environmental Technicians. On the other hand, there will be many more annual job openings for less glamorous green occupations such as Refuse & Recycle Workers, Hazardous Materials Removal Workers, Septic Tank Cleaners, Insulation Workers, etc.

Figure V-2 shows the average 2020 salaries for selected green occupations. It illustrates that the salaries for green occupations differ substantially. Some occupations pay very well; for example:

- $154,900 for natural science managers
- $112,100 for geoscientists
- $96,900 for environmental engineers
- $90,200 for hydrologists

- $79,400 for urban and regional planners

Figure V-2
Average 2020 Salaries For Selected Green/Semi-green Occupations*



Source: U.S. Bureau of Labor Statistics and MISI.

*Median annual wage are from the BLS Occupational Employment and Wage Statistics program. Wage data cover non-farm wage and salary workers and do not cover the self-employed, owners and partners in unincorporated firms, or household workers.

For other green occupations the salaries are substantially less; for example:

- $21,400 for recycle and refuse workers
- $43,900 for septic tank cleaners
- $46,900 for insulation workers
- $48,000 for solar photovoltaic installers
- $59,300 for wind turbine technicians

Thus, the salary of the green job depends very much on the nature of the job. As expected, the green jobs requiring advanced education or managerial responsibilities pay the most. However, in general, many of the green occupations forecast to have the most job openings over the coming decade have relatively low salaries.

Table V-3 lists the 25 “certifiable” green jobs in Table V-2 – those jobs that would be classified as green under just about any definition of the term. These 25 occupations in Table V-2 are probably the only unequivocally green jobs in the BLS occupational data base of over 1,000 jobs. This table lists the forecast 2030 employment, employment change, and average annual job openings for these 25 occupations and their average annual 2020 salary.

Table V-3
Employment by Detailed Certified Green Occupations,
2020 and Projected 2030, and Average 2020 Salary*

2020 National Employment Matrix title	2020 Employment (thousands)	2030 Employment (thousands)	Employment Change 2020 - 2030 (thousands)	Percent employment change, 2020-30	Average Annual Job Openings 2020 - 2030 (thousands)	Average 2020 Salary (thousands)
Natural sciences managers	79	83.5	4.5	5.8	6	$154.9
Landscape architects	23.7	23.6	-0.1	-0.3	1.6	$75.4
Environmental engineers	52.3	54.3	1.9	3.7	4	$96.9
Health and safety engineers	24.1	25.6	1.5	6.1	1.7	$97.3
Environmental engineering technicians	17.3	18.6	1.3	7.8	1.8	$56.6
Conservation scientists	25.3	26.8	1.5	6.1	2.5	$69.0
Foresters	13.7	15.1	1.4	10	1.4	$66.0
Environmental scientsts and specialists	87.1	94.4	7.3	8.4	9.4	$80.1
Geoscientists, except hydrologists	29	31	2	7	3.1	$112.1
Hydrologists	6.5	6.9	0.4	5.6	0.7	$90.2
Environmental science & protection technicians	34.2	37.8	3.6	10.6	4.7	$51.0
Geological and hydrologic technicians	16.8	18.3	1.5	8.7	2.3	$61.1
Forest and conservation technicians	33	33.3	0.2	0.7	4	$42.8
Occupational health and safety specialists	98	104.8	6.8	7	7.8	$78.1
Occupational health and safety technicians	21.3	23.2	1.9	9	1.8	$57.9
Foresty & conservation science teachers, postsecondary	1.7	1.8	0.1	5.5	0.2	$92.4
Environmental science teachers, postsecondary	7.1	7.6	0.5	6.8	0.7	$94.5
Forest fire inspectors and prevention specialists	3	3.7	0.7	23.9	0.4	$52.1
Forest and conservation workers	12.6	11.6	-1	-8	1.8	$33.5
Insulation workers, floor, ceiling, and wall	33.3	34.9	1.6	4.9	3.3	$46.9
Insulation workers, mechanical	28.2	29.6	1.4	5.1	2.8	$55.5
Solar photovoltaic installers	11.8	17.9	6.1	52.1	2.3	$48.0
Hazardous materials removal workers	44.5	47.4	2.9	6.6	5.8	$49.2
Septic tank cleaners	30.4	34.8	4.4	14.3	4.2	$43.9
Water and liquid waste treatment plant operators	122.1	119.1	-3.1	-2.5	10.5	$49.1
Wind turbine service technicians	6.9	11.7	4.7	68.2	1.4	$59.3
Refuse and recyclable material collectors	140.5	157.2	16.7	11.9	21.4	$42.6

Source: U.S. Bureau of Labor Statistics and MISI.

*Median annual wage are from the BLS Occupational Employment and Wage Statistics program. Wage data cover non-farm wage and salary workers and do not cover the self-employed, owners and partners in unincorporated firms, or household workers.

The “certifiable green jobs” in this table total:

- 881,000 in 2020 -- 11% of the jobs generated by the U.S. green economy in 2020 (see Section V-E) and 0.6% of total 2020 U.S. jobs.
- 955,000 in 2030 -- 4% of the jobs generated by the U.S. green economy in 2030 (see Section V-E) and 0.6% of total 2030 U.S. jobs.

This table illustrates the limitations of the BLS data base for estimating U.S. green jobs, no matter what the definition of green jobs. It also shows that 90% - 95% of the jobs generated by the U.S. green economy cannot be estimated by using only the readily available BLS occupational data. This reinforces two critical points that MISI has been emphasizing for three decades: The number of jobs generated by the green economy is much larger than is generally recognized and workers who owe their jobs to the green economy would not realize it unless it is brought to their attention.[313]

As noted, Figure V-1 shows the average annual job openings, 2020 – 2030, for selected certified green occupations. It once again illustrates that over the coming decade there will be many more job openings for occupations such as refuse and recycle workers, hazardous materials removal workers, and septic tank cleaners than for occupations such as wind turbine service technicians, solar photovoltaic installers, hydrologists, and foresters.

V.C. Problems With Available BLS Occupational Data And Forecasts

The BLS occupational data are of high quality, are essential for green jobs analysis and forecasting, and they are the basis for most state job analyses and forecasts. The BLS data are indeed the gold standard. However, it must be recognized that the BLS classifications have many shortcomings for green jobs assessments.[314] One major limitation is that the BLS occupational classification illustrated in Tables V-2 and V-3 does not include numerous designations that would be useful in green jobs analyses. For example, the BLS data base does not include classifications for green occupations such as:

- Environmental Lawyer
- Ecologist
- Energy Efficiency Specialist
- Environmental Grants Manager
- Renewable Energy Lobbyist
- Fuel Cell Engineer
- Emissions Control Specialist
- Biomass Energy Researcher
- Environmental Organizer
- Environmental Auditor
- ESG Funds Manager
- Sustainable Buildings Consultant
- Global Environmental Manager
- Hydrogen System Designer

[313]See, for example, Bezdek, DiPerna and Wendling, op. cit. and https://www.researchgate.net/publication/3442228366_Journal_of_Environmental_Science_and_Renewable_Resources_The_USA_New_Green_Deal_Will_Create_Over_18_Million_Jobs, op. cit.

[314]As discussed in Section II.A.2, a decade ago BLS began a project to estimate U.S. green jobs at the national level via an establishment survey. However, this work was terminated before it could be completed.

- Climate Action Coordinator
- Environmental Underwriter
- Environmental Compliance Specialist
- Water Sustainability Specialist
- Energy Efficiency Account Manager
- Climate Change Analyst
- Renewable Energy Tax Account Manager
- Clean Energy Analyst
- Carbon Portfolio Analyst
- Hydrogen Safety Investigator
- Environmental Compliance Officer
- Resource Efficiency Manager
- Energy Efficiency Operations Analyst
- Energy Auditor
- ZEV Vehicle Development Engineer

Eventually, as the green economy expands, jobs in many of these occupations will increase, the number of employees classified in the occupations will increase, and federal and state governments will add them to the occupational employment classifications. For example, this was the case with two green occupations, Wind Energy Service Technicians and Solar Photovoltaic Installers, that BLS relatively recently added to its occupational data base. However, until more green occupations are added to the BLS data base, labor market and employment analysis and forecasting will be performed using the current set of U.S. BLS occupational titles and job descriptions.[315] In the meantime, green economy and green job analyses must be conducted using the occupational data available.

More basically, the BLS occupational classifications – and thus state occupational classifications based on the BLS data -- 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 Bookkeeping Clerk,” “Green Carpenter,” etc.

Further, how “green” an occupation or skill is does not necessarily depend on the occupational definition. Rather, it is also determined by the product, process, or service involved. As noted, neither federal nor state occupational classifications exist or will likely ever exist for occupations such as “Green Welder,” “Green Computer Analyst,” “Green Accountant,” “Green Carpenter,” etc. Thus, for example and as has been discussed, the employees of a wind turbine manufacturing company include primarily standard occupations such as Assemblers, Mechanical Engineers, Maintenance and Repair Workers, Machinists, Purchasing Agents, Customer Service Representatives, Industrial

[315]These are listed in the US Department of Labor, Bureau of Labor Statistics, standard occupational classification; https://www.bls.gov/soc/. Also see US Department of Labor, Bureau of Labor Statistics. *Occupational Outlook Handbook*; https://www. bls.gov/ooh/.

Machinery Mechanics, Shipping and Receiving Clerks, etc. All of these should be considered jobs generated by the green economy.

Similarly, as also discussed, the employees of an environmental remediation services company include primarily standard occupations such as General and Operations Managers, Construction Laborers, Truck Drivers, Office Clerks, Maintenance and Repair Workers, Janitors and Cleaners, Dispatchers, Security Guards, Operating Engineers, Receptionists, etc. All of these should also be considered jobs generated by the green economy.

Nevertheless, recognizing this does not solve the estimation problem. Thus:

- Autoworkers are building ZEVs (zero emission vehicles). However, how should these FTE jobs be estimated? At present, less than 2% of new U.S. vehicle sales are ZEVs. Should less than 2% of autoworkers be thus designated as green jobs?
- Plumbers are currently installing low flush toilets and water efficiency systems. Nevertheless, it is not legitimate to classify most plumbing jobs as green.
- Drywall installers are required for energy efficiency improvements in buildings. However, most drywall installer jobs cannot be classified as green.
- Machinists are employed in wind turbine manufacturing facilities and in other renewable energy manufacturing plants. However, most machinist jobs cannot be classified as green.
- Operating engineers are employed in environmental remediation services companies. However, most operating engineer jobs cannot be classified as green.
- HVAC technicians are required to install energy efficient HVAC systems. However, this is not a unique “green” job classification, and much of the job function may not even be defined as being “green.”
- Welders are required throughout the renewable energy industry. However, most welder jobs cannot be classified as green.

Another major problem with using the existing BLS occupational classification data is that they do not identify new and emerging jobs being created by the rapidly growing U.S. green economy and green industries. Identification of these jobs and the requisite skills, education, training, and experience required is especially important for education and training purposes and for more precisely matching the skills that employers want and the skills that employees have. 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 these jobs can be successfully filled with a limited amount of retraining or on-the-job training. This is discussed in more detail in Section V.G.

V.D. The MISI Approach to Green Job Analysis and Forecasting

Contrary to general public perception and public policy understanding, in recent decades green energy and environmental protection have grown rapidly to become a major sales-generating, profit-making, job-creating industry. The size and the job creating

potential of the green industry is something that MISI has assessed and estimated but that few people are aware of. Nevertheless, there is currently widespread misunderstanding and intense debate over what actually is and is not included in the green economy and green jobs and over the net jobs issue.

The problem is at least threefold. First, the green economy and 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 economy and green labor force. MISI is the one of the few research organizations capable of rigorously remedying this serious problem.[316]

This is illustrated in Table V-4, which shows the 2019 occupational job distribution and employee earnings of a typical wind turbine manufacturing company. This table illustrates the points made above. 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.

[316]MISI has been analyzing and estimating the U.S. green economy and green jobs for the past three decades. 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 V-4
Typical Employee Profile of a 250-person Wind Turbine Manufacturing Company, 2019

Occupation	Employees	Earnings
Engine and Other Machine Assemblers	31	$33,359
Machinists	27	37,191
Team Assemblers	16	27,668
Computer-Controlled Machine Tool Operators	12	37,254
Mechanical Engineers	10	65,772
First-Line Supervisors/Managers of Production/Operating	10	54,705
Inspectors, Testers, Sorters, Samplers, and Weighers	8	37,202
Lathe and Turning Machine Tool Setters/Operators/Tenders	6	36,729
Drilling and Boring Machine Tool Setters/Operators/Tenders	4	36,509
Welders, Cutters, Solderers, and Brazers	4	36,530
Laborers and Freight, Stock, and Material Movers	4	28,466
Maintenance and Repair Workers	4	41,318
Tool and Die Makers	4	40,047
Grinding/Lapping/Polishing/Buffing Machine Tool Operators	4	31,899
Multiple Machine Tool Setters/Operators/Tenders	4	37,517
Industrial Engineers	3	64,659
Industrial Machinery Mechanics	3	42,315
Engineering Managers	3	99,404
Shipping, Receiving, and Traffic Clerks	3	29,516
General and Operations Managers	3	110,702
Industrial Production Managers	3	85,512
Industrial Truck and Tractor Operators	3	31,416
Purchasing Agents	3	51,702
Cutting/Punching/Press Machine Setters/Operators/Tenders	3	28,907
Production, Planning, and Expediting Clerks	3	41,601
Milling and Planing Machine Setters/Operators/Tenders	3	37,380
Mechanical Drafters	2	44,090
Customer Service Representatives	2	36,036
Bookkeeping, Accounting, and Auditing Clerks	2	32,760
Office Clerks, General	2	27,227
Sales Representatives, Wholesale and Manufacturing	2	50,757
Janitors and Cleaners	2	28,476
Sales Engineers	2	66,591
Accountants and Auditors	2	54,873
Tool Grinders, Filers, and Sharpeners	2	40,520
Executive Secretaries and Administrative Assistants	2	39,638
Mechanical Engineering Technicians	2	46,767
Electricians	2	45,570
Other employees	48	45,969
Employees, Total	**250**	**$57,680**

Source: Management Information Services, Inc.

Thus, the production of wind turbines and wind turbine components requires large numbers of Engine Assemblers, Machinists, Machine Tool Operators, Mechanical and Industrial Engineers, Welders, Tool and Die Makers, Mechanics, Managers, Purchasing Agents, Accountants, Office Clerks, etc. These are "green" workers only because the company they work for is manufacturing a renewable energy product. Importantly, with the current national angst concerning the erosion of the U.S. manufacturing sector and the loss of U.S. manufacturing jobs, it is relevant to note that many environmental and renewable energy technologies are growing rapidly.[317] These types of firms can help revitalize the manufacturing sector and provide the types of diversified, high skill, high-wage jobs that the U.S. seeks to promote.

Second, conventional definitions and estimates do not include indirect and induced green jobs. Specifically, MISI defines total jobs generated by the green economy (direct, indirect, and induced). As noted:

- 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 or all of the jobs created.
- For simplicity, MISI includes induced jobs in the indirect category.

This concept is critical because indirect jobs comprise a major portion of green jobs, and this is not accounted for in current green job definitions or estimates.

Third, not only are currently available green job definitions inconsistent and misleading, but they often miscount or double count existing jobs. As discussed, for jobs, the employment concept that MISI uses is a full time equivalent (FTE) job. An FTE job is defined as 2,080 hours worked in a year's time and adjusts for part time and seasonal employment and for labor turnover.

The discussion in the previous sections indicates that ex ante green jobs estimation using BLS occupational classification data can never identify more than a very small portion of the jobs actually generated by the green economy. This is why MISI uses the interindustry ex post approach to estimate the total (direct, indirect, and induced) 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.[318] A simplified version of the MISI model as it was applied here is summarized in Figure V-3.

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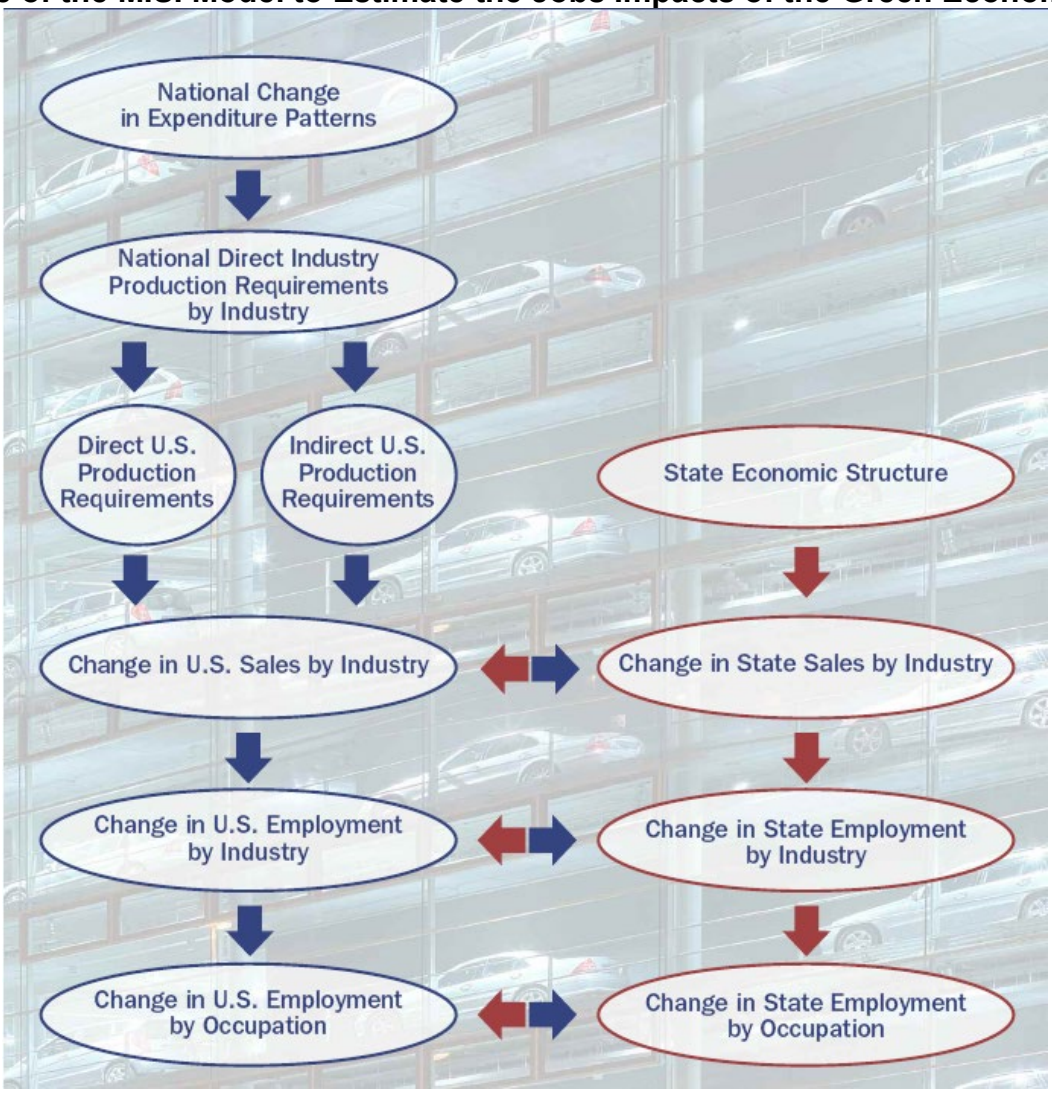
[317]For example, wind power is the most rapidly growing source of electrical power in the world.

[318]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.greenenergytimes.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-

Figure V-3
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.[319] 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

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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.

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

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 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 51 states (50 states and the District of Columbia). Because of the comprehensive nature of the modeling system, these states 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.

This approach is widely used in economic and jobs impact analyses. For example, as discussed below, there have been numerous studies conducted over the past five decades of the economic and jobs impacts of U.S. defense spending on local, regional, and national economies. These studies have determined that the jobs impacts are substantial.[320] Nevertheless, relatively few of the jobs are for workers making guns or bombs. Rather, the overwhelming majority of the jobs are indirect and induced: Jobs created by backward linkages to economic sectors that provide the materials needed for the defense industry's output, and by forward linkages to the economic sectors where the defense industry's employees spend their income. It is analogous for the jobs created by the green economy: Most of them are indirect or induced. This is the MISI approach. It estimates the total (direct, indirect, and induced) jobs created ex post by the green economy. It does not attempt to estimate green jobs ex ante by means of occupational classifications, industry sectors, surveys, "transactional triangulation," or other such methods. As discussed in Section IV.C., such methods yield estimates that are neither credible nor replicable and can differ by an order of magnitude.

Defense spending impact studies estimate the jobs impacts of defense expenditures. These include direct jobs in the defense facilities, the indirect jobs created, and the induced jobs created. Thus, induced jobs created by defense spending include occupations such as retail sales workers, waiters & waitresses, cooks, dry cleaning operatives, vehicle sales persons, highway maintenance workers, bakers, tailors, truck drivers, and so forth. To again paraphrase Gene Sperling, "If a defense production factory opens up, a Wal-Mart can be expected to follow. But the converse does not hold: A Wal-Mart opening definitely does not bring a defense plant with it."[321] Jobs in these occupations may not conform to conventional ideas of defense-related jobs, but they are nevertheless jobs created by defense spending. Analogously, jobs in these occupations may not conform to conventional ideas of green jobs, but they are nevertheless job created by the green economy.

A relevant example of this is a recent MISI analysis of the economic and jobs impacts of the Savannah River Nuclear Solutions (SRNS) Small-Business-related Program at the local, regional, and national levels.[322] MISI examined economic trends over the past decade and, through the use of a regional input-output model, estimated the economic and employment impacts from Fiscal Years (FYs) 2012 through 2020.[323]

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[320]See, for example https://stats.bls.gov/mlr/1993/04/art1full.pdf; https://www.belfercenter.org/publication/effect-us-economy-changes-defense-spending; https://www.jstor.org/stable/143531.

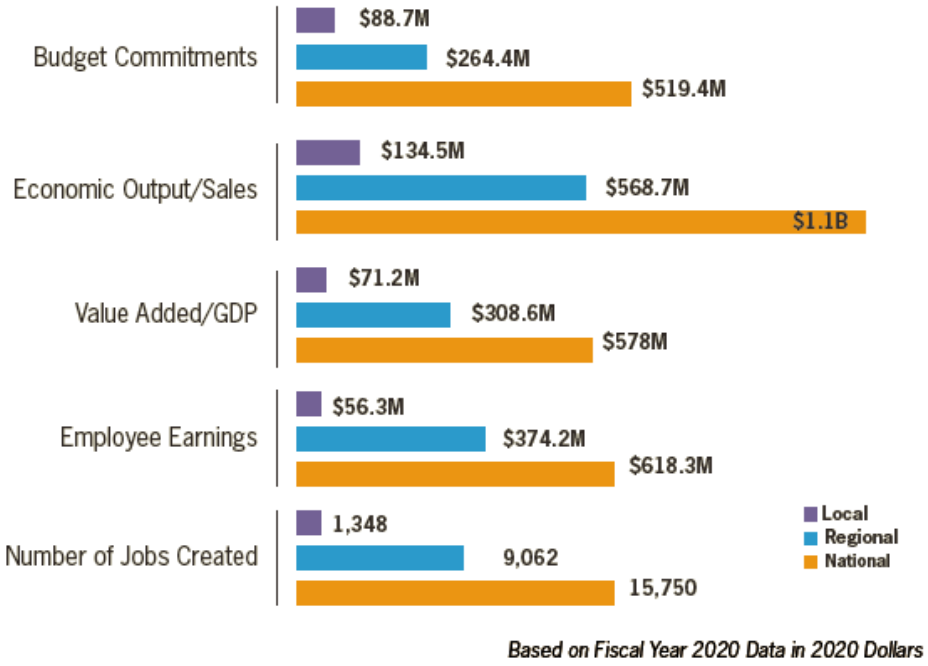
[321]https://obamawhitehouse.archives.gov/sites/default/files/administration-official/sperling_-_renaissance_of_american_manufacturing_-_03_27_12.pdf.

[322]Management Information Services, Inc., "Economic Impacts of Savannah River Nuclear Solutions Small Business-Related Budget Commitments, FY2012 - FY2020," prepared for Savannah River Nuclear Solutions, August 2021.

[323]MISI used the RIMSII model, which is managed and updated by the Regional Economic Analysis Division within the Bureau of Economic Analysis, U.S. Department of Commerce. See *RIMS-II: An Essential Tool*

MISI determined that the SRNS Small Business-related Program has played a significant role in providing an environment for small business success not just locally, but also nationally.[324] MISI found that the program has benefitted businesses in not just the five county local area, but in all 50 states and the District of Columbia. Nationally over the nine-year period, program commitments accounted for over $3 billion of SRNS expenditures leading directly and indirectly to estimates of $6.3 billion in additional sales, a contribution to GDP of $3.4 billion, $3.6 billion in payroll earnings, and approximately 15,000 jobs each year – Figure V-4.[325]

Figure V-4
Economic Impact of SRNS Procurement



Source: Savannah River Nuclear Solutions and MISI.

Expanding the geographic scope to the 50 states and the District of Columbia, SRNS commitments were $519 million in FY20, leading to just over one billion dollars in total output and a $578 million contribution to value added. Employee earnings nation-wide reached just over $618 million and MISI estimated that 15,750 jobs were generated in FY20. The salient point is that most of the jobs created were indirect and induced, many of them were nonlocal, and many of them would not be conventionally defined as being "nuclear jobs." Nevertheless, they are jobs created by SRNS.

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for Regional Developers and Planners, 2020, https://www.bea.gov/sites/default/files/methodologies/RIMSII_User_Guide.pdf.

[324]SRNS is a DOE industrial complex responsible for disposition of nuclear materials, waste management, environmental cleanup, and environmental stewardship.

[325]The economic and employment impacts are defined as the total direct, indirect, and induced impacts.

Finally, it is worth noting that many of the critics of green jobs studies discount or deride the classification of occupations such as Refuse and Recycle Workers, Hazardous Materials Removal Workers, Septic Tank Cleaners, Insulation Workers, etc. as green jobs. They contend that all that is being done to inflate green jobs numbers is to reclassify many existing jobs as "green."[326] Similarly, critics of the MISI approach will contend that classifying indirect and induced occupations such as Retail Sales Workers, Waiters & Waitresses, Cooks, Dry Cleaning Operatives, Vehicle Sales Persons, Bakers, Tailors, Truck Drivers, Assemblers, Mechanical Engineers, Maintenance and Repair Workers, Machinists, Purchasing Agents, Customer Service Representatives, Industrial Machinery Mechanics, Shipping and Receiving Clerks, Maintenance and Repair Workers, Janitors and Cleaners, Dispatchers, Security Guards, Operating Engineers, Receptionists, etc. as green jobs is not legitimate.

Such criticisms are unwarranted and are not valid. First, just because occupations such as Recycle Workers, Hazardous Materials Removal Workers, Septic Tank Cleaners, and Insulation Workers may not be as glamorous or well-paying as occupations such as Ecologist, Environmental Engineer, Solar Energy Installer, Fuel Cell Researcher, or Wind Turbine Technician does not mean that they are any less green. Unfortunately, advocates' emphasis on the latter types of green jobs has not been helpful and, as has been discussed, has often served to narrow the green job concept and to greatly underestimate the size and importance of the green economy and green jobs.

Second, jobs created – direct, indirect, or induced -- by the U.S. green economy should be evaluated as such. As discussed, such job creation is accepted in studies of the economic and jobs impacts of defense spending, local industrial and commercial projects, hospitals, highways, etc. Such job creation must also be accepted in studies of the economic and jobs impacts of the green economy.

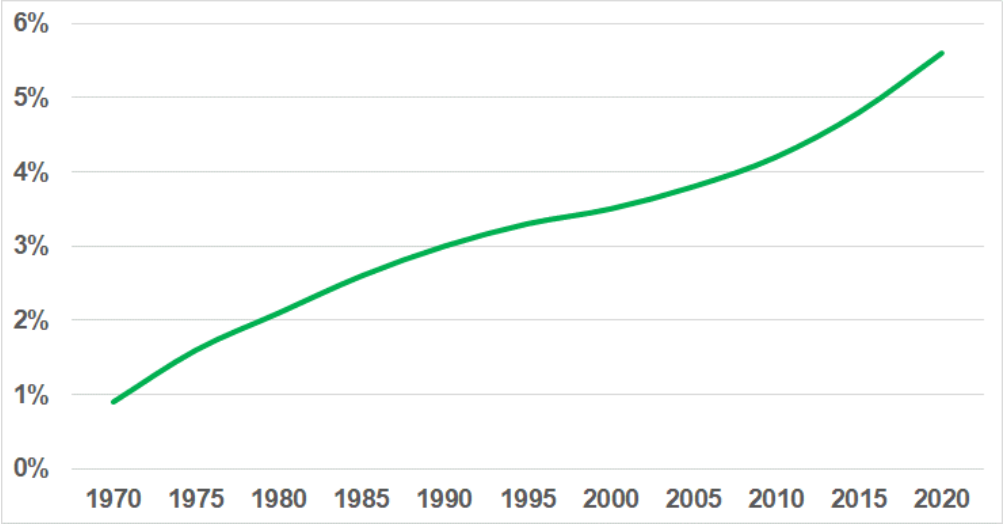
V.E. Macro Forecasts

Figure V-5 shows the U.S. jobs generated by the green economy as a percent of total U.S. jobs, 1970 – 2020.[327] This figure illustrates that over the past five decades, jobs generated by the U.S. green economy have steadily increased as a proportion of total jobs. From 1970 to 2020:

- Total U.S. jobs increased from 78.7 million to 147.8 million – an increase of a factor of 1.9 (1.9X).
- Jobs generated in the U.S. green economy increased from about 700,000 to over 8 million – an increase of 12X.
- Thus, jobs generated in the U.S. green economy increased about six times more rapidly than did total U.S. employment.
- U.S. green jobs as a percent of total U.S. jobs increased from less than 1% to nearly 6%.

[326]See, for example, https://calsmallbusinessalliance.org/green-jobs-still-a-small-fraction-of-the-california-economy/.
[327]Historical U.S. employment data retrieved from https://www.bls.gov/cps/cpsaat01.htm.

Figure V-5
Jobs Generated by the U.S. Green Economy
as a Percent of Total U.S. Jobs, 1970 - 2020



Source: U.S. Bureau of Labor Statistics and MISI.

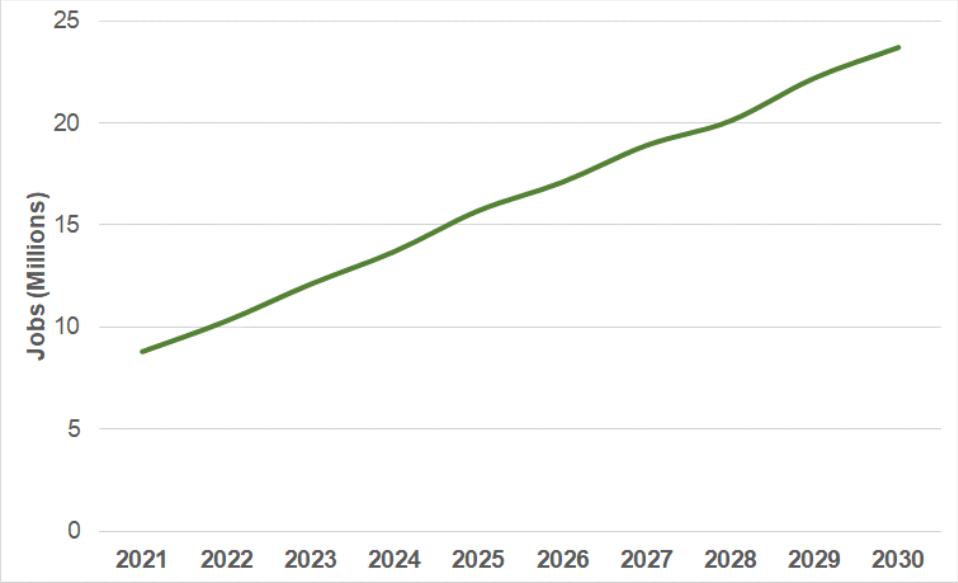
While the jobs generated in the U.S. green economy in 2020 totaled about 8.3 million and constituted less than 6% of total U.S. jobs, these jobs should be assessed in perspective. For example, in 2020 these jobs:

- About equaled the total number of jobs in New York State.
- Totaled 40% more than the total number of jobs in Illinois.
- Totaled 65% more than the total number of jobs in Indiana.
- Totaled 75% more than the total number of jobs in Georgia.
- Totaled twice the total number of jobs in Virginia.
- Totaled 2.5 times the total number of jobs in Arizona.
- Totaled three times the total number of jobs in Missouri.

Figures V-6 and V-7 show that over the coming decade, MISI forecasts that the jobs generated in the U.S. green economy will steadily increase, both in total and as a proportion of total jobs. From 2021 to 2030:

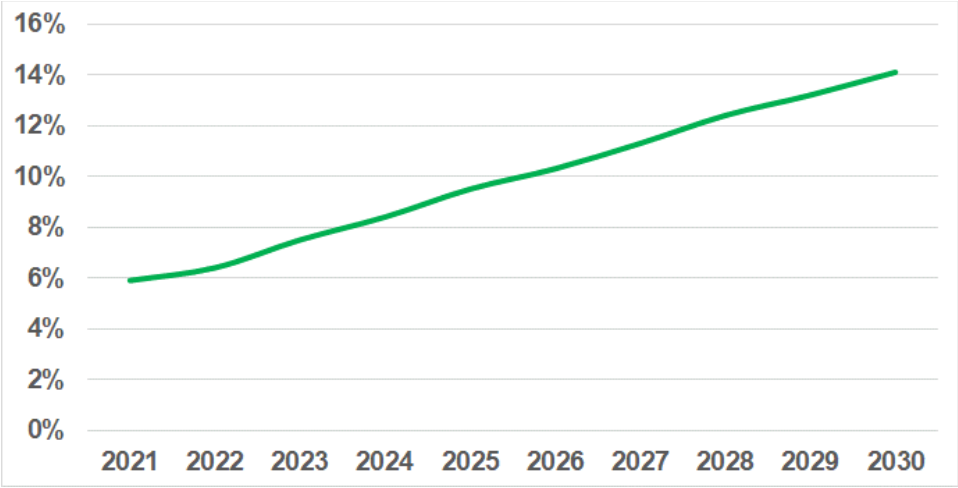
- Total U.S. jobs are forecast to increase from 153 million to 168 million – an increase of 10%, or 1.1X.
- Jobs generated in the U.S. green economy are forecast to increase from about 8.8 million to 23.7 million – an increase of 2.7X.
- Thus, jobs generated in the U.S. green economy are forecast to increase about eight times more rapidly than total U.S. employment.
- Jobs generated in the U.S. green economy as a percent of total U.S. jobs are forecast more than double, to increase from about 6% to about 14%.

Figure V-6
Jobs Generated by the U.S. Green Economy Forecast, 2021 - 2030



Source: U.S. Bureau of Labor Statistics,
U.S. Energy Information Administration, and MISI.

Figure V-7
Jobs Generated by the U.S. Green Economy
as a Percent of Total U.S. Jobs Forecast, 2021 - 2030



Source: U.S. Bureau of Labor Statistics,
U.S. Energy Information Administration, and MISI.

While the jobs generated in the U.S. green economy forecast by MISI in 2030 total nearly 24 million and constitute just over 14% of total U.S. jobs, these jobs should be assessed in perspective. For example, in 2030 these jobs are forecast to be:[328]

- Nearly 25% more than total number of jobs in California – the state with the most jobs
- 55% more than total number of jobs in Texas – the state with the second most jobs.
- More than twice the total number of jobs in Florida – the state with the third most jobs.
- Four times more than total number of jobs in Pennsylvania.
- More than five times larger than total number of jobs in Michigan.
- Nearly seven times more than total number of jobs in Arizona.

More generally, Figures V-5, V-6, and V-7 illustrate the increasing prominence of jobs generated by the U.S. green economy -- actual and forecast -- over six decades, from 1970 to 2030. For example:

- From 1970 to 2030, jobs generated by the U.S. green economy are forecast to increase from 0.73 million to 23.7 million – a 32X increase.
- Over this same six decades, total U.S. jobs are forecast to increase from 78.7 million to 168 million by 2030 – a 2X increase.
- Over these six decades, jobs generated by the U.S. green economy are forecast to increase by 2030 nearly 16 times as rapidly as total U.S. jobs.
- From 1970 to 2030 jobs generated by the U.S. green economy are forecast to increase from less than 1% of total U.S. jobs to more than 14% of total U.S. jobs.

These forecasts, like any forecasts, are subject to a considerable degree of uncertainty, and the further in the future the forecast, the higher degree of uncertainty. There is a relatively high degree of confidence in the forecast of total U.S. employment through 2030. It is based primarily on long term demographic trends, labor force participation rates, and assumptions about unemployment rates.

However, the forecasts of the jobs generated by the U.S. green economy are subject to a higher degree of uncertainty. While there is a high degree of confidence that the number of green jobs will continue to increase and that the increase in the proportion of green jobs over the past half-century as a percent of total U.S. jobs will continue, the rate of increase of jobs generated by the green economy is subject to considerable uncertainty. For example:

[328]MISI derived state employment forecasts through 2030 from data and forecasts available from BLS, the U.S. Census Bureau, EIA, and the Weldon Cooper Center for Public Service, Demographics Research Group: U.S. Energy Information Administration, *Annual Energy Outlook 2021,* op. cit.; U.S. Bureau of Labor Statistics, "Employment Projections, 2020-2030," https://www.bls.gov/news.release/pdf/ecopro.pdf; U.S. Census Bureau, https://www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1144.pdf; Weldon Cooper Center for Public Service, Demographics Research Group, University of Virginia, https://demographics.coopercenter.org/national-population-projections.

- Following EIA conventions, the forecasts are based on current, existing (as of late 2021) policies and enacted legislation.[329]
- The rate of green economy and jobs growth could accelerate if additional environmental legislation and more aggressive renewable energy and climate change incentives and mandates – such as those outlined in COP26 -- are enacted at the national and state levels.[330]
- The rate of green economy growth could decrease if there is a lessening of green awareness and a backlash against ambitious environmental and climate legislation and regulations.[331]
- Unforeseen circumstances, such as severe recessions, pandemics, political developments, etc., could materially affect the forecasts.

Since the degree of uncertainty increases with the time horizon of the forecast, by 2030 jobs generated by the green economy as a percent of total U.S. jobs could likely be anywhere between 12% and 16% -- 20 million to 27 million jobs.

Further, the MISI estimates of the jobs created by the U.S. green economy must be assessed in perspective. MISI estimates that the jobs created by the U.S. green economy in 2021 totaled 8.8 million, less than 6% of total U.S. jobs, and that in 2030 will total 23.7 million – a little over 14% of total U.S. jobs. Even under optimistic assumptions, the jobs created by the U.S. green economy in 2030 will likely not exceed about 27 million – 16% of total U.S. jobs. Thus, for the foreseeable future, the overwhelming majority of U.S. jobs, about 85%, will not be "green" by any definition. This issue is discussed further below.

V-F. Job Forecasts by Industry and Occupation

Table V-5 shows the jobs forecast to be generated by the U.S. green economy in 2030, by major industry group. Figure V-6 shows distribution of the jobs generated by the U.S. green economy in 2030, by major industry group compared to all U.S. jobs

Figure V-8 shows that jobs generated by the U.S. green economy are disproportionately concentrated in several industrial sectors (they comprise a larger portion of jobs in these sectors than do total U.S. jobs), including:

- Utilities.
- Construction.
- Manufacturing.
- Professional, Scientific, and Technical Services.
- Administrative Support, Waste Management, and Remediation Services.
- Miscellaneous Services.

[329]See U.S. Energy Information Administration, *Annual Energy Outlook 2021*, op. cit.
[330]See https://ukcop26.org/.
[331]For example, such as the "yellow vest" protests in France; https://www.reuters.com/article/us-france-electricity/yellow-vests-put-french-government-on-spot-over-power-prices-idUSKCN1PO25Y.

- Public Administration.

In the other major industrial sectors, jobs generated by the U.S. green economy are relatively less concentrated than overall U.S. jobs.

Table V-5
Jobs Generated by the U.S. Green Economy in 2030, by Major Industry Group

Industry	2017 NAICS code	Jobs (thousands)
Agriculture, Forestry, Fishing and Hunting	11	198
Mining	21	95
Utilities	22	208
Construction	23	2,080
Manufacturing	31-33	2,423
Wholesale Trade	42	967
Retail Trade	44-45	823
Transportation and Warehousing	48-49	755
Information	51	436
Finance and Insurance	52	487
Real Estate and Rental and Leasing	53	218
Professional, Scientific, and Technical Services	54	3,572
Management of Companies and Enterprises	55	276
Administrative/Support/ Waste Management/ Remediation Services	56	2,883
Educational Services	61	330
Health Care and Social Assistance	62	456
Arts, Entertainment, and Recreation	71	218
Accommodation and Food Services	72	1,505
Other Services	81	1,966
Public Administration	92	3,783
Total		23,712

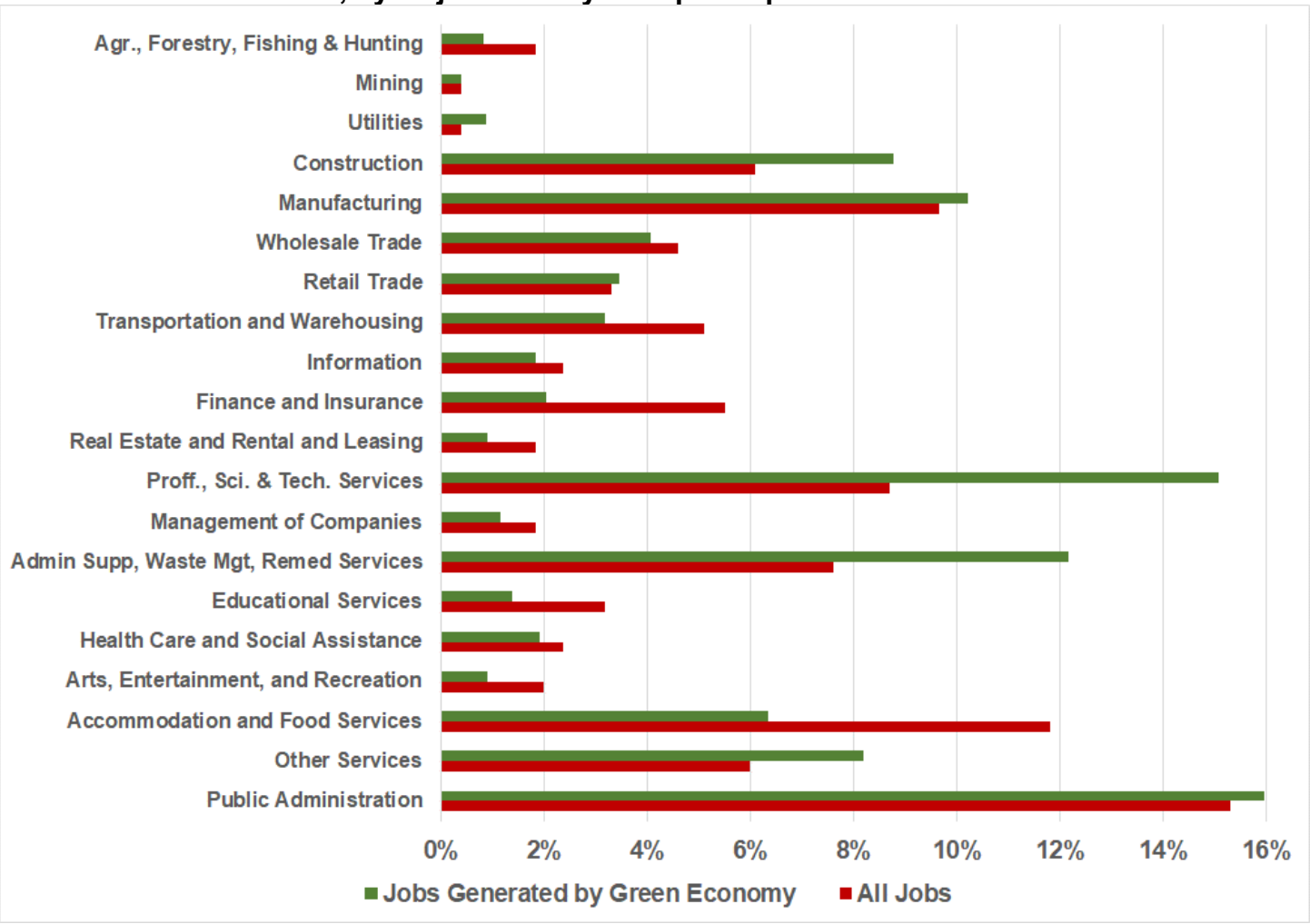
Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and Management Information Services, Inc.

Comparison of the industrial sector distribution of jobs generated by the U.S. green economy in 2030 with that of total U.S. 2030 employment is instructive. A significant portion of the green jobs is in the public administration sector which, given the public nature of green programs and initiatives, is to be expected. However, most of the jobs generated by the U.S. green economy are in the private sector, and focusing on these reveals that they are heavily concentrated in several sectors. Specifically:

- Of particular note is that the private sector green industry is more manufacturing intensive than other U.S. private sector activity. Over 10% of private sector jobs generated by the U.S. green economy are in manufacturing, compared to less than 10% in manufacturing among all U.S. private sector industrial activities.
- Over 15% of private sector jobs generated by the U.S. green economy are in professional, scientific, and technical services, compared to less than 9% of all private sector jobs.

- Over 12% of private sector jobs generated by the U.S. green economy are in administrative, support, and waste management services, compared to less than 8% of all private sector jobs.
- Nearly 9% of private sector jobs generated by the U.S. green economy are in construction, compared to 6% of all private sector jobs.
- Nearly 1% of private sector jobs generated by the U.S. green economy are in utilities, compared to less than 0.5% of all private sector jobs.

Figure V-8
Distribution of the Jobs Generated by the U.S. Green Economy in 2030, by Major Industry Group Compared to All U.S. Jobs



Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and Management Information Services, Inc.

Conversely, there are relatively fewer jobs generated by the U.S. green economy in other parts of the U.S.:

- Only 2% of jobs generated by the U.S. green economy are in the finance and insurance sector, compared to nearly 6% among all private sector jobs.
- Just over 3% of jobs generated by the U.S. green economy are in the transportation and warehousing sector, compared to over 5% among all U.S. jobs.
- Just over 6% of private sector jobs generated by the U.S. green economy are in accommodation and food services, compared to nearly 12% of all private sector jobs.
- About 1.4% of jobs generated by the U.S. green economy are in the educational services sector, compared to over 3% of all U.S. jobs.
- Less than 1% of jobs generated by the U.S. green economy are in agriculture, forestry, fishing, and hunting, compared to about 2% of all U.S. jobs.
- Less than 1% of jobs generated by the U.S. green economy are in the arts, entertainment, and recreation sector, compared to 2% of all U.S. jobs.

The concentration of green jobs within certain industrial sectors is instructive and interesting. While accounting for about 14% of total 2030 U.S. employment, the industrial sector composition of jobs generated by the U.S. green economy is skewed in favor of certain sectors. For example, more than 15% of jobs generated by the U.S. green economy are in professional, scientific, and technical services, compared to less than 9% of all private sector jobs, and more than 10% of private sector jobs generated by the U.S. green economy are in manufacturing, compared to less than 10% of all U.S. employment. This indicates that green investments will provide a greater than proportionate assist to U.S. high-tech and manufacturing sectors. The U.S. is seeking to modernize and expand its high-tech industrial and manufacturing base. Table V-5 and Figure V-6 indicate that the green industry can aid in this objective.

Similarly, green investments generate disproportionately more jobs in professional, scientific, and technical services than the U.S. average. Jobs in this sector are the high-skilled, high-wage, technical and professional jobs that the U.S seeks to promote. Table V-5 and Figure V-8 indicate that investments in the green economy can be of assistance here.

Table V-6 and Figure V-9 show the jobs generated by the U.S. green economy in 2030, by select detailed industry group. Examining the jobs generated by the green economy indicates that the impact is distributed across the entire economy and all industries. The industries involved are not surprising given the parts they will play in the evolving transformation to an increasingly green economy and subsequent economic growth. Some of the industries showing the largest jobs impacts are listed and will play an important part in the emerging green economy. For example:

- Construction -- the industry receives a direct stimulus from green economy and related infrastructure expenditures in addition to receiving a positive indirect impact from improvement in overall economic growth due to energy savings.
- Professional, scientific, and technical services -- the industry and its employees play a large part in driving the new green technologies and applications.
- Waste management and remediation services -- the industry will play an obvious major role and in environmental protection and in supplying biogas.

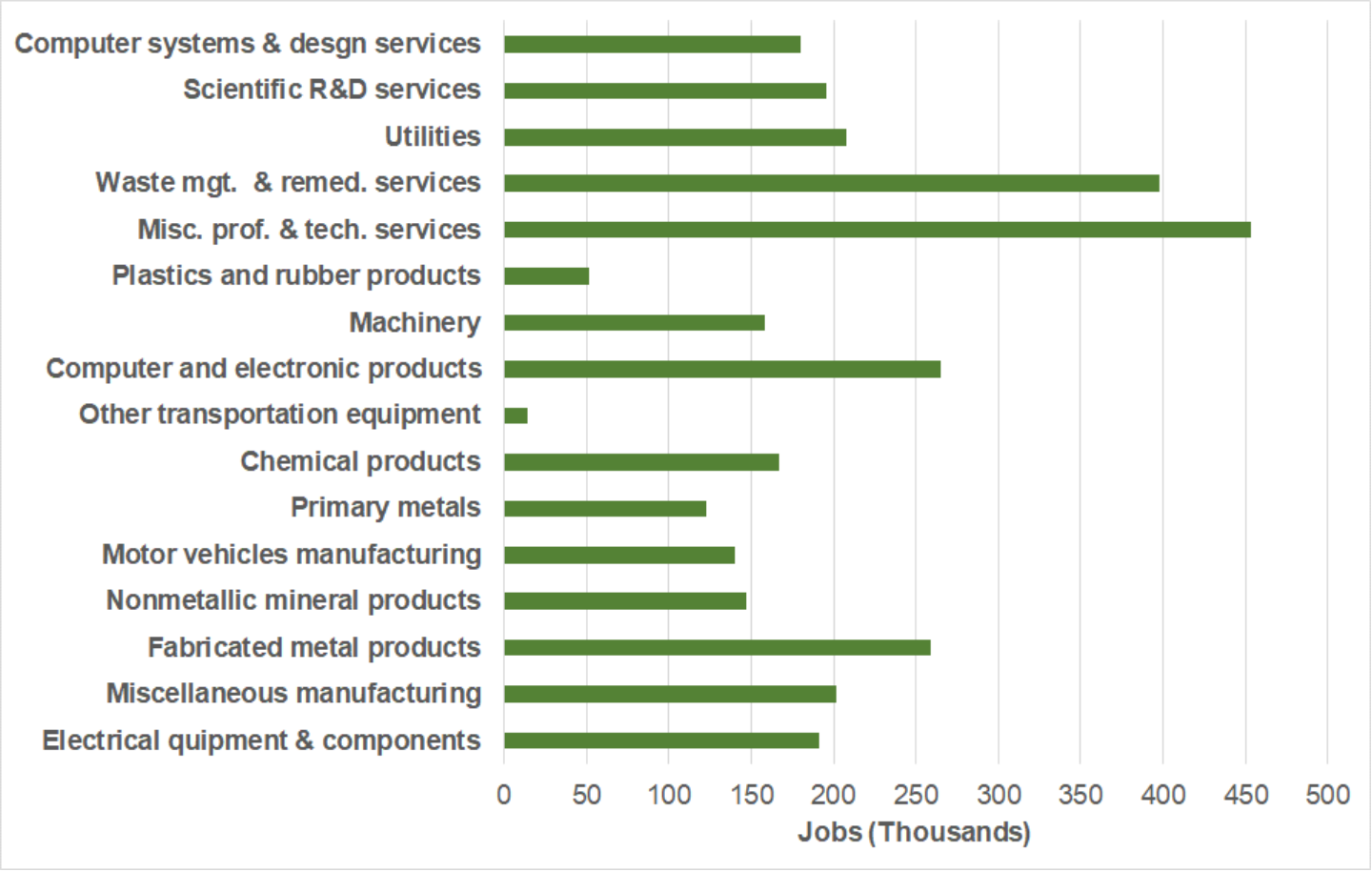
- Electrical equipment, appliances, and components -- the industry will be relied upon to supply not only new electrical components and testing equipment to all the green electric energy technologies, but will also facilitate efficiencies in the smart grid from generation to final consumer use.
- Miscellaneous manufacturing – green economy growth will require the manufacturing industry's output, and it is indirectly stimulated by overall economic growth.
- Fabricated metal products -- the industry will be the primary supplier of parts, products, and systems for the photovoltaic, wind, hydrogen, concentrating solar, fuel cell, and other green technologies.
- Nonmetallic mineral products -- the industry supplies major products that will be in high demand in several green technologies, especially glass and fiberglass.
- Utilities -- electric and gas energy supply transitions to green technologies and is stimulated by requirements for distributed energy resources and additional electric transmission and distribution, and the industry will also be stimulated by various energy efficiency initiatives.
- Motor vehicle manufacturing -- the industry will be stimulated by green energy transportation improvements that promote R&D and vehicle sales as the U.S. rolling stock turns over and by increasing requirements for fuel efficient vehicles, hybrids, and ZEVs.
- Computer systems design and related services -- the industry will be stimulated by distributed energy solutions, smart buildings, the smart grid, and other green economy applications.
- Primary metals -- as supplier of metal for finished products, this industry will be indirectly impacted by increased demand from other manufacturing industries.
- Chemical products -- the industry will benefit from the growth of biofuels and biomass.
- Other transportation equipment -- transportation energy efficiency improvements will favorably impact this industry.

Table V-6
Jobs Generated by the U.S. Green Economy in 2030, by Select Detailed Industry Group

Industry Title	Jobs (thousands)
Select Manufacturing Industries	
Electrical equipment, appliances, and components	191
Miscellaneous manufacturing	202
Fabricated metal products	259
Nonmetallic mineral products	147
Motor vehicles manufacturing	140
Primary metals	123
Chemical products	167
Other transportation equipment	14
Computer and electronic products	265
Machinery	158
Plastics and rubber products	52
Wood products	48
Paper products	39
Textile mills and textile product mills	28
Other Industries	
Construction	2,081
Miscellaneous professional, scientific and technical services	453
Waste management and remediation services	398
Utilities	208
Scientific R&D services	196
Computer systems design and related services	180
Total Jobs (including industries not listed separately)	23,712

Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.

Figure V-9
Jobs Generated by the U.S. Green Economy
in 2030, by Select Detailed Industry Group



Source: U.S. Bureau of Labor Statistics,
U.S. Energy Information Administration, and MISI.

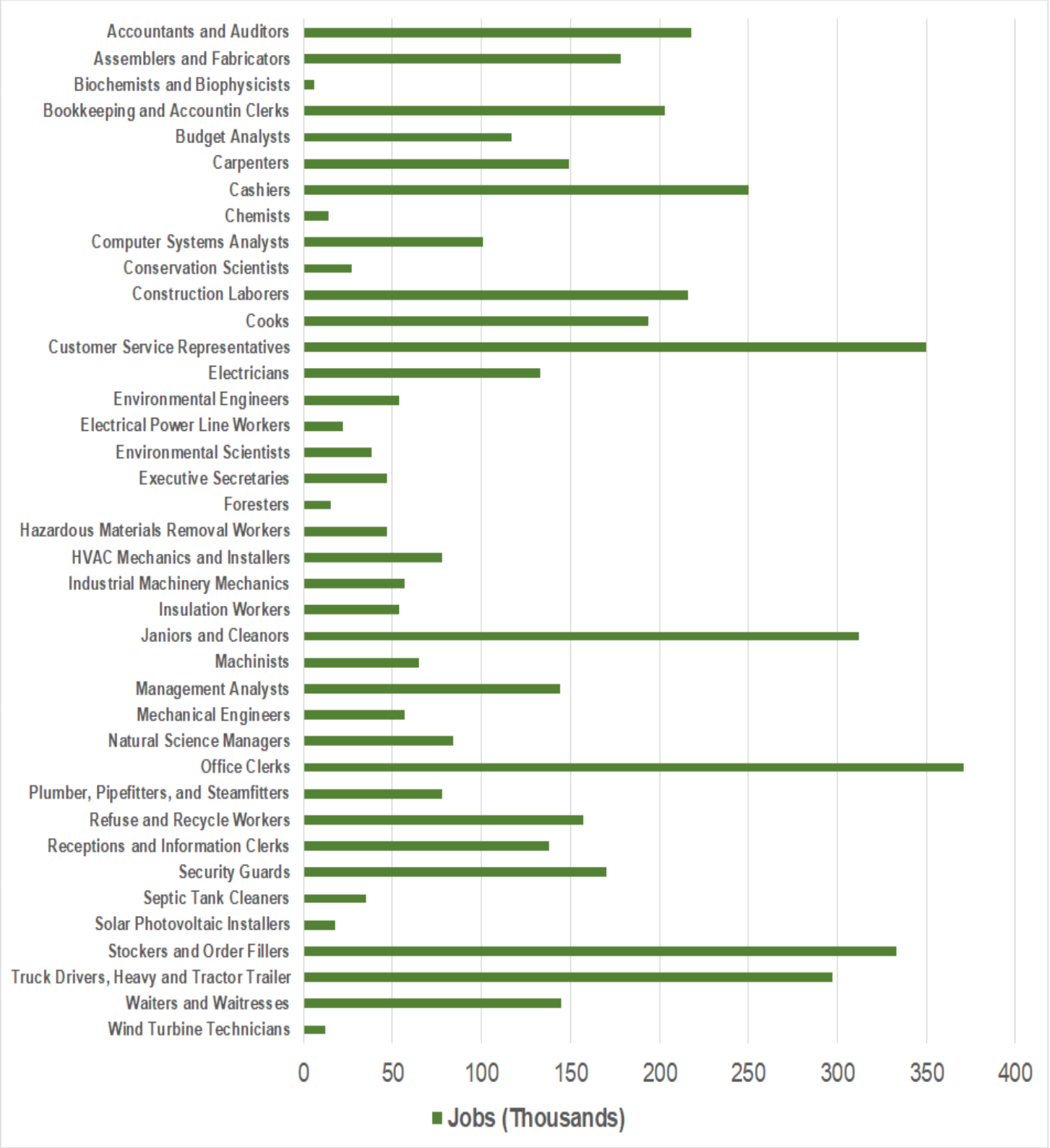
Jobs generated by the U.S. green economy in 2030 can be disaggregated by specific occupations and skills, and this information for selected occupations is given in Table V-8 and Figure V-10. This table and figure illustrate that jobs in 2030 are widely distributed among all occupations and skill levels and, while the number of jobs created in different occupations varies substantially, employment in virtually all occupations is generated by the green economy and green industries.

Table V-8
Jobs Generated by the U.S. Green Economy in 2030, by Selected Occupations

Occupation	Jobs (Thousands)
Accountants and Auditors	218
Assemblers and Fabricators	178
Biochemists and Biophysicists	6
Biological Technicians	15
Bookkeeping, Accounting, and Auditing Clerks	203
Budget Analysts	117
Carpenters	149
Cashiers	250
Chemists	14
Computer and Information Analysts	132
Computer Systems Analysts	101
Conservation Scientists	27
Construction Laborers	216
Cooks	194
Cost Estimators	28
Database Administrators	115
Customer Service Representatives	350
Dispatchers	41
Electrical and Electronic Engineering Technicians	18
Electricians	133
Environmental Engineering Technicians	19
Environmental Engineers	54
Electrical Power Line Installers and Repairers	22
Environmental Scientists and Specialists, Including Health	38
Executive Secretaries and Administrative Assistants	47
Financial Managers	97
Geoscientists, Except Hydrologists and Geographers	29
Foresters	15
Hazardous Materials Removal Workers	47
Health and Safety Engineers	23
Human Resources Managers	23
HVAC Mechanics and Installers	78
Industrial Engineers	57
Industrial Machinery Mechanics	72
Inspectors, Testers, Sorters, Samplers, and Weighers	54
Insulation Workers, Floor, Ceiling, and Wall	35
Janitors and Cleaners, Except Maids and Housekeeping Cleaners	312
Landscape Architects	20
Laundry and Dry-cleaning Workers	13
Machinists	65
Management Analysts	144
Mechanical Engineers	57
Natural Science Managers	84
Office Clerks	371
Operations Research Analysts	17
Plumber, Pipefitters, and Steamfitters	78
Public Relations Specialists	43
Refuse and Recyclable Material Collectors	157
Sales Representative, Technical and Scientific Products	51
Receptionists and Information Clerks	138
Sales Representatives, Services	317
Security Guards	170
Septic Tank Cleaners	35
Solar Photovoltaic Installers	18
Stockers and Order Fillers	333
Truck Drivers, Heavy and Tractor Trailer	297
Waiters and Waitresses	145
Water and Liquid Waste Treatment Operators	119
Welders, Cutters, Solders, and Brazers	68
Wind Turbine Technicians	12
Woodworkers	41

Source: BLS, EIA, and MISI.

Figure V-10
Jobs Generated by the U.S. Green Economy in 2030, by Selected Occupations



Source: U.S. Bureau of Labor Statistics,
U.S. Energy Information Administration, and MISI.

The importance of the green economy for jobs in some occupations is much greater than in others. For some occupations, such as Environmental Scientists and Specialists, Environmental Engineers, Hazardous Materials Workers, Water and Liquid Waste Treatment Plant Operators, Environmental Science Protection Technicians, Wind Turbine Technicians, Refuse and Recyclable Material Collectors, and Environmental Engineering Technicians, most or virtually all of the demand in is created by the green economy. This is hardly surprising, for most of these jobs are clearly identifiable as "green" jobs. Thus, the U.S. green economy in 2030 is forecast to generate most or virtually all of the jobs for clearly green occupations such as:

- Conservation Scientists
- Environmental Engineers
- Environmental Engineering Technicians
- Environmental Scientists and Specialists
- Geoscientists
- Foresters
- Hazardous Materials Removal Workers
- Health and Safety Engineers
- Insulation Workers
- Natural Science Managers
- Refuse and Recyclable Material Collectors
- Septic Tank Cleaners
- Solar Photovoltaic Installers
- Water and Liquid Waste Treatment Plant Operators
- Wind Turbine Technicians

However, in many occupations not traditionally identified as green, a greater than proportionate share of the jobs are also generated by the green economy. Recalling that, on average, in 2030 just over 14% of U.S. employment, in 2030 the green economy is forecast to generate jobs for a greater than proportionate share of many occupations. The U.S. green economy in 2030 is forecast to generate disproportionately large numbers of jobs – proportionately larger than the percent the jobs comprise of the total BLS 2030 forecast for that occupation -- for occupations, such as:

- Biochemists and Biophysicists
- Biological Technicians
- Carpenters
- Chemists
- Computer Systems Analysts
- Database Administrators
- Electricians
- Electrical Power Line Installers and Repairers
- HVAC Mechanics and Installers
- Industrial Engineers
- Machinists
- Mechanical Engineers
- Plumbers

- Sales Representatives, Technical and Scientific Products
- Welders

The U.S. green economy in 2030 is forecast to generate disproportionately smaller numbers of jobs – proportionately smaller than the percent the jobs comprise of the total BLS 2030 forecast for that occupation -- for occupations such as:

- Bookkeeping, Accounting, and Auditing Clerks
- Budget Analysts
- Cashiers
- Cooks
- Customer Service Representatives
- Dispatchers
- Executive Secretaries
- Financial Mangers
- Human Resource Managers
- Janitors
- Laundry and Dry-cleaning Workers
- Management Analysts
- Office Clerks
- Operations Research Analysts
- Receptionists
- Sales Representatives, Services
- Waiters and Waitresses

Nevertheless, it must once again be emphasized that the vast majority of the jobs generated by the U.S. green economy in 2030 are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. and most of the persons employed in these jobs may not even realize that they owe their livelihood to the green economy. Further, for most of the clearly green occupations the number of jobs created is relatively small compared to the jobs in most other occupations. Thus, Table V-8 and Figure V-10 show that the U.S. green economy in 2030 is forecast to generate:

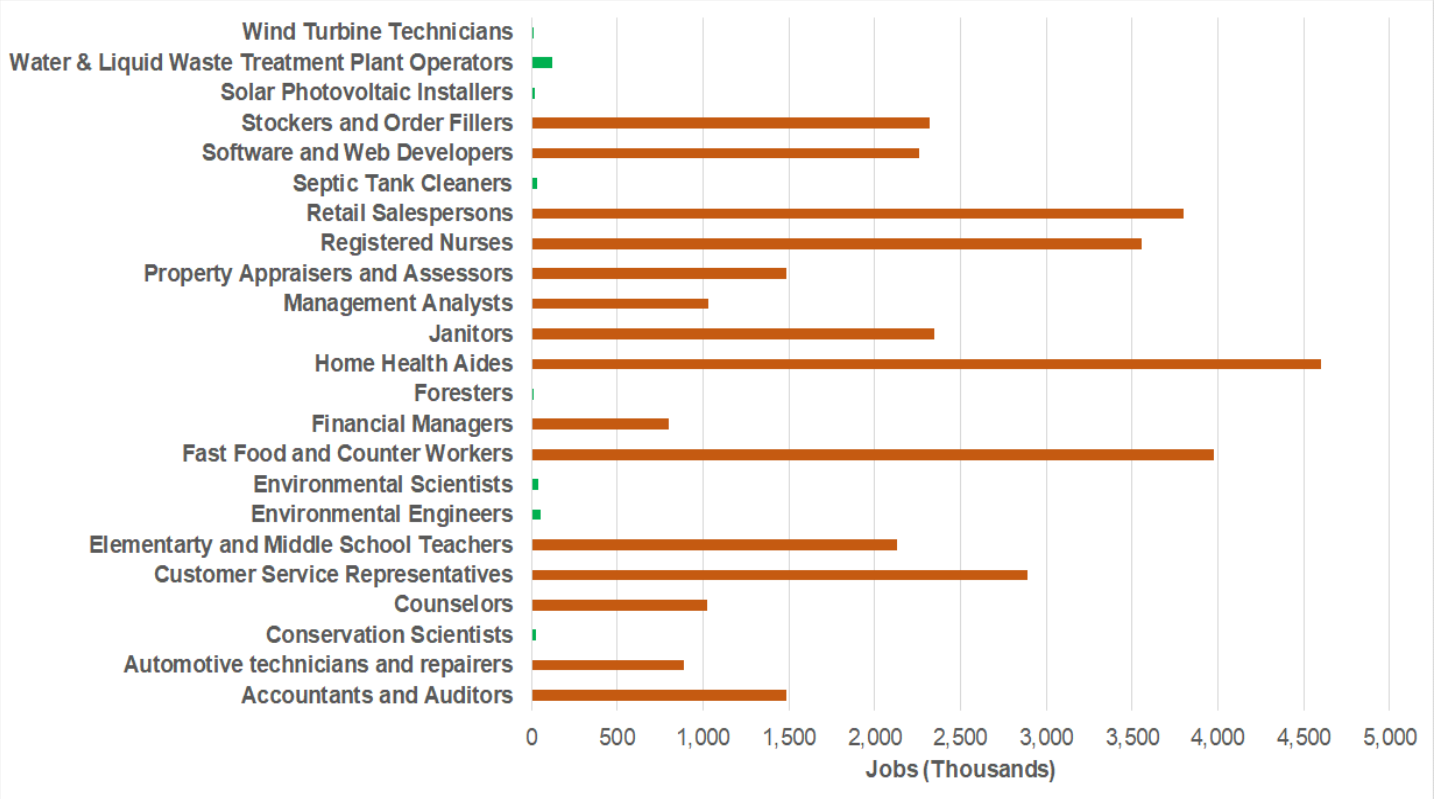
- More than eight times as many jobs for Accountants and Auditors (218,000) than for Conservation Scientists (27,000)
- Nearly five times as many jobs for Cashiers (250,000) as for Environmental Engineers (54,000)
- Nearly ten times as many jobs for Management Analysts (144,000) than for Foresters (15,000)
- Nearly eight times as many jobs for Receptionists (138,000) than for Solar Photovoltaic Installers (18,000).
- More than eight times as many jobs for Financial Analysts (97,000) than for Wind Service Technicians (12,000).
- More than four times as many jobs for Office Clerks (371,000) than for Natural Science Managers (84,000).

- Nearly ten times as many jobs for Security Guards (170,000) than for Environmental Science Technicians (19,000).
- Nearly six times as many jobs for Construction Laborers (194,000) than for Septic Tank Cleaners (35,000).

Thus, many U.S. workers are dependent on the green economy for their employment, although they often would have no way of recognizing that connection unless it is brought to their attention.

The discrepancies in the numbers of jobs created are due to the simple fact that the overwhelming majority of jobs in the BLS occupational classifications are not "green." This is illustrated in Figure V-11 which compares the BLS 2030 occupational job forecasts for select clearly green occupations with other occupations in which there are many more jobs.

Figure V-11
Comparison of BSL 2030 Occupational Job Forecasts For Select Occupations



Source: U.S. Bureau of Labor Statistics,
U.S. Energy Information Administration, and MISI.

Green jobs and jobs generated by the U.S. green economy are, in general, increasing more rapidly than overall U.S. employment. However, as illustrated in Figure V-11, in 2030, as currently, there are many more jobs in occupations that are not green. Thus, for example, BLS forecasts that in 2030 there will be:

- 221 times as many jobs for Fast Food and Counter Workers (3,973,000) as for Solar Photovoltaics Installers (18,000).
- 76 times as many jobs for Customer Service Representatives (2,889,000) than for Environmental Scientists (38,000).
- 156 times more jobs for Janitors (2,344,000) than for Foresters (15,000).
- 70 times as many jobs for Retail Sales Workers (3,796,000) than for Environmental Engineers (54,000).
- 132 times as many jobs for Registered Nurses (3,557,000) than for Conservation Scientists (27,000).
- 39 times more jobs for Home Health Aides (4,601,000) than for Water and Liquid Waste Treatment Plant Operators (119,000).
- 74 times as many jobs for Automotive Technicians and Repairers (889,000) than for Wind Turbine Technicians (12,000).

Nevertheless, the findings derived here are significant for they indicate that investments in renewable energy, energy efficiency, green initiatives, and environmental protection will create jobs in greater than proportionate shares in two critical categories:

- College-educated professional workers, many with advanced degrees.
- Highly skilled, technical workers, with advanced training and technical expertise, many of them in the manufacturing sector.

Jobs generated by the U.S. green economy are disproportionately for highly skilled, well paid, technical and professional workers, who in turn underpin and provide the foundation for entrepreneurship and economic growth. This finding is of obvious significance for U.S. economic, energy, labor, workforce, and education and training policies.

V.G. Forecasts of Emerging Green Occupations and Skill Requirements

Examples of the type of new jobs and requisite skill requirements being created in the green economy discussed above – and the associated challenges for workforce planning – can be illustrated by assessing the rapidly growing hydrogen and fuel cell industries. Growth in the hydrogen (H_2) and fuel cell (FC) industries will lead to substantial new employment opportunities, and these will be created throughout a wide variety of industries, skills, tasks, and earnings.[332] However, many of these jobs do not currently exist and do not have occupational titles defined in official classifications – as is the case

[332]For example, ASEA/MISI found that widespread hydrogen energy and fuel cell market penetration could create nearly 1 million new jobs in the U.S. by 2030; see American Solar Energy Association and Management Information Services, Inc. "Defining, Estimating, and Forecasting the Renewable Energy and Energy Efficiency Industries in the USA and in Colorado," https://ases.org/wp-content/uploads/2019/01/CO_Jobs_Rpt_summary.pdf.

for many new and emerging green economy jobs. In addition, many of these jobs require different skills and education than current jobs, and training requirements must be assessed so that this rapidly growing part of the economy has a sufficient supply of trained and qualified workers. In this section we identify by occupational titles and job descriptions the new jobs that will be created in the expanding hydrogen/fuel cell economy, estimate the average salary for each job, identify the minimum educational attainment required to gain entry into that occupation, specify the recommended university degree for the advanced educational requirements, and provide relevant job descriptions. The findings here can be applied to a wide range of industries, occupations, and skills being created and expanded in the green economy.[333]

In the countless volumes written in recent years about the emerging H_2/FC economy, very little has focused on the requisite jobs and corresponding education, skills and training required and the likely earnings that can be expected. Here we remedy this by:

- Identifying the unique occupational titles of the new jobs that will be created in the H_2/FC economy.
- Specifying the most important qualifications and skills that employers will be seeking.
- Estimating the average U.S. salary for each job.
- Identifying the minimum educational attainment necessary to gain entry into each occupation.
- Specifying the recommended university degree for the advanced educational requirements.
- Matching occupational titles with detailed job descriptions.

Table V-9 shows examples of emerging jobs, salaries, and education and training requirements in the hydrogen and fuel cell industries. As shown, wages and salaries in many sectors of the emerging H_2, FC, and related industries are higher than the U.S. averages. Although many high-tech industries almost exclusively require highly educated workers with masters or doctoral degrees, these emerging H_2 and FC industries require a wide variety of occupations at all skill levels. Nevertheless, many occupations in these industries include jobs which require associate's degrees, long-term on-the-job training, or trade certifications – and lead to jobs that pay higher than U.S. average wages.

[333]See the discussion in Roger H. Bezdek, "The Hydrogen Economy and Jobs of the Future," presented at the 2019 Fuel Cell Seminar & Energy Exposition, Long Beach, California, November 2019, https://pdfs.semanticscholar.org/4d4c/9fc58cef71bcd732c6cfe624c1810f41a28e.pdf; Roger H. Bezdek, "The Hydrogen Economy and Jobs of the Future," *Renewable Energy and Environmental Sustainability*, Vol. 4, No. 1 (2019), https://www.rees-journal.org/articles/rees/full_html/2019/01/rees180005s/rees180005s.html.

Table V-9
Examples of Emerging Jobs, Salaries, and Education and Training Requirements in the Hydrogen and Fuel Cell Industries

Occupational Title	Average Salary (2016$)	Minimum Educational Requirements
Director of hydrogen energy development	$138,000	Bachelor's (Business)
Hydrogen fueling station manager	$56,300	Bachelor's (CE)
Hydrogen/fuel cell R&D director	$129,000	Doctoral
Hydrogen fuel cell system technician	$39,500	HSD/GED/OJT/TS/apprenticeship
Junior hydrogen energy technician	$23,400	HSD/GED/OJT/TS/apprenticeship
Fuel cell engineering intern	$6,800	HSD/GED/OJT/apprenticeship
Fuel cell manufacturing technician	$45,650	Associate's
Fuel cell fabrication and testing technician	$45,800	Associate's
Hydrogen power plant installation, operations, engineering. & mgt.	$69,700	Bachelor's (EE, ME, CE)
Hydrogen energy systems designer	$47,900	Apprenticeship/TS
Fuel cell plant manager	$90,500	Bachelor's (EE, ME)
Hydrogen energy system operations engineer	$68,100	HSD/GED
Hydrogen fueling station designer & project engineer	$74,200	Bachelor's (Engineer)
Hydrogen fuel transporter – trucker	$36,950	OJT
Hydrogen fueling station operator	$29,700	OJT
Hydrogen fuels policy analyst & business sales	$56,200	Bachelor's (Business)
Hydrogen systems program manager	$73,220	Bachelor's (Engineer)
Emissions accounting & reporting consultant	$64,200	Bachelor's (various)
Fuel cell quality control manager	$74,600	Master's (Science/Engineering)
Hydrogen pipeline construction worker	$46,300	HSD/GED/OJT/TS/apprenticeship
Fuel cell designer	$78,200	Master's (Science)
Hydrogen energy engineer	$72,300	Bachelor's (Engineer)
Fuel cell power systems engineer	$76,400	Master's (EE)
Fuel cell fabrication technician	$23,150	HSD/GED/OJT/TS/apprenticeship
Hydrogen systems & retrofit designer	$90,600	Bachelor's
Fuel cell retrofit installer	$41,600	HSD/GED/OJT/TS apprenticeship
Fuel cell retrofit manufacturer plant labor	$36,500	HSD/GED
Hydrogen vehicle electrician	$44,800	HSD/GED/OJT/TS apprenticeship
Fuel cell vehicle development engineer	$69,800	Bachelor's (Engineer)
Hydrogen systems safety investigator - cause analyst	$88,350	Bachelor's (various)
Hydrogen lab technician	$40,600	Associate's
Hydrogen energy system installer helper	$23,200	HSD/GED
Hazardous materials management specialist	$55,300	Bachelor's (Science)
Hydrogen energy system installer	$31,500	HSD/GED/OJT/TS apprenticeship
Fuel cell power systems operator and instructor	$50,900	HSD/GED/OJT/TS apprenticeship
Fuel cell backup power system technician	$40,200	HSD/GED/OJT/TS apprenticeship
Senior automotive fuel cell power electronics engineer	$69,700	Bachelor's (EE)
Emissions reduction credit portfolio manager	$47,400	Bachelor's (Business)
Emissions reduction project developer specialist	$63,450	Bachelor's (various)
Emissions reduction project manager	$78,600	Bachelor's (various)
Hydrogen systems sales consultant	$53,800	Bachelor's (Business)
Hydrogen plant operations manager	$95,200	Bachelor's (EE, ME)

Source: MISI.

Unlike some industries, the hydrogen and fuel cell industries are feasible targets for job creation in many states and regions. With a wide diversity of required skills and continuing research into relevant technologies, communities can develop clusters around different sectors of the industries. However, states and cities must recognize that they will be in intense competition as communities throughout the U.S. compete for these emerging technologies and industries with traditional university-centered research areas, including Palo Alto (Stanford University), Ann Arbor (University of Michigan), Trenton (Princeton University), Boston (Massachusetts Institute of Technology), Champaign-Urbana (University of Illinois), Austin (University of Texas), the Research Triangle in North Carolina, and other university-industry complexes. In addition, communities must compete for these jobs with traditional high-tech metropolitan areas like San Jose, Boston, and Washington D.C., along with metropolitan areas with rapidly expanding manufacturing, such as Grand Rapids, Michigan, Denver, Colorado, and Portland, Oregon.

We find that jobs will be created across a new continuum of employment, skills, responsibilities and earnings. Notably, many of these jobs do not currently exist and do not have occupational titles defined in federal and state government occupational handbooks and employment guides. Further, many of these new jobs require different skills and education than current jobs, and training needs must be determined to enable this rapidly growing sector of the U.S. economy and labor market to have a sufficient supply of trained and qualified employees. Eventually, most of these occupations will grow, the number of employees classified in the occupations will increase, and federal and state governments will add them to the employment classifications. Until then, labor market and employment analysis and forecasting will be performed using the current set of U.S. Labor Department occupational titles and job descriptions.[334] In the meantime, we have developed the methodology and database discussed here.

Table V-9 identifies by occupational title some of the new jobs that we estimate will be created in the expanding hydrogen energy economy. Emerging occupational titles are listed in the first column of the table. The average U.S. salary, listed in the second column, reflects the average 2016 salary for that occupation.[335] Wages may be 15-20 percent lower at the beginning of employment and may rise to a level 15-20 percent higher as the worker becomes an experienced employee. Further, earnings are usually much higher in urban areas than in rural areas and in some regions than in others – especially coastal cities such as New York, Boston, Washington, D.C., Los Angles, Seattle, and San Francisco.

The third column of Table V-9 gives the minimum recommended education required to gain entry into the occupation, and a required degree is identified for the advanced educational requirements. Employers will not always adhere to these

[334]These are listed in the US Department of Labor, Bureau of Labor Statistics, standard occupational classification; https://www.bls.gov/soc/. Also see US Department of Labor, Bureau of Labor Statistics. Occupational outlook handbook; https://www. bls.gov/ooh/.

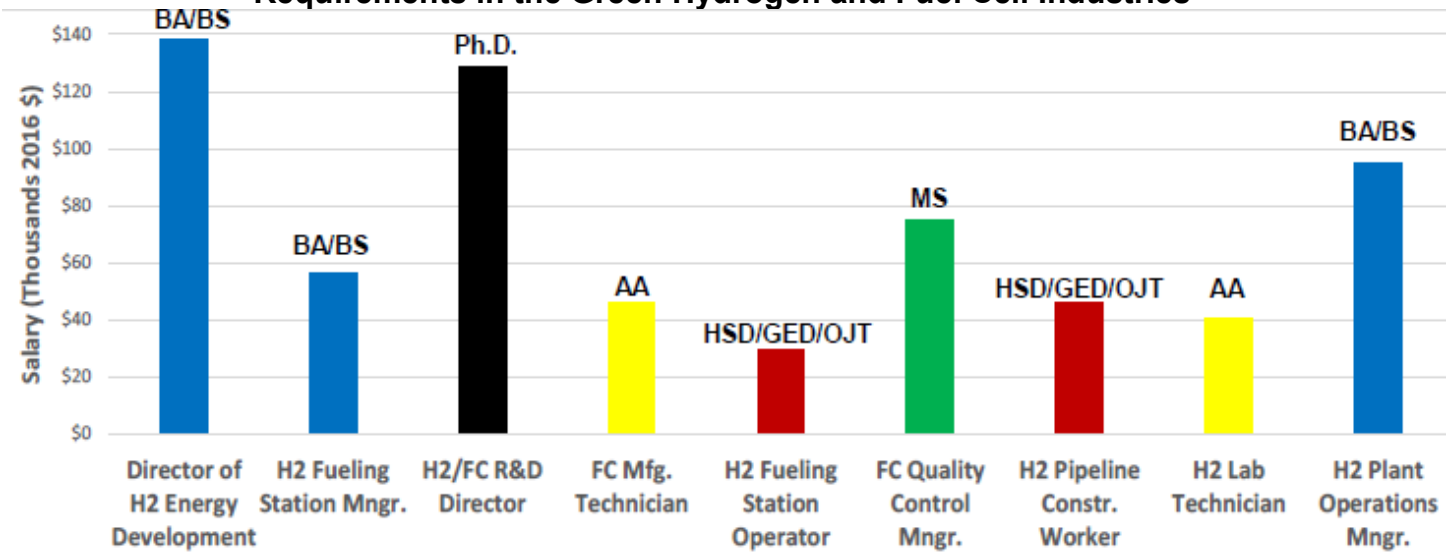
[335]These salary and wage estimates have been adjusted to reflect average USA 2016 salary and wage levels.

recommendations, but this information can be useful to policymakers and workforce planners in providing an indication of the skills that firms are seeking in an applicant. Note that the education requirements listed include HSD/GED/OJT (high school degree, General Education Development, or on-the-job training), and Apprenticeship/TS (trade school) to a Master's degree. With the advanced (Bachelor's degree and higher) college requirements, typical abbreviations were used to identify the degree: CE, ME, EE – for chemical, mechanical and electrical engineering degrees, etc. Also note that many jobs can be filled by a candidate with one of various related science or engineering degrees, and these are listed generically as such.

Table V-10 and Figure V-12 identify some of the emerging job opportunities and corresponding earnings and education/training requirements in the emerging H_2/FC economy. They illustrate that:

- Salaries differ substantially, from $20,000 - $25,000 for various technicians, to nearly $140,000 for a director of hydrogen development.
- Educational requirements cover the range from apprenticeship/ trade school and HSD/GED/OJT to advanced university degrees.
- Nevertheless, there are numerous jobs and education and training requirements, and many of the jobs do not require university degrees.
- Similar jobs in different parts of the industries have diverse earnings and education/training requirements. For example, a hydrogen lab technician requires an Associate Degree and earns a salary of nearly $41,000, whereas a junior hydrogen energy technician may require only a HSD/GED and earn a salary of less than $25,000.
- Similarly, a hydrogen plant operations manager with a Bachelor's Degree may earn more than $95,000, whereas a senior automotive fuel cell power electronics engineer with a Bachelor's Degree may earn less than $70,000.
- There exist numerous career paths that allow employees with apprenticeship/TS and HSD/GED to earn relatively high salaries, such as hydrogen vehicle technician, fuel cell power systems operator and instructor, fuel cell backup power system technician, and hydrogen energy system operations engineer.

Figure V-12
Examples of Select Jobs, Salaries, and Education & Training Requirements in the Green Hydrogen and Fuel Cell Industries



Source: MISI.

Table V-10 shows occupational titles and job descriptions for selected green hydrogen and fuel cell economy jobs. Post-pandemic, the U.S. will require a clear understanding of the skills required for new jobs -- especially in the green/environmental industries. The information in this table is useful for more precisely matching the skills that employers want and the skills that employees have. It can further assist in developing relevant searchable databases and valuable IT applications.

The bottom line is that growth in the hydrogen and fuel cell sectors of the U.S. economy will lead to vast new employment opportunities as businesses expand to serve growing markets and to meet new clean and sustainable energy requirements and mandates.[336] The hydrogen and fuel cell industries will create a variety of new high-paying jobs, many of which take advantage of technical and manufacturing skills currently going unused as industry continues to undergo restructuring, and states, regions and cities can recruit these emerging industries and companies.[337]

[336]For example, California has enacted increasingly ambitious renewable energy portfolio standards and zero emission vehicles mandates. See California Air Resources Board, https://www.arb.ca.gov/html/factsheets/2030_renewables. pdf and https://www.arb.ca.gov/msprog/zevprog/zevprog.htm.

[337]However, there is an overriding problem with hydrogen production. Much of the future increase in demand for hydrogen is based on the growing demand for clean transportation fuels, strict government regulations, and the focus on reducing CO_2 in the atmosphere. It is true that at point of use hydrogen is a clean burning fuel whose only byproduct is water. But since more than 95% of hydrogen is produced using fossil fuels, hydrogen is not really "clean and green," and electrolysis – the major hydrogen source other than reformation -- is inefficient, expensive, and energy intensive. Experimental methods involving, wind, solar, biomass, etc. are still far from being economic or commercially cost competitive.

Table V-10
Occupational Titles and Job Descriptions For
Selected Green Hydrogen and Fuel Cell Economy Jobs

Occupation Title	Occupation Description and Responsibilities
Hydrogen Plant Operations Manager	Responsible for leading and managing hydrogen engineering operations and systems. Interfaces with corporate management and commercial clients to meet requirements and ensure project execution. Provides leadership to manage activities that support hydrogen product customers.
Hydrogen Power Plant Installation, Operations, Engineering, & Management	Maintains the budget, manages the schedule, serves as the point of contact for the customer, and is responsible for the systems to meet the technical specifications. Ensures that company is bidding and executing projects as competitively as possible to continue growth in the market.
Hydrogen Energy Engineer Specialist	Provides direct technical support for the hydrogen energy business area, including sales calls, developing technical scope, and bid preparation. Works with the commercial team to develop the hydrogen energy business.
Hydrogen Fueling Station Design & Project Engineer	Responsible for the cost, schedule, and performance of the hydrogen fueling station. Works with vendors, clients, and the product team to meet goals, improve products, and reduce costs.
Fuel Cell Power Systems Engineer Specialist	Develops construction and modularization strategy for low cost fuel cell power systems execution. Develops sourcing strategies for power systems construction, development, and installation activities.
Hydrogen Systems Safety Investigator − Cause Analyst Specialist	Assesses safety standards at various parts of the production/delivery/ storage/use processes essential to the use of hydrogen at scale. Investigates accidents and systems failures and recommends remedies.
Hydrogen Systems Program Manager	Develops optimized execution strategies for hydrogen systems and ensures that lessons learned are captured and transmitted back to the product team. Works directly with commercial customers and government agencies in support of the hydrogen business area.
Emissions Accounting & Reporting Consultant	Designs and audits emissions reduction and offset projects. Manages internal resources to finalize and execute all phases of the accounting cycle. Maintains financial models for both internal and client purposes and for regulatory auditing requirements.
Fuel Cell Quality Control Manager	Responsible for leadership and development of the fuel cell quality control program, with a focus on team development to support quality assurance and on-target delivery of all current quality management programs. Provides support to all relevant internal groups, tier-one and sub-tier suppliers, and customers with quality initiatives and objectives to assure timely, cost-effective quality goal attainment.
Fuel Cell Vehicle Development Engineer	Ensures safe and economical hydrogen storage while ensuring hydrogen fuel cell vehicles and systems meet design standards and customer performance expectations. Partners with operations management, manufacturing, and R&D engineering teams to integrate new/improved products and processes into existing systems.
Fuel Cell Designer	Works with vendors and the product team to improve design of fuel cell products and to reduce costs. Supports other aspects of the fuel cell business, including engineering activities in development of new fuel cell products and applications.
Hydrogen Energy Engineer	Works closely with customer engineering, operations, logistics, product management, and process safety teams while building and installing hydrogen systems and projects. Works with indirect reports within those

	groups to develop and implement optimized execution strategies and initiatives.
Fuel Cell Power Systems Engineer	Integrates fuel cell stack design and fuel cell systems into complex energy systems. Plays a key role in the design, innovation, and development of cutting edge research programs in fuel cell power systems.
Hazardous Materials Management Specialist	Identifies hazardous materials and wastes, ensures safe handling and disposal, and works to reduce the generation of hazardous materials and wastes. Monitors hazardous materials and wastes and ensures that necessary protocols are followed and required documentation is provided.
Hydrogen Systems & Retrofit Designer	Designs retrofitting of hydrogen systems to minimize costs and to optimize hydrogen savings and reduce penalties. Assesses multiple practical retrofit options to optimize design and configuration. Assesses potential for cost savings with specified payback times or investment limits.
Emissions Reduction Project Developer Specialist	Researches and writes project documentation including emissions reduction plans, project design documents, and emissions monitoring reports. Coordinates field surveys and new product testing. Analyzes and interprets data from quantitative and qualitative emissions studies.
Emissions Reduction Project Manager	Designs and manages emissions reduction and offset projects, including technical project design, and guides projects through validation, verification, registration, and issuance. Responsible for managing the execution of all aspects of emissions reduction project development from diligence to verification on multiple projects.

Source: MISI.

Although many high-tech industries almost exclusively require highly educated workers with advanced degrees, as noted, the H_2 and FC industries possess requirements for numerous types of occupations, experience and skills. Many occupations in these industries include jobs which require associate's degrees, long-term on-the-job training, or trade certifications, including scientists, engineers, chemists, managers and technicians, all of which pay higher than average wages. Unlike some industries, the H_2 and FC industries are a realistic target industry for job creation in most regions and states. With a wide variety of the required skills as well as ongoing research into H_2 and FC technologies, communities can build clusters around different segments of the industries. The wide variety of entrance points to the H_2 and FC industries makes this market easier to penetrate if regions can market their strengths in high-tech, research, education, manufacturing, IT and energy.

VI. IMPLICATIONS OF THE FINDINGS

VI.A. U.S. Labor Market Realities

In the U.S., jobs generated by the green economy will be increasing rapidly in both absolute and percentage terms, and will be growing more rapidly than overall U.S. employment. Nevertheless, for the foreseeable future the overwhelming majority of U.S. jobs will not be "green" by any definition. This is a critical fact that is too little appreciated. Green energy advocates continually emphasizing that jobs such as Wind Energy Technician, Solar Photovoltaic Installer, Environmental Engineer, etc. are the "jobs of the future" are not only quantitatively wrong, but do a disservice to the cause of intelligent green jobs workforce planning and education and training policies.

This can be illustrated by examining the BLS occupational forecasts for the coming decade. Table VI-1 shows the BLS forecasts of most rapidly growing occupations in percent terms, 2020 – 2030. It indicates that, in percent terms, Wind Turbine Service Technician is forecast to be the most rapidly growing occupation and Solar Photovoltaic Installer is forecast to be the third most rapidly growing occupation. However, it must be noted that over the 11 year forecast period the total increase in jobs for Wind Turbine Service Technicians is forecast to be only 4,700 jobs and for Solar Photovoltaic Installers is forecast to be only 6,100 jobs. Contrast this with some of the job increase forecasts for some other occupations in this table; for example:

- Home health aides – 1.130 million jobs; 240X more jobs than Wind Turbine Service Technicians and 185X more jobs than Solar Photovoltaic Installers.
- Software developers – 410,000 jobs; 87X more jobs than Wind Turbine Service Technicians and 67X more jobs than Solar Photovoltaic Installers.
- Medical and health service managers – 140,000 jobs; 30X more jobs than Wind Turbine Service Technicians and 30X more jobs than Solar Photovoltaic Installers.
- Nurse practitioners – 115,000 jobs; 25X more jobs than Wind Turbine Service Technicians and 19X more jobs than Solar Photovoltaic Installers.
- Substance abuse counselors – 75,000 jobs; 16X more jobs than Wind Turbine Service Technicians and 12X more jobs than Solar Photovoltaic Installers.
- Logisticians – 56,000 jobs; 12X more jobs than Wind Turbine Service Technicians and 9X more jobs than Solar Photovoltaic Installers.

In other words, jobs for Wind Turbine Service Technicians and for Solar Photovoltaic Installers are forecast to be increasing so rapidly only because there are so few of these jobs to begin with. This discrepancy is illustrated even more dramatically in Table VI-2, which shows the BLS forecasts of the most rapidly growing occupations in terms of numbers of jobs, 2020 – 2030. It shows that of the 30 occupations in which employment is forecast to increase the most over the coming decade ***none*** are green or even semi-green. In 2030, these 30 occupations are forecast to contain nearly 30% of all U.S. jobs – 30% of the 1,000+ BLS occupations.

Table VI-1
Most Rapidly Growing Occupations in Percent Terms, 2020 – 2030*

2020 National Employment Matrix title	Employment, 2020	Employment, 2030	Employment change, 2020-30	Percent employment change, 2020-30	Median annual wage, 2020
Wind turbine service technicians	6.9	11.7	4.7	68.2	$56,230
Nurse practitioners	220.3	335.2	114.9	52.2	$111,680
Solar photovoltaic installers	11.8	17.9	6.1	52.1	$46,470
Statisticians	42.0	56.9	14.9	35.4	$92,270
Physical therapist assistants	93.8	126.9	33.2	35.4	$59,770
Information security analysts	141.2	188.3	47.1	33.3	$103,590
Home health and personal care aides	3,470.7	4,600.6	1,129.9	32.6	$27,080
Medical and health services managers	429.8	569.4	139.6	32.5	$104,280
Data scientists and mathematical science occupations, all other	63.2	83.0	19.8	31.4	$98,230
Physician assistants	129.4	169.5	40.1	31.0	$115,390
Epidemiologists	7.8	10.2	2.3	29.6	$74,560
Logisticians	191.0	247.3	56.4	29.5	$76,270
Speech-language pathologists	158.1	203.5	45.4	28.7	$80,480
Animal trainers	60.2	77.4	17.2	28.5	$31,520
Computer numerically controlled tool programmers	27.1	34.5	7.4	27.4	$57,740
Genetic counselors	2.4	3.1	0.6	26.2	$85,700
Crematory operators and personal care and service workers, all other	80.5	100.5	19.9	24.8	$28,420
Operations research analysts	104.1	129.7	25.6	24.6	$86,200
Actuaries	27.7	34.5	6.8	24.5	$111,030
Health specialties teachers, postsecondary	242.7	301.6	58.9	24.3	$99,090
Forest fire inspectors and prevention specialists	3.0	3.7	0.7	23.9	$42,150
Interpreters and translators	81.4	100.7	19.3	23.7	$52,330
Athletic trainers	30.0	37.0	7.0	23.4	$49,860
Respiratory therapists	135.1	166.2	31.1	23.0	$62,810
Substance abuse, behavioral disorder, and mental health counselors	327.5	402.6	75.1	22.9	$47,660
Food preparation and serving related workers, all other	71.2	87.4	16.2	22.8	$27,080
Nursing instructors and teachers, postsecondary	72.6	88.9	16.3	22.4	$75,470
Woodworkers, all other	9.5	11.6	2.1	22.2	$33,630
Phlebotomists	129.6	158.4	28.8	22.2	$36,320
Software developers and software quality assurance analysts and testers	1,847.9	2,257.4	409.5	22.2	$110,140

Source: U.S. Bureau of Labor Statistics.

*Median annual wage are from the BLS Occupational Employment and Wage Statistics program. Wage data cover non-farm wage and salary workers and do not cover the self-employed, owners and partners in unincorporated firms, or household workers.

Table VI-2
Most Rapidly Growing Occupations in Numbers of Jobs, 2020 – 2030*

2020 National Employment Matrix title	Employment, 2020	Employment, 2030	Employment change, 2020-30	Percent employment change, 2020-30	Median annual wage, 2020
Home health and personal care aides	3,470.7	4,600.6	1,129.9	32.6	$27,080
Cooks, restaurant	1,153.2	1,716.7	563.5	48.9	$28,800
Fast food and counter workers	3,455.5	3,973.0	517.5	15.0	$23,860
Software developers and software quality assurance analysts and testers	1,847.9	2,257.4	409.5	22.2	$110,140
Waiters and waitresses	2,023.2	2,430.7	407.6	20.1	$23,740
Registered nurses	3,080.1	3,356.8	276.8	9.0	$75,330
Laborers and freight, stock, and material movers, hand	2,821.7	3,077.5	255.8	9.1	$31,120
General and operations managers	2,411.9	2,638.2	226.3	9.4	$103,650
First-line supervisors of food preparation and serving workers	915.4	1,106.1	190.8	20.8	$34,570
Passenger vehicle drivers, except bus drivers, transit and intercity	707.4	887.9	180.6	25.5	$32,320
Market research analysts and marketing specialists	740.9	904.5	163.6	22.1	$65,810
Bartenders	492.3	652.3	159.9	32.5	$24,960
Security guards	1,059.0	1,213.2	154.2	14.6	$31,050
Medical and health services managers	429.8	569.4	139.6	32.5	$104,280
Maids and housekeeping cleaners	1,212.8	1,350.3	137.5	11.3	$26,220
Medical assistants	720.9	853.5	132.6	18.4	$35,850
Janitors and cleaners, except maids and housekeeping cleaners	2,217.0	2,344.2	127.2	5.7	$29,080
Management analysts	907.6	1,032.0	124.4	13.7	$87,660
Heavy and tractor-trailer truck drivers	1,951.6	2,073.6	122.1	6.3	$47,130
Exercise trainers and group fitness instructors	309.8	431.4	121.7	39.3	$40,510
Financial managers	681.7	799.9	118.2	17.3	$134,180
Maintenance and repair workers, general	1,444.1	1,561.1	117.0	8.1	$40,850
Teaching assistants, except postsecondary	1,306.3	1,422.3	116.0	8.9	$28,900
Nursing assistants	1,396.7	1,512.0	115.3	8.3	$30,850
Nurse practitioners	220.3	335.2	114.9	52.2	$111,680
Hairdressers, hairstylists, and cosmetologists	569.6	680.1	110.5	19.4	$27,380
Dining room and cafeteria attendants and bartender helpers	389.0	492.5	103.6	26.6	$25,010
Construction laborers	1,285.2	1,388.3	103.2	8.0	$37,890
Elementary school teachers, except special education	1,371.1	1,472.9	101.7	7.4	$60,940
Light truck drivers	1,035.8	1,136.8	101.1	9.8	$37,050

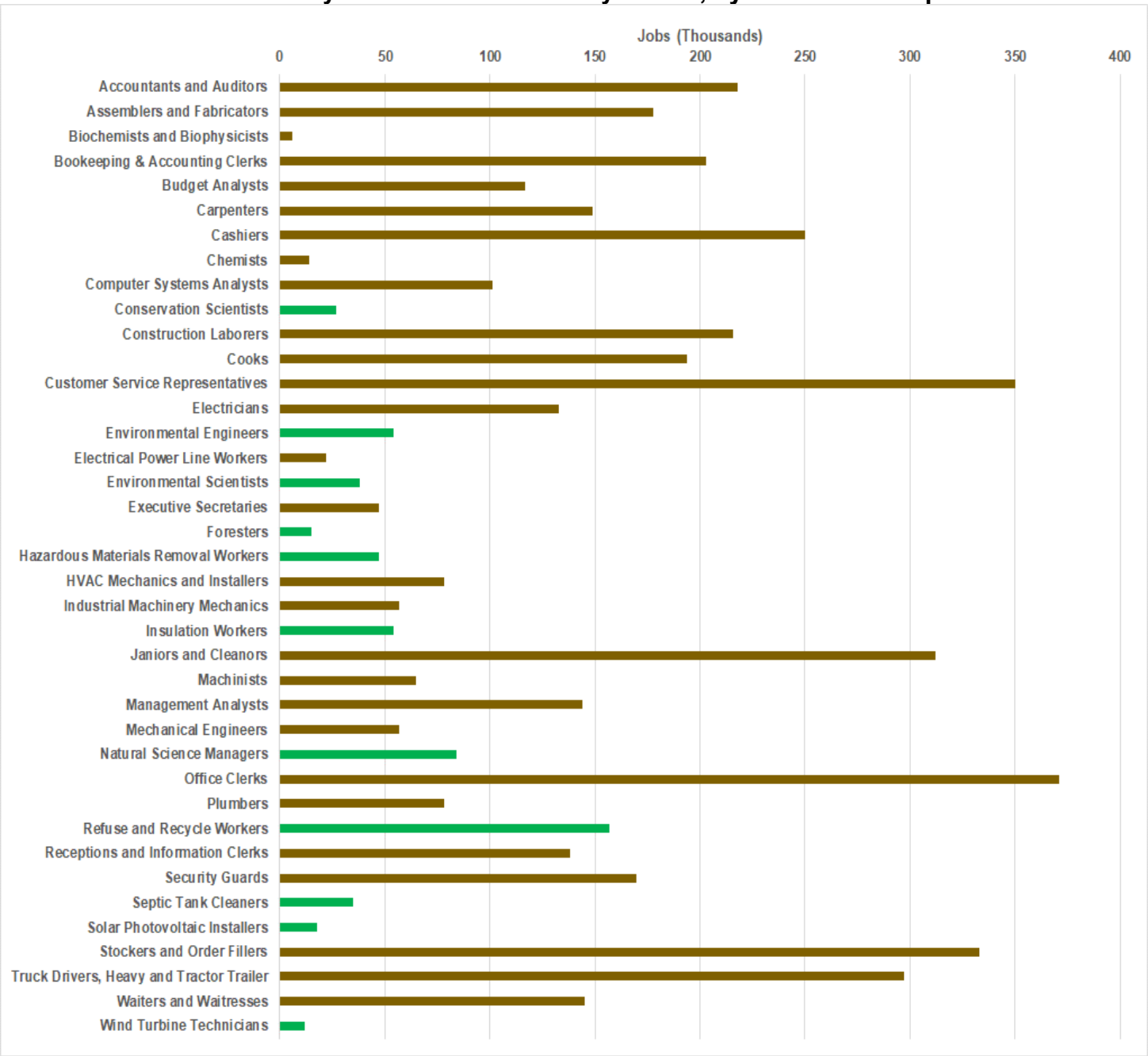
Source: U.S. Bureau of Labor Statistics.

*Median annual wage are from the BLS Occupational Employment and Wage Statistics program. Wage data cover non-farm wage and salary workers and do not cover the self-employed, owners and partners in unincorporated firms, or household workers.

VI.B. Realities of Jobs Generated by the U.S. Green Economy

It is also instructive to focus on the jobs generated by the U.S. green economy – as shown for 2030 for selected occupations in Figure VI-1. This figure illustrates that, as has been repeatedly noted here, the vast majority of jobs generated by the U.S. green economy are standard, “non-green” occupations such as accountants, clerks, customer service representatives, truck drivers, laborers, security guards, janitors, etc.

Figure VI-1
Jobs Generated by the U.S. Green Economy in 2030, by Selected Occupations



Source: U.S. Bureau of Labor Statistics,
U.S. Energy Information Administration, and MISI.

A critical metric in developing education and training policies to address the mismatch between the skills that employers want and the skills that employees have is to estimate and forecast annual new job openings by occupation and skill. These can then be compared to the likely anticipated forthcoming supply of workers in the relevant

occupations and skills. Imbalances can be remedied over time by appropriate education, training, and re-training policies.

Annual job openings depend on a number of economic, labor force, and demographic factors, including overall job growth in the occupation, labor force attrition rates, the workers leaving the occupation, the workers entering the occupation, etc. Specifically, to estimate the annual job openings for an occupation 2021-2030 it is necessary to estimate the total employment change over the period, the average annual labor force exit rate, the average annual occupational transfer rate, and the average annual occupational separations. To estimate average annual occupational job openings 2020 - 2030, for each occupation BLS estimated:

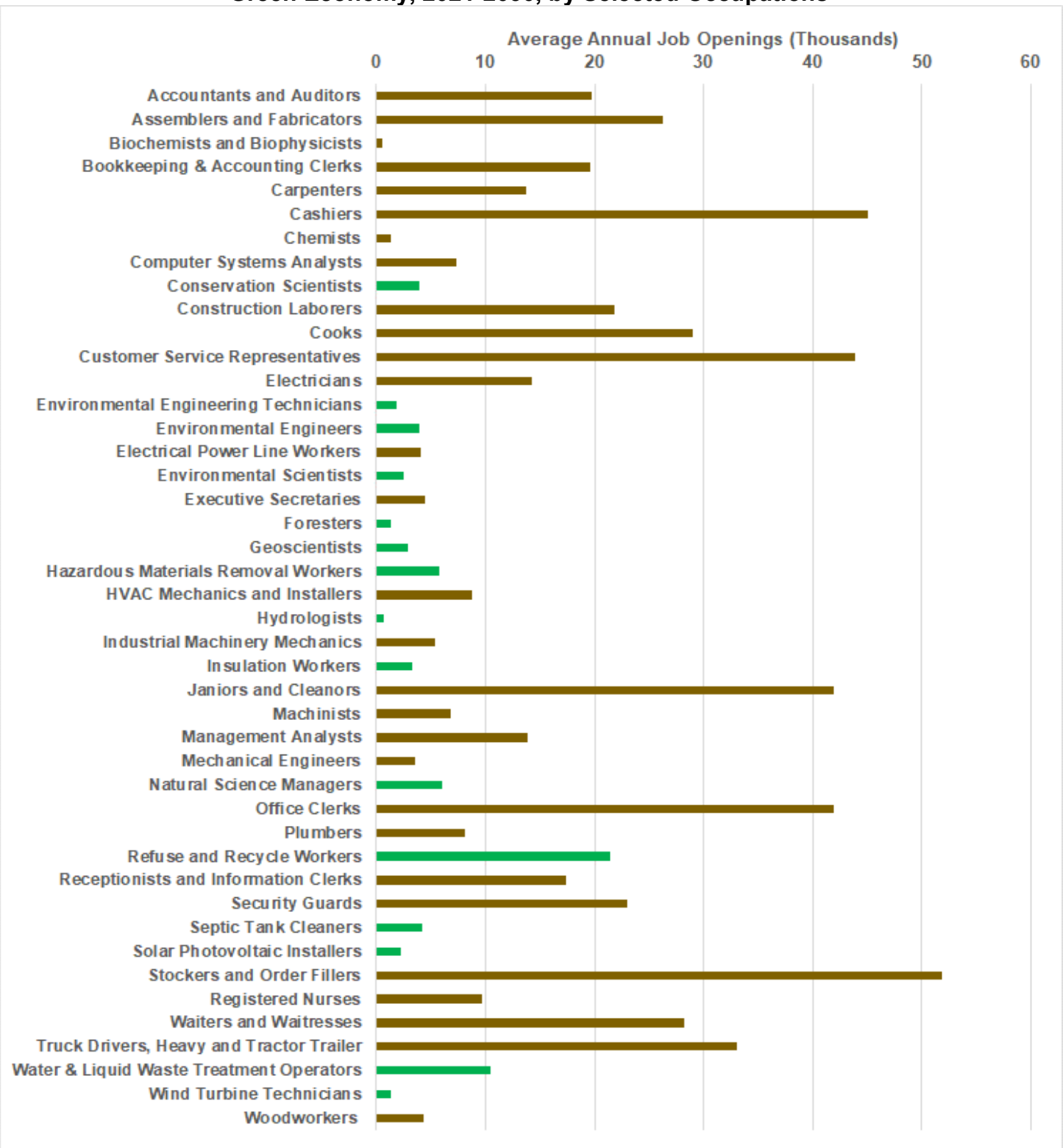
1. 2020 employment.
2. 2030 employment.
3. The employment change, 2020-2030.
4. The average annual labor force exit rate, 2020-2030.
5. The average annual occupational transfer rate, 2020-2030.
6. The average annual occupational separations, 2020-2030.
7. The average annual occupational openings, 2020-2030.

MISI utilized similar methodology to estimate the average annual occupational job openings for selected jobs generated by the green economy. The results are illustrated in Figure VI-2. This figure illustrates that the vast majority of the annual job openings generated (direct, indirect, and induced) by the green economy, 2021 – 2030, will not be for “green” or even “semi-green” occupations. For example, over the coming decade the average annual U.S. job openings generated by the green economy will total:

- 30 times as many Office Clerks (42,000) as Wind Turbine Service Technicians (1,400).
- More than 11 times as many Assemblers and Fabricators (26,300) as Solar Photovoltaic Installers (2,300).
- More than 16 times as many Construction Laborers (22,000) as Foresters (1,400).
- 11 times as many Customer Service Representative (44,000) as Environmental Engineers (4,000).
- More than 13 times as many Truck Drivers (33,100) as Environmental Scientists (2,500).
- More than 11 times as many Accountants and Auditors (20,000) as Environmental Engineering Technicians (1,800).
- More than 23 times as many Management Analysts (14,000) as Hydrologists (600).
- 18 times as many Stock and Order Fillers (52,000) as Geoscientists (2,900).

Thus, over the coming decade, annual total U.S job openings for Wind Turbine Service Technicians will total 1,400 and for Solar Photovoltaic Installers will total 2,300. It is not optimal educational or training policy to plan to produce many thousands of workers annually certified in these occupations given the relatively small number of annual job openings likely to be available. The end result is likely to be disappointed workers trained in these skills functioning as baristas and fast food workers.

Figure VI-2
Average Annual Job Openings Generated by the U.S. Green Economy, 2021-2030, by Selected Occupations



Source: U.S. Bureau of Labor Statistics,
U.S. Energy Information Administration, and MISI.

Further, 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 promoted, publicized and hyped; e.g., Wind Turbine Service Technician, Solar Photovoltaic Installer, Environmental Scientist, etc. Rather, most of annual green job openings generated by the green economy will be for occupations such as, for example:

- Refuse and Recycle Workers – 21,400 average annual job openings.
- Water and Waste Treatment Plant Operators – 10,500 average annual job openings.
- Hazardous Materials Removal Workers – 5,800 average annual job openings.
- Septic Tank Cleaners – 4,200 average annual job openings.
- Insulation Workers – 3,300 average annual job openings.

Nevertheless, it is unlikely that any of the environmental organizations or green job advocates will be publicizing Refuse and Recycle Workers or Septic Tank Cleaners as the glamorous and exciting "green jobs of the future."[338]

The information in Table VI-2 can be used in conjunction with that in Table VI-3, which shows the education and training requirements, required work experience, and on-the-job training required for selected jobs generated by the green economy. That is, the anticipated annual job openings in each occupation can be compared with the education, training, and work experience required for the occupation to aid in developing optimal green economy education and training policies. For some occupations, relatively little advanced planning is required, whereas for other occupations the planning horizon may approach a decade. For example, to increase the supply of some occupations may require nearly a decade:

- To educate Biochemists and Biophysicists requires four years of undergraduate school and an additional four years or more of graduate school.
- To produce a credentialed Natural Science Manager requires four years of undergraduate school and more than five years of work experience.
- To produce a Management Analyst requires four years of undergraduate school and three to five years of work experience.

[338]Similarly, many green job seekers may be disappointed. For example, "For some young professionals, the competition to land a meaningful job remains high. New-Hampshire-born Marielle Brunelle, 23, was looking for jobs in sustainability after getting international and public relations degrees from Syracuse University. 'You could find senior-level jobs, chief sustainability roles or roles for lifelong experts in sustainability who worked in cocoa firms for 10 years and had a really niche expertise,' she said, otherwise 'for internship roles, you needed a master's degree.' That's the route she decided to take." A master's degree to get an internship? https://www.bloomberg.com/news/articles/2021-12-09/ students-young-workers-insist-on-jobs-with-green-values-deloitte-finds?srnd=green&sref=fyhEsXfZ&mccid= 3fa49 0850 e&mc_eid=c66e751941.

Table VI-3
Education and Training Requirements for Selected Jobs Generated by the Green Economy

Occupation	Typical education needed for entry	Work experience in a related occupation	Typical on-the-job training needed to attain competency in the occupation
Accountants and Auditors	B.A	none	none
Assemblers and Fabricators	HS/GED	none	MOJT
Biochemists and Biophysicists	Ph.D.	none	none
Bookkeeping & Accounting Clerks	SC-ND	none	MOJT
Carpenters	HS/GED	none	Apprenticeship
Cashiers	Minimal	none	STOJT
Chemists	B.A	none	none
Computer Systems Analysts	B.A	none	none
Conservation Scientists	B.A	none	none
Construction Laborers	Minimal	none	STOJT
Cooks	Minimal	none	STOJT
Customer Service Representatives	HS/GED	none	STOJT
Electricians	HS/GED	none	Apprenticeship
Environmental Engineering Technicians	A.D	none	none
Environmental Engineers	B.A	none	none
Electrical Power Line Workers	HS/GED	none	LTOJT
Environmental Scientists	B.A	none	none
Executive Secretaries	HS/GED	Less than 5 yrs.	none
Foresters	B.A	none	none
Geoscientists	B.A	none	none
Hazardous Materials Removal Workers	HS/GED	none	MOJT
HVAC Mechanics and Installers	PSNDA	none	LTOJT
Hydrologists	B.A	none	none
Industrial Machinery Mechanics	HS/GED	none	LTOJT
Insulation Workers	Minimal	none	STOJT
Janiors and Cleanors	Minimal	none	STOJT
Machinists	HS/GED	none	LTOJT
Management Analysts	B.A	Less than 5 yrs.	none
Mechanical Engineers	B.A	none	none
Natural Science Managers	B.A	More than 5 yrs.	STOJT
Office Clerks	HS/GED	none	none
Plumbers	HS/GED	none	Apprenticeship
Refuse and Recycle Workers	Minimal	none	STOJT
Receptionists and Information Clerks	HS/GED	none	STOJT
Security Guards	HS/GED	none	MOJT
Septic Tank Cleaners	HS/GED	none	MOJT
Solar Photovoltaic Installers	HS/GED	none	MOJT
Stockers and Order Fillers	HS/GED	none	STOJT
Registered Nurses	B.A	none	none
Truck Drivers, Heavy and Tractor Trailer	PSDA	none	STOJT
Waiters and Waitresses	Minimal	none	STOJT
Water & Liquid Waste Treatment Operators	HS/GED	none	LTOJT
Wind Turbine Technicians	PSNDA	none	LTOJT
Woodworkers	HS/GED	none	MOJT

Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.

Legend:
B.A. – Bachelor's Degree
HS/GED – High School Degree or Equivalent
LTOJT – Short Term on-the-job Training

MOJT – Moderate on-the-job Training
Ph.D. – Doctoral Degree
PSNDA – Post Secondary Non Degree Award
SC-ND – Some College, no Degree
STOJT – Short Term on-the-job Training

To increase the supply of workers in some occupations requires less time, but still substantial time. For example:

- HVAC Mechanics and Wind Turbine Technicians require a post-secondary non degree award and long term on-the-job training (OJT).
- Electricians, Carpenters, and Plumbers require a high school degree and lengthy apprenticeships.
- Electrical Power Line Workers, Machinists, and Water & Liquid Waste Treatment Plant Operator require high school or equivalent, and long term OJT.

The supply of other occupations can be increased much more rapidly. For example:

- Insulation Workers and Recycle Workers require minimal education and only short term OJT.
- Septic Tank Cleaners and Solar Photovoltaic Installers require only high school or equivalent and moderate OJT.
- Environmental Engineering Technicians require an Associate Degree.
- Truck Drivers require a post-secondary non degree award and short term OJT.

The information in Table VI-3 complements that in Table V-9, which shows examples of emerging jobs, salaries, and education and training requirements in the hydrogen and fuel cell industries. Specifically:

- Table VI-3 shows the education and training requirements for existing green and semi-green BLS occupational classifications.
- Table V-9 shows analogous information for a subset of new and emerging green occupations.

The information in both tables can be used to develop optimal green economy jobs education, training, and retraining policies and to address the growing mismatch between the skills that employers want and the skills that employees have.

Also important, the numbers and distributions of the jobs generated by the green economy can elucidate another important ongoing controversy: The relative earnings of green jobs compared to non-green jobs. In Section II.C we discussed the issue of the relative earnings of green jobs compared to non-green jobs. However, as we noted, most of the information available on this topic in the literature is derived from the USEER reports which pertain only to jobs in the energy fields – including renewable energy and

energy efficiency. In estimating and comparing relative salaries, there are at least three major problems with the USEER data:[339]

- First, the USEER estimates only direct employment in the energy industries – about 1 million workers, which comprises only about 0.5% of total U.S. employment and equals only about 10% of the total number of jobs generated by the green economy – and many of the USEER energy jobs are not "green."
- Second, energy jobs generally pay higher wages compared to the national median and other sectors of the economy across all energy technology sectors and nearly all energy industry sectors. The median hourly wage for all energy workers is $25.60 -- 34% percent higher than the national median hourly wage of $19.14.
- Third, the USEER data exclude the overwhelming majority of jobs generated by the green economy -- not only indirect and induced jobs, but also green jobs that are not energy related.

Here we have emphasized that the vast majority of jobs generated by the U.S. green economy are standard, "non-green" occupations such as accountants, clerks, customer service representatives, truck drivers, laborers, security guards, janitors, etc. The average earnings of the jobs generated by the U.S. green economy are illustrated in Figure VI-3. This figure shows that while many of the jobs generated pay higher than average salaries, many others do not. Further, three types of the most numerous certifiable green jobs created – Refuse and Recycle Workers, Insulation Workers, and Septic Tank Cleaners – pay below average wages.

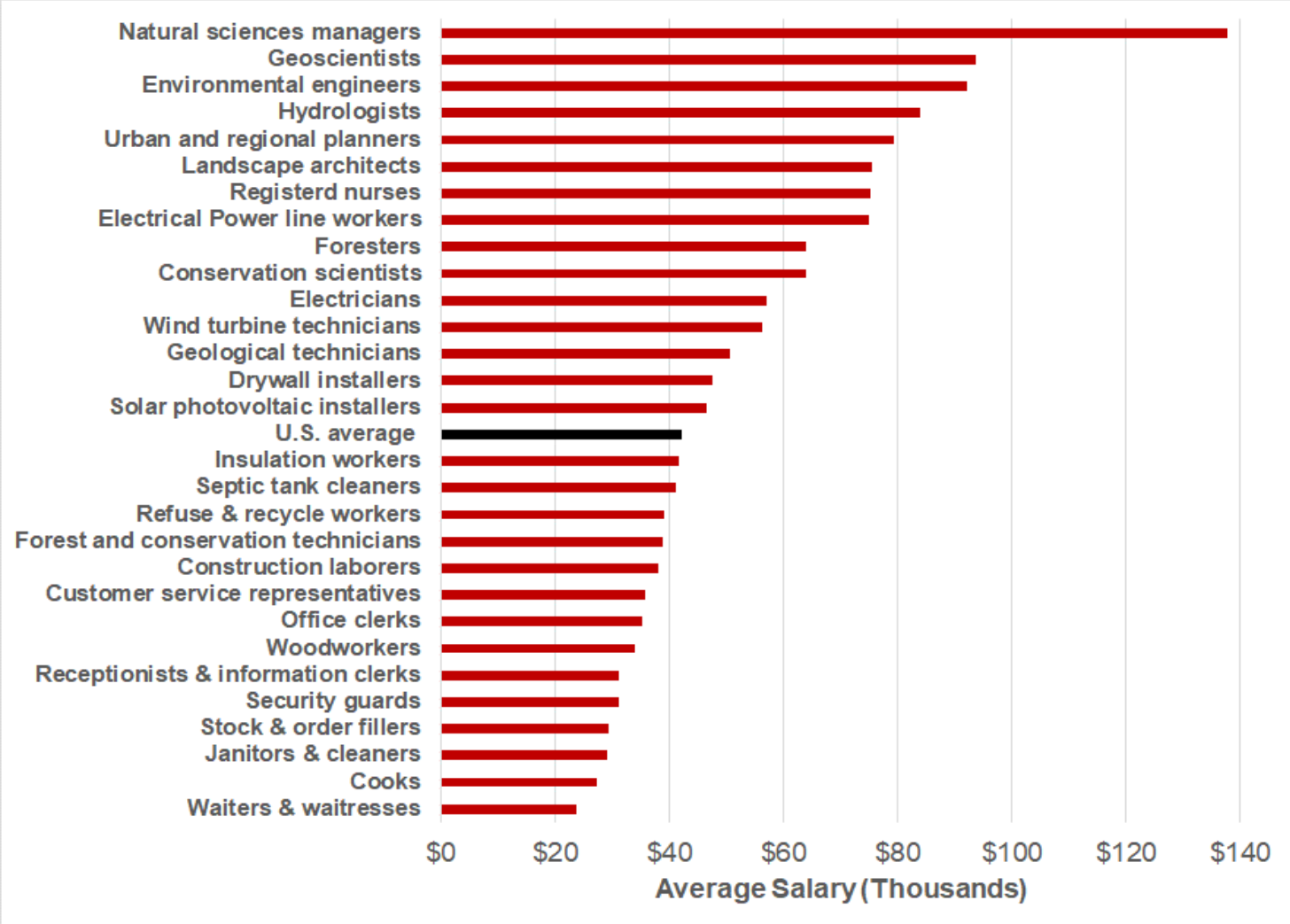
However, Figure VI-3 emphasizes a major finding that should resolve the contentious debate over the relative salaries of green jobs as compared to non-green jobs. Since the vast majority of the jobs generated by the U.S. green economy are standard "non-green" jobs, the average salaries for these jobs must, due to the law of large numbers, be relatively close to the U.S. average.[340] As noted in Chapter V, the U.S. green economy generates disproportionately more jobs in professional, scientific, and technical services occupations than the U.S. 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 U.S. green economy. For example, as noted, the green economy generates annual job openings for:

- 30 times as many Office Clerks (42,000), with an average salary of $35,300, as Wind Turbine Service Technicians (1,400), with an average salary of $56,200.
- More than 16 times as many Construction Laborers (22,000), with an average salary of $37,900, as Foresters (1,400), with an average salary of $64,000.
- 11 times as many Customer Service Representative (44,000), with an average salary of $35,800, as Environmental Engineers (4,000), with an average salary of $92,100.
- 18 times as many Stock and Order Fillers (52,000), with an average salary of $29,200, as Geoscientists (2,900), with an average salary of $112,100.

[339]In addition, as discussed, MISI has identified major problems with the USEER methodology and data bases; see Section II.A.2.

[340]The law of large numbers, in probability and statistics, states that as a sample size grows, its mean gets closer to the average of the whole population.

Figure VI-3
Average 2020 Annual Salaries of Selected Jobs Generated by the Green Economy*



Source: U.S. Bureau of Labor Statistics, U.S. Energy Information Administration, and MISI.
*Median annual wage are from the BLS Occupational Employment and Wage Statistics program. Wage data cover non-farm wage and salary workers and do not cover the self-employed, owners and partners in unincorporated firms, or household workers.

Thus, at best, the average salary for all of the jobs generated by the U.S. green economy may be only slightly higher than the U.S. average – and the difference is likely to be in the statistical noise of the estimates. It is simply not valid to contend that the jobs generated by the U.S. green economy pay wages and salaries that are significantly higher – or lower -- than the U.S. averages.[341]

[341]IMF found that clean-energy investments produce jobs at all pay levels -- higher as well as lower-paying jobs; International Monetary Fund, "Building Back Better: How Big Are Green Spending Multipliers?" op. cit. WRI/NCE/ITCU found that "Clean energy wages are not as high as those for fossil fuel jobs." https://www.wri.org/research/green-jobs-advantage-how-climate-friendly-investments-are-better-job-creators.

This important point is further emphasized in Table VI-4, which shows the typical employee profile of a 250-person wind turbine manufacturing company, and in Table VI-5, which shows the typical employee profile of a 100-person environmental remediation services company. Table VI-4 illustrates that in a typical wind turbine 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.

Table VI-5 shows that in a typical environmental remediation services company there are a large number of certifiable green occupations. However, very few are the green occupations widely publicized as the "desirable green jobs of the future." Specifically, in such a company there are jobs for:

- 22 Hazardous Material Removal Workers
- 8 Septic Tank Cleaners
- 2 Refuse and Recyclable Material Collectors
- 2 Insulation Workers
- 1 Environmental Engineer
- 1 Environmental Scientist

These findings corroborate two major points emphasized throughout this report:

- First, the vast majority of the jobs generated by the U.S. green economy are jobs for standard, "non-green" occupations such as accountants, clerks, customer service representatives, truck drivers, laborers, security guards, janitors, etc.
- Second, many of the "green" jobs generated by the U.S. green economy are for less glamorous and rarely publicized occupations such as Refuse and Recycle Worker, Hazardous Material Removal Worker, Insulation Worker, Septic Tank Cleaner, Mold Remediation Worker, etc.

Table VI-4
Typical Employee Profile of a 250-person Wind Turbine Manufacturing Company, 2019

Occupation	Employees	Earnings
Engine and Other Machine Assemblers	31	$33,359
Machinists	27	37,191
Team Assemblers	16	27,668
Computer-Controlled Machine Tool Operators	12	37,254
Mechanical Engineers	10	65,772
First-Line Supervisors/Managers of Production/Operating	10	54,705
Inspectors, Testers, Sorters, Samplers, and Weighers	8	37,202
Lathe and Turning Machine Tool Setters/Operators/Tenders	6	36,729
Drilling and Boring Machine Tool Setters/Operators/Tenders	4	36,509
Welders, Cutters, Solderers, and Brazers	4	36,530
Laborers and Freight, Stock, and Material Movers	4	28,466
Maintenance and Repair Workers	4	41,318
Tool and Die Makers	4	40,047
Grinding/Lapping/Polishing/Buffing Machine Tool Operators	4	31,899
Multiple Machine Tool Setters/Operators/Tenders	4	37,517
Industrial Engineers	3	64,659
Industrial Machinery Mechanics	3	42,315
Engineering Managers	3	99,404
Shipping, Receiving, and Traffic Clerks	3	29,516
General and Operations Managers	3	110,702
Industrial Production Managers	3	85,512
Industrial Truck and Tractor Operators	3	31,416
Purchasing Agents	3	51,702
Cutting/Punching/Press Machine Setters/Operators/Tenders	3	28,907
Production, Planning, and Expediting Clerks	3	41,601
Milling and Planing Machine Setters/Operators/Tenders	3	37,380
Mechanical Drafters	2	44,090
Customer Service Representatives	2	36,036
Bookkeeping, Accounting, and Auditing Clerks	2	32,760
Office Clerks, General	2	27,227
Sales Representatives, Wholesale and Manufacturing	2	50,757
Janitors and Cleaners	2	28,476
Sales Engineers	2	66,591
Accountants and Auditors	2	54,873
Tool Grinders, Filers, and Sharpeners	2	40,520
Executive Secretaries and Administrative Assistants	2	39,638
Mechanical Engineering Technicians	2	46,767
Electricians	2	45,570
Other employees	48	45,969
Employees, Total	**250**	**$57,680**

Source: Management Information Services, Inc.

Table VI-5
Typical Employee Profile of a 100-person Environmental Remediation Services Company, 2019

Occupation	Employees	Earnings
Hazardous Materials Removal Workers	22	$36,204
Septic Tank Servicers and Sewer Pipe Cleaners	8	30,419
Construction Laborers	7	32,382
First-Line Supervisors/Managers of Construction/Extraction	5	50,673
Truck Drivers, Heavy and Tractor-Trailer	5	33,044
General and Operations Managers	3	86,258
Laborers and Freight, Stock, and Material Movers	2	21,620
Truck Drivers, Light Or Delivery Services	2	27,437
Office Clerks	2	23,384
Refuse and Recyclable Material Collectors	2	26,796
Insulation Workers	2	32,256
Secretaries (except Legal, Medical, and Executive)	2	25,998
Bookkeeping, Accounting, and Auditing Clerks	2	31,217
Plumbers, Pipefitters, and Steamfitters	1	41,202
Executive Secretaries and Administrative Assistants	1	36,729
Maintenance and Repair Workers	1	30,849
Environmental Engineering Technicians	1	36,939
Operating Engineers and Other Const. Equip. Operators	1	40,520
First-Line Supervisors/Managers of Office/Administrative	1	47,576
Chief Executives	1	116,435
Construction Managers	1	73,994
Cleaners of Vehicles and Equipment	1	21,704
Cost Estimators	1	56,753
Janitors and Cleaners	1	25,746
Environmental Engineers	1	69,930
Industrial Truck and Tractor Operators	1	27,741
Carpenters	1	38,588
Construction and Maintenance Painters	1	33,296
Accountants and Auditors	1	53,865
Dispatchers (except Police, Fire, and Ambulance)	1	29,537
Water and Liquid Waste Treatment Plant and System Operators	1	31,049
First-Line Supervisors/Managers of Transportation Operators	1	46,914
Sales Representatives, Wholesale and Manufacturing	1	42,683
Customer Service Representatives	1	30,366
First-Line Supervisors/Managers of Mechanics and Repairers	1	49,088
Environmental Scientists and Specialists	1	62,003
Receptionists and Information Clerks	1	22,775
Environmental Science and Protection Technicians	1	44,867
Other employees	12	47,422
Employees, Total	**100**	**$54,530**

Source: Management Information Services, Inc.

VI.C. Findings and Implications

The information and analyses contained in this report are potentially significant and path breaking. They contradict disinformation being disseminated by analysts and interest groups who are opposed to green programs and green jobs initiatives and are attempting to minimize their potential significance. However, the findings here also upend much of the conventional wisdom currently being propagated by environmental, clean energy, and green jobs organizations and advocates. Further, the findings derived here are of direct relevance to many of the current economic, environmental, and job issues currently being debated in the U.S. – including infrastructure spending, climate mitigation policies in the wake of COP 26, the Green New Deal, and jobs, employment, and training policies. This report can become the acknowledged definitive authority and source for data and analysis on the U.S. green economy and green jobs. Specific findings and their implications are summarized below.

Perhaps the most important finding derived here is that the U.S. green economy and the jobs generated by the green economy are much larger and more important than is generally realized, are growing more rapidly than the overall U.S. economy or employment, and will continue to increase rapidly in both absolute and percent terms. Jobs generated in the U.S. green economy currently total nearly nine million and comprise 6% of total U.S. jobs; by 2030 jobs generated in the U.S. green economy are forecast to total nearly 24 million and comprise about 14% of total jobs. These estimates are much larger than most currently available green jobs estimates. This information can be critical in garnering support for the green economy and for green initiatives, programs, and incentives. The findings can be used to communicate to policy-makers that green jobs in the U.S. are being seriously under-estimated, and that the potential implications of this for jobs and training programs are serious.

Another important finding is that most jobs generated in and by the U.S. green economy are not “green.” Rather, the vast majority of the jobs generated are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. and most of the persons employed in these jobs may not even realize that they owe their livelihood to the green economy. These findings can be used to inform companies, workers, and policy-makers of the importance of green expenditures and the green economy in generating company sales, jobs, tax revenues and economic growth. Many workers in the U.S. are dependent on the green economy for their employment, although they have no way of recognizing this unless it is brought to their attention. Many companies in the U.S., whether they realize it or not, owe their profits -- and in some cases their existence -- to “green” expenditures. This will be a revelation to green jobs advocates and others and represents a major contribution to the debate.

The rapid historical growth of the U.S. green economy and jobs is not recognized and its significance is not appreciated. Over the five decades 1970 – 2020, jobs generated by the U.S. green economy increased from less than 1 million and 1% of total U.S. jobs in 1970 to over 8 million jobs and 6% of total jobs by 2020. By 2030, MISI forecasts that the jobs generated by the U.S. green economy will total nearly 24 million

and will comprise more than 14% of total jobs in the economy. Over the six decades, 1970 – 2030, jobs generated by the U.S. green economy are forecast to increase nearly 16 times as rapidly as total U.S. jobs. Thus, encouraging green/environmental and related industries nationally and in specific states can form an integral part of economic development strategy and innovative learning opportunities and solutions to the national/state/local jobs skills gap.

There is no consistent definition – in the U.S. or internationally – of a "green job." Further, it is impossible to develop such a definition, and different organizations and researchers have different concepts and definitions of green jobs – many of which are inconsistent and 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.

Accordingly, numerous attempts have been made to define and estimate green jobs by means of occupational classifications, industry sectors, surveys, "transactional triangulation," and various other methods. The occupational approach is deficient because many green jobs are not specified in current occupational classifications. The industry approach is inadequate because there are many green jobs that are not part of NAICS industries classified as green, and limiting the scope only to businesses that produce green products or services excludes green-related jobs at traditional firms. The major disadvantage of the survey approach is that interpretation of what constitutes a green job is, at least partially, left up to the survey respondent. Approaches such as "transactional triangulation" are difficult to evaluate, are impossible to consistently replicate, and are not directly comparable to job estimates derived from available national statistical data bases.

Different estimates of U.S. green jobs are available from a variety of government and non-government sources, and they evidence a wide range of green jobs estimates depending on the green job definition, the source of the estimate, and other factors. Even estimates from the same organization can differ substantially. State green jobs estimates also differ markedly and illustrate the enormous range of green jobs estimates among states and even for the same state depending on the green job definition, method of estimation, and the source of the estimate. Different organizations and states produce vastly different estimates of green jobs at the national and state levels. The national estimates differ by a factor of 40, and even the most recent estimates differ by a factor of 10, and the state estimates differ even more. Critically, until now, 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. For, as Abraham Lincoln once stated "Prior to determining where we are headed, we must first determine from whence we came."

The MISI green job concept does not attempt to develop a unique green job definition based on industrial or occupational characteristics or on survey methods. Rather, MISI defines green jobs as those FTE jobs generated – directly, indirectly, or induced – by the activities of the green economy. This approach has at least five advantages:

1. It does not bog down into interminable debates over a specific green job definition.
2. It corresponds to interindustry job creation concepts that have been validated over the past half-century and utilized in many disparate economic and job impact analyses.
3. It provides a consistent national data base of estimates of jobs generated by the U.S. green economy over the past five decades.
4. It is viable and credible and produces neither the highest nor the lowest estimates of U.S. green jobs.
5. Importantly, it emphasizes that most of the jobs created by the green economy are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, etc., that the classic green job (solar energy engineer, ecologist, etc.) constitutes only a small portion of the jobs created, and that most of the persons employed in the jobs created may not even realize that they owe their livelihood to the green economy.

Much discussion and analysis of green jobs is based on the USEER studies. However, this is misleading and inaccurate:

- The USEER estimates only direct employment in the energy industries – less than 1 million workers, which is only about 0.5% of total U.S. employment and equals only about 10% of the total number of jobs generated by the green economy – and many of the USEER energy jobs are not "green."
- The USEER data exclude the overwhelming majority of jobs generated by the green economy -- not only indirect and induced jobs, but also green jobs that are not energy related.
- There are serious methodological and empirical problems with the USEER estimates.

A major finding reported here should resolve the contentious debate over the relative salaries of green jobs as compared to non-green jobs. Since the vast majority of the jobs generated by the U.S. green economy are standard "non-green" jobs, the average salaries for these jobs must, due to the law of large numbers, be relatively close to the U.S. average. The U.S. green economy generates disproportionately more jobs in professional, scientific, and technical services occupations than the U.S. 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 U.S. green economy. Further, while many of the jobs generated pay higher than average salaries, many others do not. For example, three types of the most numerous certifiable green jobs created – Refuse and Recycle Workers, Insulation Workers, and Septic Tank Cleaners – pay below average wages. Thus, at best, the average salary for all of the jobs generated by the U.S. green economy may be only slightly higher than the U.S. average – and the difference is likely to be in the statistical noise of the estimates. It is simply not valid to contend that the jobs generated by the U.S. green economy pay wages and salaries that are significantly higher – or significantly lower -- than the U.S. averages.

However, policy initiatives could be focused on increasing the salaries for green jobs and for greatly increasing the rate of unionization of green jobs.[342]

Many or even most jobs in firms producing green products or services are not necessarily green. For example, in a typical wind turbine 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.

Environmentalists and green jobs advocates can be their own worst enemies. Numerous organizations, advocates, and politicians have significantly tightened the criteria for defining and characterizing green jobs and have, paradoxically, greatly reduced the number of jobs that can according to these criteria or characteristics be legitimately defined as being "green." The more stringent the criteria, the fewer the jobs that are defined as green. The reality is that the overwhelming majority of jobs created in and by the green economy may not adhere to the stringent criteria. It is clear that a very strict list of necessary criteria will greatly reduce the estimate of the number of green jobs in the economy. Utilization of these criteria will very seriously underestimate the size, importance, and rates of growth of the U.S. green economy and the jobs created by the green economy. 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 the publicity from environmental organizations and green jobs advocates, most green jobs are not necessarily glamorous, exciting, or desirable. Thus, current and forecast jobs 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 Engineering Technician. It is thus essential to be realistic as to the "green jobs of the future" and to the education and training policies implemented concerning green jobs.

There are a large number of studies contending both that environmental regulations and green initiatives create substantial numbers of jobs and just the opposite – that they destroy jobs or create negative net jobs. Nevertheless, the bottom line is that the balance of research indicates that investments in environmental and green programs have favorable net positive economic and jobs benefits. At least as important though, the net positive economic and jobs impacts, while significant and powerful for policy purposes, should not blind us to the fact that the major purpose and rationale for these programs are the energy and environmental and benefits they will create. The cart should not be put before the horse: The energy and environmental and benefits are the reason these programs are necessary and desirable. Jobs benefits are an important secondary benefit, and should be evaluated as such.

[342]For example, the Colorado AFL-CIO and eight Colorado unions developed a plan for a transformative green jobs program for Colorado; https://www.peri.umass.edu/publication/item/1168-a-green-growth-program-for-colorado.

The BLS occupational data are of high quality, are essential for green jobs analysis and forecasting, and they are the basis for most state job analyses and forecasts. The BLS data are the gold standard. Nevertheless, the BLS classifications have some serious shortcomings for green jobs assessments. One major problem is that the BLS occupational classification does not include numerous designations that would be useful in green jobs analyses. More basically, the BLS occupational classifications – and thus state 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 Bookkeeping Clerk," "Green Carpenter," etc. Further, how "green" an occupation or skill 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 the existing BLS occupational classification data is that they do not identify new and emerging jobs being created by the rapidly growing U.S. green economy and green industries.

Identification of the job openings and the requisite skills, education, training, and experience required is especially important for education and training purposes. 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 successfully 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 supply of 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 growing mismatch between the skills that employers want and the skills that employees have.

MISI estimated the average annual occupational job openings for selected jobs generated by the green economy through 2030. The vast majority of the annual job openings generated (direct, indirect, and induced) by the green economy, 2021 – 2030, will not be for "green" or even "semi-green" occupations. For example, over the coming decade the average annual U.S. job openings generated by the green economy will total 30 times as many Office Clerks (42,000) as Wind Turbine Service Technicians (1,400); more than 11 times as many Assemblers and Fabricators (26,300) as Solar Photovoltaic Installers (2,300); more than 16 times as many Construction Laborers (22,000) as Foresters (1,400); and 11 times as many Customer Service Representative (44,000) as Environmental Engineers (4,000). Thus, over the coming decade, annual total U.S job openings for Wind Turbine Service Technicians will total 1,400 and for Solar Photovoltaic Installers will total 2,300. It is not optimal educational or training policy to plan to produce many thousands of workers annually certified in these occupations given the relatively small number of annual job openings likely to be available. The end result is likely to be disappointed workers trained in these skills functioning as baristas and fast food workers.

Policy-makers 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. They can warn against fixation on "sexy" green jobs such as Wind Turbine Technicians and Solar Photovoltaic Installers, where annual new job openings in the entire U.S. will total only about 1,000 – 2,000 annually. 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 U.S. high-tech and manufacturing sectors, and green investments generate, proportionately, more than jobs in professional, scientific, and technical services than the U.S. average. This has important implications for U.S. economic, jobs, and education and training programs. However, green jobs will continue for the foreseeable future to comprise only a small portion of total jobs in the U.S. Any ambitious employment and job creation programs must take such discrepancies into account.

Jobs generated by the green economy will be created across a new continuum of employment, skills, responsibilities, and earnings. Training for new skills will be needed across a wide spectrum of industries. Some changes in skills are relatively well defined, but many likely changes remain difficult to forecast since the technologies are still evolving. Many 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 and employment guides. Further, many of these new jobs require different skills and education than current jobs, and training needs must be determined to enable this rapidly growing green sector to have a sufficient supply of trained and qualified employees.

Examples of the type of new jobs and requisite skill requirements being created in the green economy – and the associated challenges for workforce planning – was illustrated here by assessing the rapidly growing hydrogen and fuel cell industries. Growth in the hydrogen (H_2) and fuel cell (FC) industries will lead to substantial new employment opportunities, and these will be created throughout a wide variety of industries, skills, tasks, and earnings. However, many of these jobs do not currently exist and do not have occupational titles defined in official classifications – as is the case for many new and emerging green economy jobs. In addition, many of these jobs require different skills and education than current jobs, and training requirements must be assessed so that this rapidly growing part of the economy has a sufficient supply of trained and qualified workers. MISI identified by occupational titles and job descriptions the new jobs that will be created in the expanding hydrogen/fuel cell economy, estimated the average salary for each job, identified the minimum educational attainment required to gain entry into that occupation, specified the recommended university degree for the advanced educational requirements, and provided relevant job descriptions. The findings

here can be applied to a wide range of industries, occupations, and skills being created and expanded in the green economy.

While conventional debate on the environment, climate change, and alternative energy has focused on applying new technology to offset traditional energy sources, RE&EE and related green sectors are more than sources of fuel or energy savings. They are sources of jobs. This report shows that employment growth in the RE&EE and green industries varies greatly among the different segments of the industries, but breakthroughs in RE&EE and environmental technologies will emerge from the growing sectors of the industries, including architectural and engineering services, manufacturing, IT & smart systems, materials processing, systems design, and R&D. In addition, utilities are an area for pioneering a number of alternative energy technologies, including H_2 blending with natural gas and superconducting power lines -- which reduce the 20 percent loss of electricity due to transmission -- solar thermal, photovoltaic, H_2/FC, wind systems, and distributed power technologies which will reduce the losses from transmission and supply more reliable localized power and enable power production across the electrical grid. Increasingly, however, advances and breakthroughs in the green economy will come from all areas of the economy, and may not necessarily be captured by traditional industry sources of energy/green technologies or current job classifications. This represents both a challenge and an opportunity. The opportunity is to get ahead of the curve on how and where the jobs of the future are being created as the economy rebuilds from COVID-19, determine which are the best green industries to target, assist companies and communities seeking solutions to their own workforce issues, and identify for workers and job seekers where the jobs of the future will be. Thus, the opportunity is to identify where these industries, companies, and jobs currently are and where they will be in the near future. There is widespread interest in this type of information from workers, companies, and all levels of government.

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