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Green Jobs Myths

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Green Jobs Myths

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Abstract

A rapidly growing literature promises that a massive program of government mandates, subsidies, and forced technological interventions will reward the nation with an economy brimming with "green jobs." Not only will these jobs improve the environment, but they will be high paying, interesting, and provide collective rights. This literature is built on mythologies about economics, forecasting, and technology.

Myth: Everyone understands what a "green job" is.

Reality: No standard definition of a "green job" exists.

Myth: Creating green jobs will boost productive employment.

Reality: Green jobs estimates include huge numbers of clerical, bureaucratic, and administrative positions that do not produce goods and services for consumption.

Myth: Green jobs forecasts are reliable.

Reality: The green jobs studies made estimates using poor economic models based on dubious assumptions.

Myth: Green jobs promote employment growth.

Reality: By promoting more jobs instead of more productivity, the green jobs described in the literature encourage low-paying jobs in less desirable conditions. Economic growth cannot be ordered by Congress or by the United Nations. Government interference – such as restricting successful technologies in favor of speculative technologies favored by special interests – will generate stagnation.

Myth: The world economy can be remade by reducing trade and relying on local production and reduced consumption without dramatically decreasing our standard of living.

Reality: History shows that nations cannot produce everything their citizens need or

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desire. People and firms have talents that allow specialization that make goods and services ever more efficient and lower-cost, thereby enriching society.

Myth: Government mandates are a substitute for free markets.

Reality: Companies react more swiftly and efficiently to the demands of their customers and markets, than to cumbersome government mandates.

Myth: Imposing technological progress by regulation is desirable.

Reality: Some technologies preferred by the green jobs studies are not capable of efficiently reaching the scale necessary to meet today's demands and could be counterproductive to environmental quality.

In this Article, we survey the green jobs literature, analyze its assumptions, and show how the special interest groups promoting the idea of green jobs have embedded dubious assumptions and techniques within their analyses. Before undertaking efforts to restructure and possibly impoverish our society, careful analysis and informed public debate about these assumptions and prescriptions are necessary.

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The solutions to environmental and economic problems, domestically and internationally, are often tied together. The assertion that "green jobs" can be created to improve environmental quality while reducing unemployment is behind an aggressive push for a "green economy" in the United States and elsewhere. For example, a recent report from the U.S. Conference of Mayors, *Current and Potential Green Jobs in the U.S. Economy,* contends that investing in green jobs would produce a remarkable range of benefits:

> The economic advantages of the Green Economy include the macroeconomic benefits of investment in new technologies, greater productivity, improvements in the U.S. balance of trade, and increased real disposable income across the nation. They also include the microeconomic benefits of lower costs of doing business and reduced household energy expenditures. These advantages are manifested in job growth, income growth, and of course, a cleaner environment.[1]

Green jobs advocates see no downside to their preferred polices: "It is all good news."[2] The Conference of Mayors estimated that green jobs can provide "up to 10% of new job growth over the next 30 years"[3] and others are similarly optimistic.[4] Governments, non-governmental organizations, and international bodies all seek to promote the creation of green jobs. Given the claims that every dollar spent on a host of green job programs will be repaid many times over, it is hard to see how creating green jobs or "greening" existing jobs could be seen as anything other than a fantastic opportunity.

Our review of the claims of green jobs proponents, however, leaves us skeptical because the green jobs literature is rife with internal contradictions, vague terminology, dubious science, and ignorance of basic economic principles. Indeed, the green jobs literature claims resemble the promises of long-term financial prosperity offered by Ponzi schemes. New taxes, increased public borrowing, and government subsidies will be needed to support green jobs programs. We find no evidence that these "investments" in green jobs can support the promised results. Investing taxpayers' money in developing green jobs as an economic and environmental

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[1] UNITED STATES CONFERENCE OF MAYORS, U.S. METRO ECONOMIES: CURRENT AND POTENTIAL GREEN JOBS IN THE U.S. ECONOMY 2 (2008), *available at* http://www.usmayors.org/pressreleases/uploads/GreenJobsReport.pdf [hereinafter MAYORS].

[2] Roger Bedzek, AMERICAN SOLAR ENERGY SOCIETY, RENEWABLE ENERGY AND ENERGY EFFICIENCY: ECONOMIC DRIVERS FOR THE 21ST CENTURY, at vii (2007), *available at* http://www.misi-net.com/publications/ASES-EconomicDrivers07.pdf [hereinafter ASES].

[3] MAYORS, *supra* note 1, at 17.

[4] As of Dec., 2008 ASES projects over 37 million green jobs by 2030. AMERICAN SOLAR ENERGY SOCIETY, DEFINING, ESTIMATING, AND FORECASTING THE RENEWABLE ENERGY AND ENERGY EFFICIENCY INDUSTRIES IN THE U.S. AND IN COLORADO, at xii (2008), *available at* http://www.ases.org/images/stories/ASES/pdfs/CO_Jobs_Final_Report_December2008.pdf. In 2007, the estimate was over 40 million (assuming an "aggressive deployment forecast scenario"). ASES, *supra* note 2, at iv.

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panacea, are likely, like a Ponzi scheme, to result in empty bank accounts.[5]

Our review convinces us that the real purpose of the green jobs initiative is not to create jobs but to remake society. The sweeping changes advocated in these reports under the guise of greening our economy are intended to shift the American and world economies away from decentralized decision making, in favor of centralized planning. Therefore, instead of allowing individuals to voluntarily trade in free markets in pursuit of their own ends, green jobs advocates would instead discourage trade and allow technologies to be chosen by central planners and politicians, who would determine the choices faced by consumers and workers. By wrapping these policy shifts in the green jobs mantle, those advocating the reorganization of much of life hope to avoid a debate over the massive costly changes they want to impose.

We assess the green jobs literature by focusing on several recent major reports purporting to demonstrate both the need for and benefits of green jobs, the most ambitious of which we briefly summarize below to present the vision of the economy green jobs advocates propose. These are the most serious efforts to document claimed benefits. They are frequently quoted and cited as authoritative by the news media and in public policy debates. Our analysis has three parts. First, we examine the problems with their attempts to both define when a job qualifies as "green" and to calculate how many such jobs exist. Second, we analyze how the green jobs literature treats key economic concepts and find the literature makes fundamental economic errors in its analysis. Third, we examine specific areas of technology where we believe the green jobs literature makes errors that typify the literature as a whole. We then conclude by suggesting that deep skepticism is the most appropriate response to the hyperbolic claims of the green jobs literature.

Green job claims are widespread. Some assertions are based on political posturing,[6] while others tout impressive numbers with little accompanying analysis to back up the claims – this is especially true of press accounts. We focus most intensively in this paper on the recent substantive efforts to describe green jobs: The United Nations Environment Programme (UNEP) report,[7] the U.S. Conference of Mayors ("Mayors") report,[8] the American Solar Energy Society report[9] ("ASES") and the Center for American Progress ("CAP") report.[10] All of these reports attempt comprehensive analyses, providing greater detail than the anecdotal claims elsewhere.

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[5] The expenditures required "will likely be in the hundreds of billions, and possibly trillions, of dollars." *See* UNITED NATIONS ENVIRONMENT PROGRAMME, GREEN JOBS: TOWARDS DECENT WORK IN A SUSTAINABLE, LOW-CARBON WORLD 306 (2008) [hereinafter UNEP], *available at* http://www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf. That is, the wealth of nations is at stake.

[6] During the 2008 presidential campaign, John McCain stated "We can move forward and clean up our climate and develop green technologies … so that we can clean up our environment and, at the same time, get our economy going by creating millions of jobs." Jeanne Cummings, *Can Green Jobs Save Us?*, POLITICO, Oct. 14, 2008, http://www.politico.com/news/stories/1008/14551.html. In the same debate, Barack Obama stated that "if we create a new energy economy, we can create 5 million jobs, easily, here in the United States." *Id.* The Republican Party platform in 2008 did not discuss this issue; the Democratic Party platform did, *see* DEMOCRATIC NATIONAL CONVENTION COMMITTEE, THE 2008 DEMOCRATIC NATIONAL PLATFORM: RENEWING AMERICA'S PROMISE 17-18 (2008), *available at* http://www.democrats.org/a/party/platform.html.

[7] *See* UNEP, *supra* note 5. At 376 pages, this is a substantive report, not just a call to action.

[8] MAYORS, *supra* note 1.

[9] ASES, *supra* note 2.

[10] CENTER FOR AMERICAN PROGRESS, GREEN RECOVERY: A PROGRAM TO CREATE GOOD JOBS AND START BUILDING A LOW-CARBON ECONOMY, (2008), *available at* http://www.americanprogress.org/issues/2008/09/pdf/green_recovery.pdf [hereinafter CAP].

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Assessing green jobs claims requires examining the underlying arguments made in favor of them, not just assertions or the hyperbole of political discourse.

These four studies are authored by different interest groups. The UNEP report is the joint product of the United Nations' staff that focuses on environmental issues and the Worldwatch Institute, an environmental advocacy group noted for promoting population reduction,[11] with the assistance of the Cornell University Global Labor Institute, a pro-union organization.[12] That report starts with the climate change analysis of another international organization, the Intergovernmental Panel on Climate Change (IPCC), which concludes that global warming poses a significant threat to the quality of life on earth.[13] Using the IPCC assessment as its point of departure, the UNEP report calls for major actions to force changes in economic activity so as to significantly lower levels of carbon emissions, as well as other greenhouse gas emissions, and force what is asserted to be more efficient use of resources. The programs recommended would mean a worldwide restructuring of almost all economic activity and employment, as the report concedes.[14]

The Mayors report, on the other hand, is an effort to forge a consensus among a diverse set of American local politicians and focuses on making a case for green jobs as an urban economic development strategy. Unsurprisingly, given the interests of its sponsor, this report does not focus on radical restructurings of the economy but instead on specific benefits for every community in the nation, paid for by the federal government rather than the community that would benefit.

The ASES report is published by a trade group for an alternative energy industry – solar power. As such, it reflects the interests of that industry, promoting, at a cost to the taxpayers, a particular energy technology rather than a wholesale change in the structure of the economy.

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[11] UNEP's report was produced by the Worldwatch Institute, a Washington, D.C. based environmental advocacy group, founded by Lester Brown. Press Release, Worldwatch Institute, *Lester Brown to Launch New Venture* (Mar. 21, 2001), *available at* http://www.worldwatch.org/node/1691. Worldwatch lists its mission statement as "Worldwatch Institute delivers the insights and ideas that empower decision makers to create an environmentally sustainable society that meets human needs. Worldwatch focuses on the 21st century challenges of climate change, resource degradation, population growth, and poverty by developing and disseminating solid data and innovative strategies for achieving a sustainable society." Worldwatch Institute, Worldwatch *Mission Statement*, http://www.worldwatch.org/node/24 (last visited Feb. 18, 2009). Worldwatch was founded by Lester Brown, author of a number of alarmist books on population. *See, e.g.*, Lester R. Brown, WHO WILL FEED CHINA? WAKE-UP CALL FOR A SMALL PLANET (1995); Lester R. Brown, TOUGH CHOICES: FACING THE CHALLENGE OF FOOD SCARCITY (1998), Lester R. Brown, et al., BEYOND MALTHUS: NINETEEN DIMENSIONS OF THE POPULATION CHALLENGE (1999). In 1997, *The Economist* summarized Brown's record on population and food issues as follows:

> Lester Brown of the Worldwatch Institute began predicting in 1973 that population would soon outstrip food production, and he still does so every time there is a temporary increase in wheat prices. In 1994, after 21 years of being wrong, he said: "After 40 years of record food production gains, output per person has reversed with unanticipated abruptness." Two bumper harvests followed and the price of wheat fell to record lows. Yet Mr. Brown's pessimism remains as impregnable to facts as his views are popular with newspapers. The facts on world food production are truly startling for those who have heard only the doomsayers' views. Since 1961, the population of the world has almost doubled, but food production has more than doubled.

Plenty of Gloom: Forecasters of Scarcity Are Not Only Invariably Wrong, They Think That Being Wrong Proves Them Right, ECONOMIST, Dec. 20, 1997, at 21, 22.

[12] The Institute's homepage explains its mission by stating: "The Cornell Global Labor Institute (GLI) offers a unique venue for unions at the local, national and global level to work together to strengthen labor's response to the challenges posed by globalization." Cornell Global Labor Institute Home Page, http://www.ilr.cornell.edu/globallaborinstitute/ (last visited Feb. 18, 2009).

[13] *See, e.g.*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007 SYNTHESIS REPORT 13-14 (Rajendra K. Pachauri et al. eds., 2007), *available at* http://www.ipcc.ch/ipccreports/ar4-syr.htm.

[14] UNEP, *supra* note 5, at 292-93 (discussing the "Challenges to Just Transition").

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Finally, the CAP report is the product of left-leaning think tanks in Washington, D.C.[15] and a University of Massachusetts think tank.[16] Like the UNEP report, this one uses green jobs as a means to develop economic policies that suit its underlying vision of a greatly expanded government.

These interests are inevitably reflected in the substance of the reports and comparing them allows us to examine the interplay between interests, assumptions, and predicted outcomes.[17]

Absent from our analysis is our own laundry list of policy proposals. We believe the world economy would benefit from more economic activity, and that, all else equal, reducing energy consumption and developing new sources of energy are good ideas. However, we do not believe that massive bets by politicians on their preferred energy sources are likely to deliver any of the above.

As we discuss later in this Article, market forces constantly "green" both consumer goods and industrial processes. From refrigerators to steel production, energy use has fallen dramatically without any central direction or infusion of massive amounts of taxpayer resources. This greening of industries and jobs is the natural result of competitive markets' pressure to reduce costs combined with the ingenuity of millions of production workers, product designers, managers, property developers, and engineers.

We are not arguing for our own alternative set of favored policy prescriptions, but for a different approach to the issue. By analyzing the problems with the green jobs literature's claims, we hope to persuade readers that the fundamental question is not whether to spend $20 billion or $400 billion of taxpayers' money on solar or wind power but who should decide how resources should be allocated: people in the marketplace or planners and politicians in Washington, D.C.

Before we dive into the analysis of the green jobs literature, we want to note that much of this discussion is really about energy. Modern economies and the lives we enjoy rely on energy

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[15] CAP is headed by former Clinton Administration member John Podesta, Center for American Progress, John Podesta: President and Chief Executive Officer, http://www.americanprogress.org/aboutus/staff/PodestaJohn.html (last visited Feb. 18, 2009), who served as co-chair of the Obama transition team, Lois Romano, *In Any Guise, Podesta a Smooth Master of the Transition Game*, WASH. POST, Nov. 25, 2008, at C01. After the 2008 election, the CAP report was cited by members of the incoming Obama economics team. It issued a report asserting that the proposed "economic stimulus" plan would create nearly four million jobs by the end of 2010 and that some of these would be green jobs. Christina Romer & Jared Bernstein, THE JOB IMPACT OF THE AMERICAN RECOVERY AND REINVESTMENT PLAN, 11 (2009), *available at* http://otrans.3cdn.net/ee40602f9a7d8172b8_ozm6bt5oi.pdf.

[16] PERI (Political Economy Research Institute) describes itself as "progressive" and notes its links to "activists" such as ACORN. *See* PERI – Political Economy Research Institute: Links & Organizations, http://www.peri.umass.edu/203/ (last visited Feb. 18, 2009). At the time of this writing, it was promoting a statement by "progressive economists" who advocate a massive expansion of government, income redistribution, more political power for labor, and regulation of financial institutions "so they will serve people's needs." PERI – Political Economy Research Institute: Economists' Statement, http://www.peri.umass.edu/statement (last visited Feb. 18, 2009).

[17] Readers should be just as skeptical of us as we are of the authors of the various green jobs reports. Three of us are traditional economists (i.e. not "ecological economists" or some other variety) trained at mainstream economics Ph.D. programs and inclined to be skeptical of claims that governments or international NGOs such as UNEP can effectively induce significant improvements in the U.S. economy without causing significant costs. This Article was produced with support from the Institute for Energy Research, a nonprofit organization that favors market solutions to energy issues where one of us (Morriss) is a Senior Fellow. While we think it likely that IER asked us to undertake this project with a pretty good guess where our professional skepticism would likely lead us, neither IER nor anyone else had advance approval rights over our results or interfered in any way with our analysis. We suspect the same is true of the authors of the reports discussed herein – that the people who commissioned the reports had reasonable ideas about how the results might come out given the authors they selected. Healthy skepticism is our recommendation for all analyses of green job claims, including ours.

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usage at a much greater level than our ancestors enjoyed. The following figures from the Department of Energy explain the sources of energy used today and the primary uses of that energy.

The green jobs literature focuses on phasing out virtually all of our current energy sources – 93 percent (as shown on the left side of Figure 1). Only about 7 percent of our energy now comes from what are called renewable sources. Regardless of the source, as the right side of the figure shows, the energy goes to heat and cool our homes, schools, and offices. Energy powers our cars, the ambulances that take injured people to hospitals, and the trucks that deliver goods. Our current energy sources provide power for industry and agriculture to help produce every good we enjoy. Green jobs promoters assert that this energy should be eliminated. In fact, former Vice President Al Gore has stated that our current sources of electricity – almost 40 percent of all energy in the United States – should be eliminated within a decade.[18]

Since Gore, like others, focuses on electricity, let us consider it in more detail. As Figure 2 shows, less than 10 percent of electricity in the U.S. comes from renewable sources, making the change insisted upon by Gore and others draconian. As Table 1 shows in detail, what are commonly called "renewable" energy sources by green jobs advocates—wind, solar, geothermal and biomass—represent about 3 percent of our electricity generation capacity.[19] While the capacity is rising, it will still represent a tiny fraction of our electric capacity in 10 years—and beyond—regardless of the wishes of Mr. Gore and other politicians.[20]

[18] "If we set our minds to it, we in this country could produce 100 percent of our electricity from renewable and carbon free sources in 10 years," Gore said. "That is possible." J.R. Pegg, *Gore Urges Congress to Confront Climate Emergency*, ENVIRONMENT NEWS SERVICE, January 28, 2009. Available at: http://www.ens-newswire.com/ens/jan2009/2009-01-28-10.asp

[19] As we discuss below, conventional hydroelectric and nuclear power, while not carbon emission sources, are not considered to be "renewable."

[20] President Obama, in his stimulus plan, asserts the nation's renewable energy sources will double in three years. See *Remarks of President Barack Obama – Address to Joint Session of Congress*, February 24, 2009. Available at http://www.whitehouse.gov/the_press_office/remarks-of-president-barack-obama-address-to-joint-session-of-congress/. That is very ambitious and will require massive taxpayer subsidies, but even if it happens, and then happens again and again in subsequent three-year periods, it will be not remotely close to what Mr. Gore advocates.

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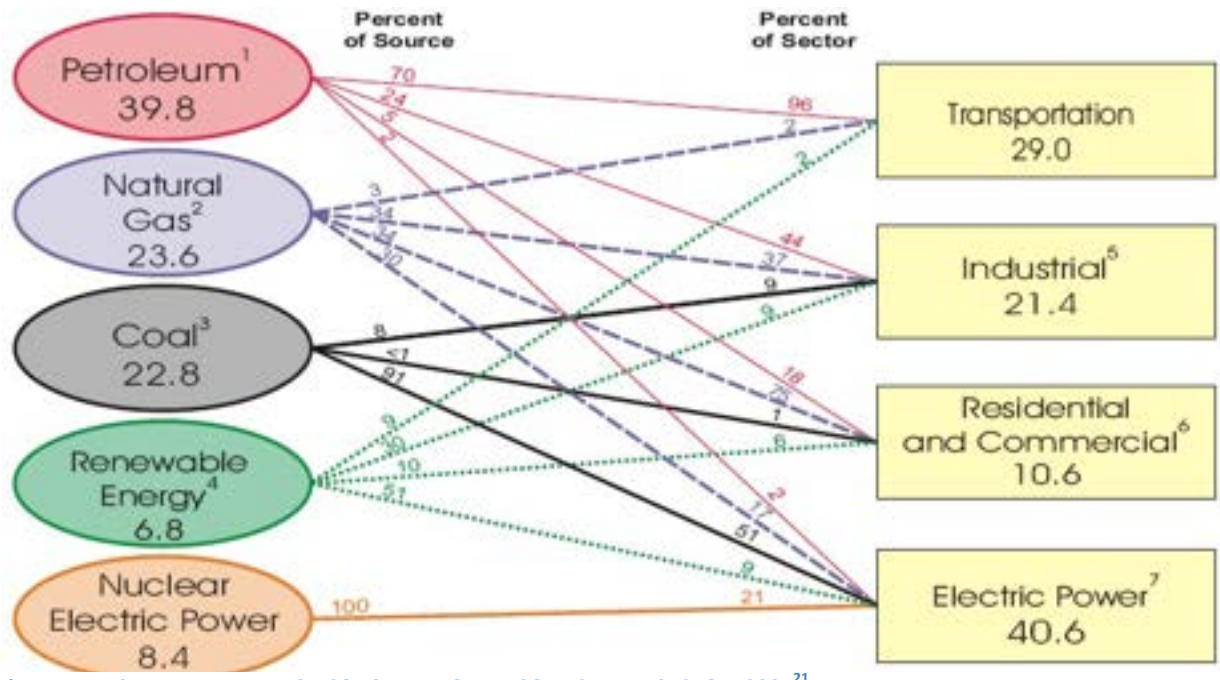

Figure 1 - U.S. PRIMARY ENERGY CONSUMPTION BY SOURCE AND SECTOR, 2007[21]

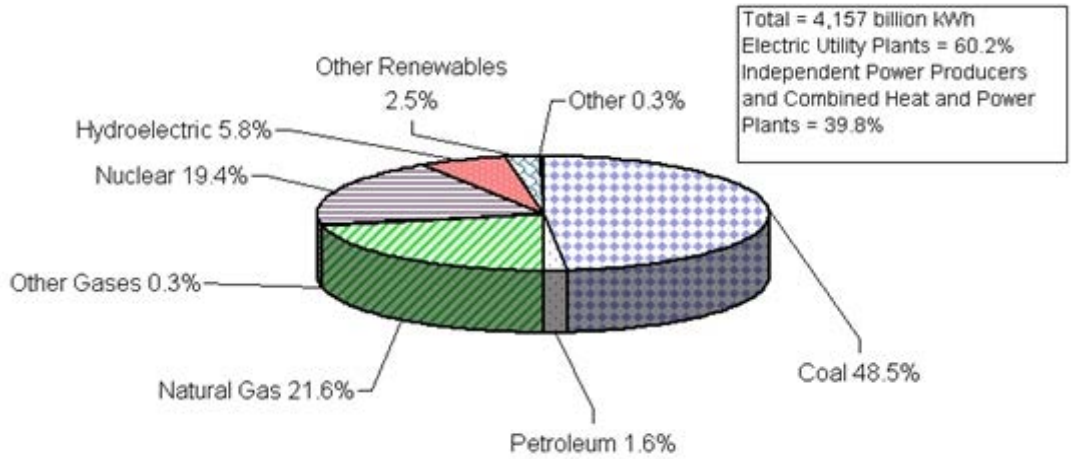

Figure 2 - US ELECTRIC POWER INDUSTRY NET GENERATION, 2007[22]

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[21] Energy Information Administration, U.S. Department of Energy, ANNUAL ENERGY REVIEW 2007, Report No. DOE/EIA-0384 (2007); Posted: June 23, 2008. Available at: http://www.eia.doe.gov/emeu/aer/pecss_diagram.html. Table footnote numbers:

[1]Excludes 0.6 quadrillion Btu of ethanol, which is included in "Renewable Energy."
[2]Excludes supplemental gaseous fuels.
[3]Includes 0.1 quadrillion Btu of coal coke net imports.
[4]Conventional hydroelectric power, geothermal, solar/PV, wind, and biomass.
[5]Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[6]Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[7]Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public.

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Table 1 - Existing Electrical Capacity by Energy Source, 2007[23]

Electrical Energy Sources	Capacity (MW)	Source as % Capacity
Coal	336,040	30.9
Petroleum	62,394	5.7
Natural Gas	449,389	41.3
Other Gases	2,663	0.24
Nuclear	105,764	9.7
Hydroelectric Conventional	77,644	7.1
Wind	16,596	1.5
Solar Thermal and Photovoltaic	503	0.05
Wood & Wood Derived Fuels	7,510	0.7
Geothermal	3,233	0.3
Other Biomass	4,834	0.4
Pumped Storage	20,355	1.9
Other	866	0.08
TOTAL	1,087,791	100

Cost aside—and the cost is too big to be ignored—significant technical issues exist that would prohibit a commitment to electricity only from renewable sources in 10 years. Turning off the electricity generated from coal and other non-renewable sources that soon would mean that most Americans would literally freeze in the dark. The reasons why the green jobs programs touted—and partly funded by the 2009 stimulus package—are unrealistic and extraordinarily costly helped inspire this Article. We appreciate that many people like to believe that good things happen when we all "pull together" and that policy makers want to offer solutions, but the reality is more complex than politicians and "green" promoters want us to believe—and the alternative is not as grim as they portray.

I. Envisioning a World of Green Jobs

Before beginning our analysis of the green jobs literature, we briefly summarize the most comprehensive piece of green jobs literature, the UNEP report. We do so to provide the reader with a sense of the scope of the transformation that would be required of the American economy, the world, economy and our society to implement green jobs proposals. These suggestions by the report are not simple ones, such as hiring the unemployed weatherize schools. They are suggestions that fundamentally restructure our society and the world economy.

The UNEP report stresses that new, green jobs will be created to achieve its programmatic goals. Some workers will switch from traditional production to greener

[22] Energy Information Administration, Form EIA-923, *Power Plant Operations Report,* and predecessor form(s) including Energy Information Administration, Form EIA-906, *Power Plant Report,* and Form EIA-920, *Combined Heat and Power Plant Report.* Available at: http://www.eia.doe.gov/cneaf/electricity/epa/figes1.html

[23] Energy Information Administration, ELECTRIC POWER ANNUAL with data for 2007, Table 2.2. Report Released: January 21, 2009. Available at: http://www.eia.doe.gov/cneaf/electricity/epa/epat2p2.html.

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production. But the report notes, unlike most green jobs reports, that existing jobs will be destroyed as disfavored methods of production are forced to cease, replaced by new, preferred methods of production. It also explains that while some existing jobs will, after retooling, continue to exist, these are usually lumped into the category of green jobs since the change is forced by environmental objectives.[24]

How will all this happen? "Forward-thinking government policies" are "indispensible."[25] The report presumes that little will happen without government action. The policy changes called for by the report fall into nine categories:

- **Subsidies.** Subsidies for "environmentally harmful industries" will be terminated; the funds will be shifted to renewable energy, efficiency technologies, clean production methods, and public transit.
- **Carbon Markets.** Carbon markets, such as carbon trading under the Kyoto Protocol, are not doing as much as needed, so they must be strengthened. Besides carbon credits being traded, carbon must be taxed so revenues can be used as "adequate funding sources for green projects and employment."
- **Eco-taxes.** Eco-taxes must be initiated and used to discourage polluting and carbon-producing activities.
- **Government Regulations.** "Regulatory tools" must be used "to the fullest extent" to force greener technologies. This includes expanded government land-use controls, revised building codes, more stringent energy-efficiency standards, and increased renewable energy production.
- **Electrical Grid Access.** Alternative energy production will be forced by guaranteeing access to electric grids at favorable prices.
- **Expanding Recycling Requirements.** Manufacturers will be required to take back their products after use, so producers will ensure that products will be recycled properly at the end of their useful life.
- **Mandatory Eco-labeling.** Eco-labeling of products will be required, so consumers can make informed choices among alternatives given the environmental costs.
- **Shifting Energy Research Funding.** Cut support for nuclear power and fossil fuel research in favor of greater funding for renewable energy and technical efficiency.
- **Changes in Foreign Aid.** Reorient foreign aid away from fossil fuel and hydro-electric power projects in favor of renewable energy sources.

Note that the action items are all government mandates. This is because the report claims that environmental improvements that occur naturally "are insufficient and may simply be overwhelmed by continued economic growth." Not only will new kinds of jobs be created in place of old jobs, but for environmental (and human) sustainability, lower standards of living are an unfortunate fact. The UNEP report, for example, calls for "retool[ing] not only the economy, but also economic thought" so that people will use "a different way of measuring human activity" and a "different theory," no longer focused on "quantitative growth" but instead on "a shift from the acquisition of goods" to "the continuous receipt of quality, utility, and

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[24] UNEP, *supra* note 5, at 3 ("it would appear that many existing jobs (such as plumbers, electricians, metal workers, and construction workers) will simply be transformed and redefined as day-to-day skill sets, work methods, and profiles are greened.").

[25] *Id.* at 5. The discussion that follows immediately comes from this source.

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performance."[26] Mass production will generally end, as will the jobs that comprise the modern economy, according to UNEP. [27] This will mean many displaced workers, so we need to think of how to "share available work better among all those who desire work."[28]

Another major green job area is building. New buildings should high green standards, but existing buildings can be retrofitted to be more efficient.[29] Emission savings can be significant and the technology exists now to incur such savings, according to these reports.[30] The UNEP report estimates that this could create two million jobs in the European Union and the United States, and, obviously, millions more around the world.[31]

Energy conservation is another major area of concern in the green jobs reports. Although private incentives to save resources are strong, the report asserts that they are insufficient to resolve the greenhouse gas problem. Transportation contributes about 23 percent of such emissions.[32] While aircraft today are 70 percent more fuel-efficient than those built 40 years ago, and continued improvements are projected, those are insufficient and will not halt emissions, the reports claim.[33] Car and truck traffic are also major contributors. While engines are more efficient now than in the past, and new engine technology is coming into play, given the rapid increase in demand for vehicles in China, India, and other parts of the world, the emission problem will not be "solved," if you believe the green jobs reports.[34]

Besides continued improvement in cars and truck engines, there must be a push to public transit systems, they report.[35] For this to succeed, cities throughout the nation must have greater density, implying massive population shifts from the suburbs to central cities. Subways are not realistic in sprawling cities.[36] High-density living also means that walking and bicycling will become more realistic alternatives and will replace cars for many, according to the reports.[37] All this will be done in a labor-intensive way. For example, the UNEP report decries the falling employment in the production of locomotives and rolling stock in China. Despite the growth of the rail network by 24 percent from 1992 to 2002, employment fell from 3.4 million to 1.8 million. "A sustainable transport policy needs to reverse this trend," UNEP reports.[38] A senior manager at a Chinese rolling stock company, a state-owned enterprise, told one of the authors that the single biggest challenge for his company is to keep employment up (which the government prefers) as it continues to modernize and expand production. Most such state-dominated organizations have surplus, inefficient labor. With modern production methods, it seems dubious that more workers will be needed as the UNEP report hopes.

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[26] *Id.* at 83.

[27] It surely must since we are no longer going to focus on "large scale purchases of 'stuff'" but instead on "quality retail, in which the salesperson knows how to sell intelligent use rather than simple ownership." *Id.* at 77. Consumers will "obtain desired services by leasing or renting goods rather than buying them outright." *Id.* at 78.

[28] *Id.* at 6.

[29] *Id.* at 131.

[30] *Id.* (suggesting savings of 29 percent in greenhouse gas emissions from retrofitting).

[31] *Id.* at 12.

[32] *Id.* at 12-14.

[33] *Id.* at 149.

[34] *Id.* at 151.

[35] *Id.* at 152.

[36] *Id.* ("Denser cities and shorter distances reduce the overall need for motorized transportation.")

[37] *Id.* at 14, 167.

[38] *Id.* at 13.

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The UNEP also puts great hope on increased recycling of steel and aluminum to reduce energy usage compared to production of virgin metals.[39] In addition, it assumes new technology will allow for less pollution than traditional production. The same is true in other areas where recycling is technologically feasible. As we show below in more detail, there is a trend toward more energy efficiency in steel and aluminum production, but it is the result of market forces not mandates. And millions of people are in already recycling[40] - but this includes people who scour garbage dumps around the world.[41] The employment problem is that much existing recycling is small scale and not environmentally friendly.[42]

The green reports also take aim at the world's agricultural system. A little over a third of the world's workforce is in agriculture.[43] Much of the work is on small plots of land, not the large industrial-scale farming in the United States that requires few workers. The continuous decline of the share of the workforce in agriculture poses a conundrum for the UNEP authors as they recognize the tradeoff between large-scale, efficient modern agriculture and traditional small plots that still dominate in poor countries.[44]

Modern agriculture relies on inputs such as chemical fertilizers. Those are not green.[45] Further, existing global integration of agriculture means large companies "dictate 'take it or leave it' terms on those who actually grow the food."[46] That is, farmers who have found it to their advantage to sell produce to large companies must cease such activities so food is not carried off to Carrefour and other large retailers.[47] Farmers should focus on local production and consumption.[48] Small-plot agriculture is to be encouraged.[49] Large scale meat production "is neither green nor decent"[50] and must come to an end in favor of a few animals on small plots of land that keep hundreds of millions employed.[51] Of course, with many people living in high-density cities, if agricultural production as we know it is undesirable because shipments across long distances is carbon-intensive, then we must have "sustainable urban agriculture" that will employ hundreds of millions, according to the United Nations report.[52] Unfortunately, the net effect of this proposal is to increase food prices, thereby injuring the poor most of all, and reduce choice as people will be required to eat domestic products and not enjoy diverse foods from around the world.

The last major sector considered is forestry. Forests must be expanded and deforestation

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[39] *Id.* at 14-18.

[40] *Id.* at 219.

[41] *Id.* at 242.

[42] *Id.* at 216-17 (describing Egyptian "Zabaleen" or informal garbage collectors and South Asian ship dismantlers).

[43] *Id.* at 40.

[44] *Id.* at 19.

[45] *Id.*

[46] *Id.*

[47] *Id.* at 19-20.

[48] *Id.* at 19.

[49] *Id.* at 19-20.

[50] *Id.* at 19.

[51] *Id.* at 19-21.

[52] *Id.* at 20.

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reversed in many countries.[53] Since this occurs primarily in very low income areas, the cost of moving from deforestation to forestation is estimated to be relatively small at $5-10 billion per year.[54] Keeping millions busy requires investment in agroforestry, such as expansion of fruit trees, but the report authors admit that the fragmented nature of the industry makes solid projections difficult.[55]

The change to green jobs will not be easy, voluntary or cheap. "Governments at the global, national, and local levels must establish an ambitious and clear policy framework to support and reward sustainable economic activity and be prepared to confront those whose business practices continue to pose a serious threat to a sustainable future."[56] What this means is that massive public spending is needed and many existing methods of production terminated if we are to achieve the technological and economic transformations on the scale needed to achieve significant reductions in energy production and use, and to have the changes in methods of energy production.

The UNEP report explains the scope of what is at stake in the green jobs policy discussion; it does not pretend that this is a simple matter. In contrast to domestic reports we review here, which assert that green jobs programs are all win-win and assert to know how exactly many green jobs will be created decades from now, the UNEP report, while comprehensive, does not pretend that the costs can be known exactly, nor does it sugarcoat some parts of the structural changes that would be needed to force massive change.

What the UNEP report makes clear is the broad scope of the social change it proposes. Virtually every aspect of daily life – from where people live, where their food comes from, how they commute to work, to what they do at work – will be dramatically altered. Such massive social change is costly in both monetary terms and in terms of the disruption of lives. Before launching a program to transform the lives of billions of people at a cost of hundreds of billions of dollars, we should be sure that not only is this the future we want but that the theory on which the vision is built is correct. The history of the twentieth century is in part the history of failed efforts to remake societies according to visions that proved unsustainable. Before launching yet another effort, on an even grander scale, we need to thoroughly critique the vision. We turn to doing so now.

II. Defining "green" jobs

We must address four definitional issues concerning green jobs before we can understand green job proponents' claims. First, studies differ on what constitutes a green job among. They differ on their definitions of both green jobs that might be created by new environmental initiatives as well as how to "green" existing jobs. When examined closely, green job estimates turn out to depend on highly contested definitions of "green" which differ from study to study. These differences render most comparisons among green jobs claims fruitless. If we want to conduct a policy debate over green jobs measures, we must requiring greater specificity about what constitutes a green job. Even more importantly, the varying definitions incorporate important, but often unstated, assumptions about environmental policy, economics, and the appropriate standard of living. These assumptions have the potential to produce counterproductive environmental policies that lead to worsening of environmental quality,

[53] *Id.* at 22.

[54] *Id.*

[55] *Id.* at 23.

[56] *Id.* at 24.

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interfere with economic efficiency, and a reduce standard of living.

Second, forecasts of potential growth in green jobs, however they are defined, depend on extrapolating from recent growth rates in the numbers of existing green jobs, which raises issues about the calculation of these growth rates. As a result of low base numbers for many categories of jobs, green jobs forecasts are likely to be over-optimistic about the potential for green employment, however defined. Moreover, these calculations are largely based on surveys by interest groups and conjecture rather than on hard numbers from comprehensive research. As a result, policy debates over green job measures cannot be reasonably conducted without ensuring that those advocating particular green job strategies include technical appendices so as to disclose the basis for the extrapolations central to their claims. They have largely failed to do so. Given the scale of the investment, much better data is needed to justify the gamble that such growth rates can be sustained.

Third, many green job estimates focus only on job gains without considering job losses as employment shifts to favored industries, such as solar power, and away from disfavored ones, such as coal power plants. Even when green job estimates attempt to calculate job losses, they do so using inappropriate methodology. Subjecting any claims regarding a jobs program to a net jobs test is critical to informed decision making, and a green jobs program should be no exception.

Finally, the green jobs literature often defines a job as "green" based on the inefficient use of labor within a production process. While low labor productivity is a drag on the economy, it does not follow that it will lead to lower environmental impact. This focus on inefficiency stems in part from the efforts of those dissatisfied with free markets, and its logical outgrowth, free trade, to use environmental issues to achieve political policy objectives for the economy.[57] Further, by focusing green job expenditures on economic activity with low labor productivity, resources can be forced to be shifted from capital to favored workers in line with these groups' economic priorities. Before policymakers adopt green jobs strategies, they need to be aware that these proposals are often simply part of a "Bootleggers and Baptists" coalition to achieve unrelated policy aims of the labor movement.[58]

In this section we examine each of these definitional issues in detail, providing examples from the four reports.

A. What counts as "green"

As the UNEP report notes, "not all green jobs are equally green."[59] To its credit, that report's authors insist that the "bar needs to be set high" in defining green jobs to prevent the term from becoming so diluted as to be meaningless and to stop short of achieving the goal of "dramatically reduc[ing] humanity's environmental footprint."[60] In economic terms, the

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[57] *See* Jonathan H. Adler, *Clean Politics, Dirty Profits: Rent-Seeking Behind the Green Curtain, in* POLITICAL ENVIRONMENTALISM: GOING BEHIND THE GREEN CURTAIN 1, 2 (Terry L. Anderson ed., 2000).

[58] That concept was first developed in Bruce Yandle, *Bootleggers and Baptists: The Education of a Regulatory Economist*, REGULATION, May-June 1983, at 12. It means politics makes for strange bedfellows. Those who wanted prohibition of alcohol (the Baptists) ended up on the same side of the issue as the bootleggers who profited from the existence of prohibition. Those parties have nothing in common but end up, inadvertently, in an alliance. That can be seen in certain environmental issues where environmental groups (the Baptists in this case) champion a policy, such as mass transit construction, that finds a natural alliance in labor unions that will profit from the union-wage construction jobs created.

[59] Some actions and related jobs are "lighter shades of green" than others. UNEP, *supra* note 5, at 299.

[60] *Id.* at 4.

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definitional issue is critical. If the widespread subsidies proposed by many for green jobs are implemented, classifying a job as green will be valuable. Special interest groups and employers will assert many activities to be green where the jobs in question are not green at all. For an analogy, consider how the federal financial bailout program grew from a focus on repairing financial institutions to include subsidies for wooden arrow makers and tax breaks for rum producers.[61] So too, a massive green jobs program will attract its own set of what economists refer to as "rent seekers." Rent-seeking refers to the use of the political process to obtain rewards for a factor of production in excess of the market rate.[62] It often occurs when individuals or groups invest in the political process to create barriers to entry or capture public resources for private gains, especially for the groups promoting the policies. Any efforts to develop a public program to promote green jobs must therefore include a carefully drafted definition of "green" to limit rent-seeking.

What qualifies as "green"? In the literature, being green differs significantly depending on who is doing the classification. For example, the Mayors defined a "green" job as:

> Any activity that generates electricity using renewable or nuclear fuels, agriculture jobs supplying corn or soy for transportation fuels, manufacturing jobs producing goods used in renewable power generation, equipment dealers and wholesalers specializing in renewable energy or energy-efficiency products, construction and installation of energy and pollution management systems, government administration of environmental programs, and supporting jobs in the engineering, legal, research and consulting fields.[63]

Somewhat inexplicably, the Mayors report counts *current* nuclear power generation jobs as green jobs but not *future* jobs in nuclear power.[64] In contrast, the UNEP report defined "green jobs" both more restrictively, excluding all nuclear power related jobs and many recycling jobs, and more expansively, including all jobs asserted to "contribute substantially to preserving or restoring environmental quality."[65] The UNEP defines a green job as:

> Work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high-efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution.[66]

The differences between these definitions are substantial. The more expansive supply chain claims included in the UNEP report allows the authors to claim credit for a considerable number of jobs in supplier industries. For example, wind turbine towers involve "large amounts

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[61] Emergency Economic Stabilization Act of 2008, Pub. L. No. 110-343, § 503, 122 Stat. 3765, 3877 ("Exemption from Excise Tax for Certain Wooden Arrows Designed for Use by Children"); Section 308. Increase in Limit on Cover Over of Rum Excise Tax to Puerto Rico and the Virgin Islands. 122 Stat. 3765, 3869.

[62] Gordon Tullock, *Rent Seeking*, *in* 4 THE NEW PALGRAVE: A DICTIONARY OF ECONOMICS 147, 147-149 (John Eatwell, Murray Milgate & Peter Newman eds., 1987).

[63] MAYORS, *supra* note 1, at 5. The report included jobs involved in the production of corn and soy to the extent the corn and soy are used for biofuels. *Id.*

[64] *Id.* at 12 (nuclear power jobs "are not included in our projection scenario.").

[65] UNEP, *supra* note 5, at 3.

[66] *Id.*

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of steel" and so the supply chain for the wind power industry involves green jobs extending back into the steel industry so long as the steel being created ends up in a wind turbine.[67] The steel jobs themselves are not required to be "green," only the use of the steel made by the employees in question. Comparing these two definitions illustrates the significant hurdles to establishing a consistent, workable definition of a "green job." Important value judgments, that are often not explained, are embedded in the definitions.

One important issue is illustrated by the Mayors and UNEP reports' respective treatments of nuclear power-generation jobs and their comparison with the broader debate over the future role of nuclear power. While the UNEP report explains (briefly) the basis for nuclear jobs' total exclusion from the green category, the Mayors report says little about its reasons for including the nuclear jobs of today, but not those in the future.[68] The more restrictive approach with respect to nuclear power means that the UNEP report does not count any jobs in nuclear power.[69] There is room for disagreement over whether nuclear power is a "green" strategy or not, and advocates of increasing nuclear generation include both governments traditionally seen as green[70] and some environmentalists.[71]

As we discuss in detail later, nuclear power is seen by many as an important component of a strategy to address greenhouse gas emissions by fossil-fuel-based power plants,[72] yet the environmental impact of waste disposal issues could be the basis for a principled exclusion, as it appears to be in the UNEP report. The lack of consensus across reports is significant not simply because it reflects a major difference among those calculating green job numbers but because it mirrors a wider debate over the appropriate role of nuclear power created by the growing

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[67] *Id.* at 4. Creating a "sustainable" steel industry itself is also expected to produce green jobs. *Id.* at 15 ("Making steel mills greener and more competitive is a must for job retention.").

[68] One possible explanation for the difference is that Worldwatch, a major contributor to the UNEP report, like many environmental advocacy groups, has opposed nuclear power, lumping it with coal and oil. Gary Gardner & Michael Renner, *Opinion: Building a Green Economy*, EYE ON EARTH, Nov. 12, 2008, http://www.worldwatch.org/node/5935 ("Wind and solar technologies are not just more environmentally benign than oil, coal, and nuclear power, but also more jobs-intensive."). On the other hand, the Mayors report represents mayors who benefit from nuclear power plants roles as taxpayers and as the source of energy, and that report is careful to stress that all regions of the United States could benefit from a focus on green jobs. *See, e.g.*, Mayors, *supra* note 1, at 21 ("one of the promising aspects of Green Jobs is that the vast majority of them are not restricted to any specific location, so cities and their metro areas across the country can and are expected to compete to attract this job growth.")

[69] These are excluded because

> nuclear power is not considered an environmentally acceptable alternative to fossil fuels, given unresolved safety, health, and environmental issues with regard to the operations of power plants and the dangerous, long-lived waste products that result. Being capital-intensive, the nuclear industry is also not a major employer, and is thus similarly ill-suited as a solution to the world's employment challenges.

UNEP, *supra* note 5, at 89.

[70] France leads among larger nations at nearly 80 percent of power from nuclear sources. World Nuclear Association, Nuclear Power in the World Today, http://www.world-nuclear.org/info/inf01.html (last visited Feb. 19, 2009). Globally, sixteen percent of electricity is from nuclear sources. *Id.* Coal is the dominant alternate source. *Id.* Sweden, which gets about half its electricity from nuclear power, had planned to phase out nuclear plants, but the government is reversing policy and considering building new plants. *Sweden Wants to Lift Reactor Ban*, N.Y. TIMES, Feb. 6, 2009, at A10, *available at* http://www.nytimes.com/2009/02/06/world/europe/06sweden.html?ref=world.

[71] Jeremy Plester, *Environmentalists May Go Nuclear*, TIMES (United Kingdom) 50 (Jan. 3, 2005); Ira Flatow, *Some Environmentalists Warming Up to Nuclear*, TALK OF THE NATION/SCIENCE FRIDAY (NPR). (June 2, 2006).

[72] William Tucker, TERRESTRIAL ENERGY: HOW NUCLEAR POWER WILL LEAD THE GREEN REVOLUTION AND END AMERICA'S ENERGY ODYSSEY (2008). *See also* Max Shulz, *Nuclear Recovery*, AMERICAN SPECTATOR, Dec. 2008, at 90, 90-91 (reviewing Tucker and contrasting Tucker's views to those of Amory Lovins and Thomas Friedman).

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concern with greenhouse gas emissions.[73]

Nuclear power is not the only technology, or even the only energy technology, that requires trading off one environmental problem for another. As an illustration, consider that producing renewable energy equipment creates pollution. As the UNEP report notes, producers of solar photovoltaic (PV) cells often produce long-lived hazardous byproducts that are frequently disposed of improperly[74] – a problem conceptually similar to the waste disposal problems of the nuclear power industry. Unlike nuclear power jobs, however, the UNEP report does not exclude all photovoltaic-related jobs, even as the lower cost photovoltaic production caused by improper disposal has played a role in the rapid expansion of the use of photovoltaics by reducing their costs.

The failure to treat technologies consistently – such as excluding products that pose environmental threats when disposed of improperly – is emblematic of an important problem in the green jobs literature. When winners and losers are selected according to non-transparent and inconsistent application of selection criteria, the potential for rent-seeking is enormous. Before billions in public money is committed to promoting green jobs, proponents need to make clear the criteria used to select those who qualify for access to those resources.

A different version of this problem can be seen in the way some analyses consider almost anything green if the technology does not use petroleum without considering the environmental impacts of the alternative's environmental impact. For example, the Mayors report touts biomass as a "group of technologies where additional investment and jobs will help to develop the nation's alternative energy infrastructure."[75] Most of the green jobs literature extols the virtues of generating energy using "wood waste and other byproducts, including agricultural byproducts, ethanol, paper pellets, used railroad ties, sludge wood, solid byproducts, and old utility poles. Several waste products are also used in biomass, including landfill gas, digester gas, municipal solid waste, and methane."[76]

Unfortunately, because biomass includes burning wood, "perhaps the oldest form of human energy production,"[77] a means of energy production associated with smog, air pollution, and massive release of carbon.[78] Yet biomass is included "because of the short time needed to re-

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[73] *See, e.g.*, TUCKER, *supra* note 72 (discussing role of nuclear power); Amarjit Singh, *The Future of Energy*, 9 LEADERSHIP & MGMT. ENGINEERING 9, 9-25 (2009); Kathleen Vaillancourt, Maryse Labriet, Richard Loulou & Jean-Philippe Waaub, *The Role of Nuclear Energy in Long-Term Climate Scenarios: An Analysis with the World-TIMES Model*, 36 ENERGY POLICY 2296, 2296-2307 (2008); Benjamin. K. Sovacool, *Valuing the Greenhouse Gas Emissions from Nuclear Power: A Critical Survey*, 36 ENERGY POLICY 2950, 2950-2963 (2008) (study of total lifecycle emissions, not direct GHG emissions).

[74] UNEP, *supra* note 5, at 111. Using "environmentally responsible" methods raises the cost of producing polysilicon for solar PV cells from between $21,000/ton and $56,000/ton to $84,000/ton. *Id.*

[75] MAYORS, *supra* note 1, at 9.

[76] *Id.*

[77] *Id.*

[78] Wood burning, despite its status as a renewable source, can be a major source of fine particulate matter air pollution. As noted by Michael Faust of the Sacramento Metro Chamber,

> Wood burning has been identified as the largest single source of wintertime PM 2.5 in the Sacramento region. The 2005 emission inventory for Sacramento County shows that wood smoke accounts for 45% of wintertime PM 2.5 emissions and is the largest single category. Prohibiting wood burning on days when particulate levels are projected to exceed a set threshold has been identified as the most cost effective way to reduce PM 2.5. By prohibiting the release of particulate matter from wood smoke on specific days, the Sacramento region can prevent particulate matter levels from reaching unhealthy levels, and avoid being designated an nonattainment for the federal 24-hour PM 2.5 standard.

Michael Faust, Vice President of Public Policy, Sacramento Metro Chamber, Testimony before Sacramento Metropolitan Air Quality Management District regarding Wood Burning Rule 421 (Sept. 26, 2007), *available at* http://sacramentocacoc.weblinkconnect.com/cwt/external/wcpages/wcwebcontent/webcontentpage.aspx?contentid=1225.

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grow the energy source relative to fossil fuels."[79] In other words, biomass counts as green because it is not petroleum, even though biomass causes environmental problems. Similarly, the Mayors report counts biodiesel and ethanol as green "because of their ability to reduce reliance on fossil fuels,"[80] overlooking arguments that growing corn or soy for ethanol or biodiesel requires agricultural practices that increase air and water pollution,[81] bring marginal land into production reducing wildlife habitat,[82] increase emissions of carbon dioxide and nitrous oxides,[83] and increase the amount of nitrogen and pesticides in the environment.[84]

Even if we focus on the one environmental issue that the green jobs literature generally puts at the top of the list of reasons to develop green jobs – preventing greenhouse gas emissions – there are significant problems with the definitions. It is not surprising that "not all fuels derived from biomass necessarily offer meaningful carbon emission advantages over fossil fuels, and some may even impose new environmental costs," UNEP concedes.[85] Even if we ignore the costs of heavily-subsidized programs such as ethanol, before embarking on large-scale burning of used railroad ties and corn extracts (which may not be so environmentally friendly), it would be wise to know more about the specifics of the science underlying the claim that all the things labeled "biomass" do in fact produce a net environmental gain when used as an energy source.

While we do not claim to know the science of such diverse technical matters to make a

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Areas that have been declared nonattainment of Federal primary (health-related) ambient air quality standards for particulate matter pollution at one time or another partly due to wood burning include Tacoma, and Spokane, Washington; Eugene, Oregon; Sandpoint and Pinehurst, Idaho; and Kalispell and Missoula, Montana. Tacoma Urbanist, Port Activities and Wood Stoves Designate Tacoma as *Non-Attainment* For Pollution, http://i.feedtacoma.com/Erik/port-activities-wood-stoves-designate/ (Jan. 17, 2008); SPOKANE COUNTY AIR POLLUTION CONTROL AUTHORITY, DRAFT TECHNICAL ANALYSIS PROTOCOL FOR THE SPOKANE PM10 NONATTAINMENT AREA PM10 LIMITED MAINTENANCE PLAN AND REDESIGNATION REQUEST (2004), *available at* http://www.spokanecleanair.org/documents/sip/Draft%20Spokane%20LMP%20TAP.pdf; Idaho Dep't of Envtl. Quality, *Air Monitoring Overview: How DEQ Assesses Air Quality*, http://www.deq.state.id.us/air/data_reports/monitoring/overview.cfm (last visited Feb. 19, 2009); Mont. Dep't of Envtl. Quality, *Citizens' Guide to Air Quality in Montana: Understanding Air Quality*, http://www.deq.state.mt.us/AirMonitoring/citguide/understanding.asp (last visited Feb. 19, 2009).

[79] MAYORS, *supra* note 1, at 9.

[80] *Id.* at 11 n.12.

[81] *See* Timothy Searchinger et al., *Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change*, 319 SCIENCE 1238, 1240 (2008). We are aware of the controversy this paper sparked. *See, e.g.*, Posting of pwintersatbiodotorg to Biofuels & Climate Change, http://biofuelsandclimate.wordpress.com/2008/02/28/is-the-debate-on-land-use-over/#comments (Feb. 28, 2008). The point is not whether Searchinger et al. are correct about the net impact but whether the green jobs literature acknowledges the active scientific controversy over these issues. It largely does not.

[82] Conversion of habitat to cropland is generally deemed to be the most significant pressure on terrestrial species, habitat and ecosystems. *See* MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING 67 (2005), *available at* http://www.millenniumassessment.org/documents/document.356.aspx.pdf [hereinafter MEA]; Indur M. Goklany, *Saving Habitat and Conserving Biodiversity on a Crowded Planet*, 48 BIOSCIENCE 941, 941 (1998). Likewise, diversions of freshwater for human uses are deemed to exert the greatest pressure on freshwater biodiversity. *E.g.*, A. Brautigam, *The Freshwater Biodiversity Crisis*, 2 WORLD CONSERVATION 4, 4-5 (1999), *available at* http://www.iucn.org/bookstore/bulletin/1999/wc2/content/freshwaterbio.pdf. 7 November 2001; IUCN. 2000. Confirming the Global Extinction Crisis. IUCN Press Release, 28 September 2000. <http://www.iucn.org/redlist/2000/news.html>. Visited 7 November 2001; Wilson 1992; *see also* MEA, *supra* note 82.

[83] Searchinger et al., *supra* note 81, at 1238 (carbon dioxide); G. Philip Robertson et al., *Sustainable Biofuels Redux*, 322 SCIENCE 49, 50 (2008) (nitrous oxide).

[84] *See infra* Part III.C, where this matter is addressed in greater detail. The UNEP report took a more skeptical approach to biofuels, perhaps because it was less concerned with the political calculation necessary to build support for green jobs initiatives within the United States. *Full of Sound and Fury*, ECONOMIST, July 14, 2007, at 32, 32-33 (U.S. Congressional debates over energy policy, ethanol and other renewable, and taxation of oil companies); Paul B. Thompson, *The Agricultural Ethics of Biofuels: A First Look*, J. AGRIC. & ENVTL. ETHICS, Apr. 2008, at 183, 183-198.

[85] UNEP, *supra* note 5, at 90.

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final judgment on how green particular biomass and biofuel programs are, the enthusiastic advocates of the green jobs programs do not appear to know the difference either. They make simplistic assertions about what energy can be counted on to substitute for current supplies and offer only vague cost and environmental impact estimates. Policies designed to have major impacts on the economy and environment should be better researched and understood before massive resources are committed to them.

Finally, calculations of green jobs often incorporate criteria unrelated to the environmental impact of the job or production process. For example, recycling is generally touted as a major source of green employment.[86] But in the UNEP report many current jobs in recycling industries[87] are excluded because those jobs are "characterized by extremely poor practices, exposing workers to hazardous substances or denying them the freedom of association."[88] Even today's symbol of environmental consciousness, the hybrid car, is not necessarily "green" in the eyes of all green jobs proponents. The UNEP report cautions that "only under certain conditions" can hybrids "be seen as unambiguous proxies for a greener auto industry."[89]

There may be good reasons to exclude public support from jobs that fail to meet various criteria related to the ability to form labor unions or employers' record in workplace safety. However, those reasons have nothing to do with the environmental impact of the job and including such criteria in a definition of a "green" job obscures the issues. Moreover, those criteria are themselves contested – whether governments should promote, hinder, or remain neutral in labor disputes is not something on which there is a consensus.

What these examples demonstrate is that the green jobs literature does not engage in serious analysis of whether a particular job is "green" but instead simply labels jobs as green if they are found within a favored industry.[90] Are these jobs truly green? The only criteria used by any of these analyses to exclude a job within a favored industry is UNEP's insistence on job characteristics unrelated to environmental quality, such as "decent work, i.e. good jobs which

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[86] ASES, *supra* note 2, at 29 (noting that recycling is the second biggest "green job" in the U.S.).

[87] UNEP, *supra* note 5, at 215 ("While recycling is of great value in terms of resource conservation, it can entail dirty, undesirable, and even dangerous and unhealthy work, and it is often poorly paid."); *Id.* at 219 ("While recycling offers the benefit of recovering resources that otherwise would have to be mined and processed at considerable environmental expense, the procedures prevalent in most of China's recycling sector themselves impose considerable human and environmental costs. Particularly the manual disassembly jobs cannot be described as green jobs.").

[88] UNEP, *supra* note 5, at 4.

[89] *Id.* at 154; *see also* CNW Marketing Research, Inc., DUST TO DUST: THE ENERGY COST OF NEW VEHICLES FROM CONCEPT TO DISPOSAL (2007), http://cnwmr.com/nss-folder/automotiveenergy/DUST%20PDF%20VERSION.pdf (a controversial report contending that the net environmental impact of a Toyota Prius was greater than of a Hummer H1).

[90] For example, *Occupational Outlook Quarterly* quoted Ann Randazzo of the Center for Energy Workforce Development in Washington, D.C. that "jobs in renewable energy are not all that different from jobs in traditional energy sources. . . . For example, a person who is trained to work on power lines also has many of the skills to work on wind turbines." Phillip Bastian. On the Grid: Careers in Energy. 52(3) OCCUPATIONAL OUTLOOK QUARTERLY 33-41 (Fall 2008). Similarly, Mayors suggests that existing manufacturing operations will simply switch from making other things to making wind turbines. *See* MAYORS, *supra* note 1, at 13. The report states

> The technology of wind electricity is relatively new, but the manufacturing base for its production is very similar to past products. Every state in the country has firms and a labor force with experience making products similar to the blades, gearboxes, brakes, hubs, cooling fans, couplings, drivers, cases, bearings, generators, towers and sensors that make up a wind tower. These jobs fall into the familiar durable manufacturing sectors of plastics and rubber, primary metals, fabricated metal products, machinery, computer and electronic products, and electrical equipment.

Id. Likewise, the CAP report states that "the vast majority" of the green jobs its program would create are "in the same areas of employment that people already work in today…" CAP, *supra* note 10, at 5. And the UNEP study noted that job creation in "sheet metal work, semiconductors, electronic equipment, and others" would be "a welcome antidote to the loss of manufacturing jobs in recent years." UNEP, *supra* note 5, at 110.

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offer adequate wages, safe working conditions, job security, reasonable career prospects, and worker rights."[91] These are wonderful characteristics of any job, but their inclusion seems to be motivated more by a desire to build a coalition with labor groups than by any interest in improving the environment.

In fact, making green jobs more expensive seems like a sure way to ensure that there are fewer of them. Other groups, including developing nations[92] and women and ethnic minorities[93] also receive consideration that has little to do with the environment. Again, there is nothing wrong with advocating transfer payments to developing nations or employment quotas or other programs for favored groups; the troubling aspect is the inclusion of such advocacy in an "environmental" strategy.

These definitional issues are not simply inconveniences to the analysis of green jobs claims, although they make it impossible to compare the different reports' claims.[94] They represent fundamental confusion about the very idea of a "green job," a confusion that ought to be resolved before committing billions of taxpayer dollars and compelling even larger sums of private resources to generate "green jobs." Indeed, these examples point to a serious problem in the green jobs literature. Because there is not only no agreement on what it means to be a "green" job, and little transparency in making clear the differences in assumptions underlying the various definitions, the literature obscures fundamental public policy choices that require thorough debate. The green job advocates create incentives for interest groups to work the political system to have their own industries or jobs designated as "green" and their rivals' excluded. Such rent-seeking not only wastes resources but is likely to entrench inferior technologies in the market place, as has occurred with ethanol.[95] The heavy weight put on non-environmental criteria suggests that the "green" label is already a vehicle for rent seeking. Moreover, failure to consider the entire life cycle costs of technologies in choosing which will be favored and which will not undermines the credibility of the literature's definitions of "green."[96] The lack of such consideration is endemic in the literature. Developing an open, clear definition of "green" is a critical prerequisite to public policy measures to promote green jobs if such efforts are not to turn into rent-seeking extravaganzas with little impact on the environment. Thus far such a definition has not appeared.

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[91] UNEP, *supra* note 5, at 4. It is unlikely that the vast majority of jobs around the world, green or not, would meet that criteria as it would be understood by most Americans.

[92] *See, e.g.*, *id.* at 28 ("Just as vulnerable workers should not be asked to incur the costs of solving a problem they did not cause, the same principle should apply to resource-starved countries that today face major problems due to climate change caused by the emissions of the richer countries.").

[93] *See, e.g.*, *id.* at 26 ("There are important equity issues with regard to minorities as well as gender.").

[94] Even the UNEP study conceded that existing green jobs literature is made up of studies using quite different methodologies and assumptions. *Id.* at 101 ("One problem with the array of existing studies is that they employ a wide range of methodologies, assumptions, and reporting formats, which makes a direct comparison of their job findings—or any aggregation and extrapolation-very difficult or impossible.")

[95] Jonathan H. Adler, *Rent Seeking Behind the Green Curtain*, 19 REGULATION, Fall 2006, at 26, 26, *available at* http://www.cato.org/pubs/regulation/regv19n4/v19n4-4.pdf (describing rent seeking in 1990s ethanol programs); *see also* U.S. Office of Tech. Assessment, INNOVATION AND COMMERCIALIZATION OF EMERGING TECHNOLOGIES 87-88 (1995) ("Regulations that are overly prescriptive can lock in existing technologies to the detriment of other technologies that might meet or exceed requirements."); Envtl. Law Inst., BARRIERS TO ENVIRONMENTAL TECHNOLOGY AND USE 6 (1998) ("Technology-based emission limits and discharge standards, which are embedded in most of our pollution laws, play a key role in discouraging innovation.").

[96] We will discuss this below in the case of mass transit in the U.S.

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There is some overlap – every report thinks weatherizing public buildings is a good idea, for example. If there are unemployed people, why not put them to work replacing windows in public schools? There are undoubtedly less productive uses of public funds – such as the classical Keynesian suggestion of having one group dig holes and another fill the holes in[97] – but that is hardly a positive recommendation. The question is not whether weatherization is a good thing generally but whether the weatherization that occurs only when subsidized is a good thing. Without a clearer explanation of the theory of market failure underlying the proposals, even these areas of overlap are questionable.

B. What counts as a "job"

The second major problem with the green jobs literature is that it consistently counts jobs that do not produce final outputs as a benefit of spending programs. These jobs should be counted as a cost. For example, the Mayors report includes as green jobs those jobs involved in "government administration of environmental programs, and supporting jobs in the engineering, legal, research and consulting fields.[98] The UNEP report also includes such jobs in its definition.[99] Another estimate of green jobs, by Management Information Services, the primary consultant on the ASES report, found that the single biggest increase were secretarial positions; next were management analysts; then bookkeepers, followed by janitors. Most dramatically, Management Information Services estimated that there were fewer environmental scientists than any of the other jobs just listed.[100]

The impact of including non-productive employees within the definition of green jobs can be seen in the Mayors' list of the top 10 metropolitan areas for current green jobs, which is led by New York City (25,021) and Washington, D.C. (24,287).[101] As there is little manufacturing or corn or soy farming in such locations, this suggests that most of the green jobs in both locations are likely to be in the overhead categories. Indeed, the report emphasizes that "engineering, legal, research and consulting positions play a major role in the Green Economy, as they account for 56% of current Green Jobs. They have also grown faster than direct Green Jobs since 1990, expanding 52%, compared with 38% growth in direct jobs."[102] Note that this lumps engineers and scientists inventing new technologies with lawyers and accountants devising ways to obtain government subsidies, lobbying, or engaging in other forms of unproductive rent-seeking.

The Mayors report makes a "conservative" estimate of one new indirect job for every two direct jobs, conceding that "we do not expect that each marginal electricity generating job will require another environmental lawyer … and not every retrofitting position will require commensurate growth in research or consulting."[103] That it could be seen as a positive benefit if policies required more lawyers or consultants demonstrates the fundamental incoherence of green job definitions. This problem is widespread in the green jobs literature, with the focus

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[97] John Stossel, *Jobs Plan: Dig Holes, Fill Them*, FORT WAYNE JOURNAL GAZETTE (Feb. 22, 2009) available at http://www.jg.net/apps/pbcs.dll/article?AID=/20090222/EDIT05/302229929/1021/EDIT

[98] MAYORS, *supra* note 1, at 5.

[99] UNEP, *supra* note 5. *See supra* note 66 and accompanying text.

[100] Roger H. Bezdek, et al., *Environmental Protection, the Economy, and Jobs: National and Regional Analyses*, 86 J. ENVTL. MGMT. 53, 66 (2008). Bezdek and his associates are primary authors of the ASES report.

[101] MAYORS, *supra* note 1, at 5.

[102] *Id.* at 16.

[103] *Id.* UNEP also notes a high range of indirect jobs from energy efficiency measures, finding estimates from 90percent to 66percent indirect job creation. UNEP, *supra* note 5, at 136-137.

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almost entirely on the hypothesized economic impact of increased public spending on favored projects.[104]

These numbers illustrate an important point. The purpose of a business, green or not, is not to *use* resources (e.g. labor, energy, raw materials, or capital). The purpose of a business is to produce a good or service desired by consumers that can be sold in the marketplace for more than the cost of production. For a given level of output, businesses that use more resources are less efficient – have higher costs -- than those using fewer resources. Moreover, it is crucial to recognize that many jobs created in response to government mandates are *not* a *benefit* of environmental measures but rather represent a *cost* of such programs. Such costs may be worth incurring for the benefits the program produces, but they must be counted as costs not benefits.[105]

A simple example comparing two hypothetical energy policies illustrates the point. Both policies require power companies – whenever possible – to use renewable energy plants rather than their fossil fuel power plants to generate the energy they sell. Policy A requires the power companies to install a data recorder that measures how much power comes from each type of plant in real time and transmit the information to the Environmental Protection Agency (EPA), where a computer program analyzes the data. When the program detects underuse of renewable energy plants, it alerts an EPA official, who can then initiate enforcement action against the power company for violating the rules. Aside from the initial work in installing the monitor and programming the computer, and whatever maintenance is required on the monitors and computer program, this policy requires only the occasional attention of the EPA official. Policy B requires the same monitor, software, and EPA headquarters staff. However, it also requires an EPA employee be stationed in the power companies' control rooms 24 hours a day, 7 days a week, 365 days a year to ensure that no one tampers with the monitoring unit. Policy B produces many more "green" jobs under both the Mayors and UNEP definitions. Yet these additional employees add nothing to the actual greening of energy production.[106]

The inclusion of consultants, lawyers, and administrators as benefits of green job spending illustrates a major problem with the definition of green jobs.[107] By making increasing labor use the *end*, rather than treating labor inputs as a *means* to production of environmentally friendly goods and services, the literature makes a foundational error in analyzing the economy. By promoting inefficient use of labor resources, green jobs policies will steer resources towards technologies, firms, and industries that will be unable to compete in the marketplace without

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[104] For example, CAP touts retrofits of public buildings because they "have the most potential for operating at a large scale within a short time period." CAP, *supra* note 10, at 16. (CAP's proposal is for a $26 billion program to retrofit all 20 billion square feet of education, government office, and hospital space.) *Id.* The average pay back for these expenditures would be "about five years" because they would save "about $5 billion per year" in energy costs. *Id.* And CAP promises that spending $20 billion on "mass transit and light rail and smart grid electric transmission systems" would "reap similar macroeconomic returns over time as these investments stabilized oil prices through transportation diversification and energy efficiency gains." *Id.*

[105] On the costs and benefits of alternative environmental policies, *see* Andrew P. Morriss & Roger E. Meiners, *Borders and the Environment*, 39 ENVTL. L. (forthcoming 2009).

[106] At most they deter some fraudulent tampering with the monitors. For our purposes we can assume this is zero. Of course, much tampering can be detected *ex post* rather than prevented *ex ante*, and so the marginal amount of fraud deterred will be less than the total amount of fraud possible. It is not just bureaucrats who get counted as a benefit rather than a cost under these definitions but repair personnel as well. For example, UNEP forecasts that there will be "tremendous job growth" in installing and maintaining solar systems. UNEP, *supra* note 5, at 8. This ignores the fact that a system that requires more labor to install or maintain is less efficient than one that requires less labor.

[107] This is the same logic as declaring that a "benefit" of the war on drugs is an increase in the number of prison guards.

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permanent subsidies. Dooming the environmentally friendly economic sector to an unending regime of subsidies is both fiscally irresponsible and harmful to efforts to continue to build a competitive and environmentally friendly economy. As we discuss later, this is a seriously under-appreciated feature of economic progress.

C. Forecasting

Forecasts of green jobs are universally optimistic. For example, *Occupational Outlook Quarterly's* forecast for green jobs notes that renewable power "is one of the fastest growing segments of the electric power industry."[108] The Mayors report asserts that "wind energy is currently the fastest growing alternative energy source in the country,"[109] and "solar power is an alternative energy source providing opportunity for massive job growth" [110] Similarly, the UNEP report claims that "[a]long with expanding investment flows and growing production capacities, employment in renewable energy is growing at a rapid pace, and this growth seems likely to accelerate in the years ahead."[111]

We found five major problems with these optimistic forecasts. First, many of the sectors declared to be green are extremely small and even quite minor changes in capacity produce large percentage increases in growth. Whether such large percentage increases will continue, or whether the progressively larger denominator from prior periods' growth will result in a slower rate of growth is thus an important question that must be answered before extrapolating from current growth rates. Ironically for an area so concerned with sustainability issues, the reports generally assume that these rapid rates of growth can continue even as the denominator grows.

Second, the growth rates forecast are huge by any standard, thus raising questions regarding their reliability. In the energy field in particular, the projections in green job reports yield astonishingly fast spreads of new technologies, some of which do not even exist yet in economically viable forms. Such assumptions are inconsistent with past experience with other technologies.

Third, the green jobs literature exhibits a selective technological optimism, assuming away any problems that might slow adoption of favored technologies while ignoring the likelihood of technological improvements of disfavored ones. This selective optimism about technological change biases the forecasts in favor of the favored technologies, but is unsupported by evidence of systematically faster growth in favored technologies over their competitors.

Fourth, because many industries discussed as major drivers of green jobs are small and new, no official, vetted statistics are available. This means that quite a few assumptions about the distribution of green and less green employment within the larger categories for which data are collected are necessary. As a result, the underlying basis for many of these forecasts are not statistics collected by neutral, skilled analysts, such as those at the U.S. Energy Information Administration, but estimates made by green jobs proponents and interest groups with a vested interest in the outcomes.[112] This source of potential bias means that caution must be exercised in

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[108] Bastian, *supra* note 90, at 38.

[109] MAYORS, *supra* note 1, at 6-7.

[110] *Id.* at 7.

[111] UNEP, *supra* note 5, at 6.

[112] For example, the Department of Energy estimated that if the U.S. attempted to achieve 20 percent wind power by 2030 (which would be an incredible undertaking given the slow rate of growth), there would be 500,000 jobs at that time in the wind-related field, of which 150,000 would be manufacturing, construction, and maintenance. U.S. Dep't of Energy, 20% WIND ENERGY BY 2030: INCREASING WIND ENERGY'S CONTRIBUTION TO U.S. ELECTRICITY SUPPLY 13 (2008), *available at* http://www.nrel.gov/docs/fy08osti/41869.pdf [hereinafter DOE, 20% WIND]. That contrasts to the ASES claim that to achieve a

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making policy decisions based on such numbers.

Finally, the reports often assert results that appear precise, giving the illusion of scientific certainty. Yet these apparently detailed results vary widely from estimate to estimate of the same issue, thereby illustrating the inappropriateness of reliance on the results. We will now walk through the specific details of each of these areas.

1. Small base numbers

Rapid growth on a small base produces an absolute number that is still small. This is concealed in the presentation in green jobs reports by emphasizing growth rates and using misleading base numbers. For example, the Mayors report states:

> Wind energy is currently the fastest growing alternative energy source in the country. … The rapid pace of investment has continued, leading to a 45% increase in capacity, and net generation from wind energy is expected to increase significantly in 2008. This rapid investment has led to an increased share of electricity generations, and it now accounts for 10% of renewable electricity generation. In terms of total energy generation for the U.S., though, it maintains an extremely low share, generating just 0.8% of the total in 2007.[113]

If one focused on the "rapid pace of investment," the "45% increase in capacity," and "significantly" increased share of electricity generation, it would appear that shifting a large share of electricity production to wind generators would be feasible in the short term. When we look at the base on which these increases are calculated, however, it becomes clear how small even a much larger wind energy sector would be. For example, even the Mayors note that solar power provided just "0.2% of [U.S.] alternative-based energy in 2007."[114]

Let us be clear what this means. Wind power constituted 0.3 percent of total energy consumption in the U.S. and solar PV only 0.08 percent -- eight-one-hundredths of 1 percent -- of total energy consumption in the U.S. in 2007.[115] The consequence of the tiny level of production is ignored in the emphasis on rapid growth: electricity generated from photovoltaic and thermal devices rose 23 percent between 2000 and 2007 and investment in solar "surged 21% in 2007."[116] Extrapolating from the growth over such a small base is unreliable, however, since random factors can have an immense impact due to the small base size. Indeed, wind power generation has run into significant problems, as the quality of equipment has proven

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goal of 15% renewable energy (wind, solar, etc.) by 2030 would mean 3.1 million jobs by then; a goal of 30% would mean 7.9 million new jobs in that sector of the economy by 2030. ASES, *supra* note 2, at 7. The ASES numbers are not broken down by energy source, but they are vastly higher than the jobs numbers projected by the Department of Energy, which only looked at wind.

[113] MAYORS, *supra* note 1, at 6-7.

[114] *Id.* at 7. The Mayors report notes that solar has not been adopted widely because of "high generation costs relative to fossil fuel-based power." *Id.*

[115] Energy Info. Admin., U.S. Dep't of Energy, RENEWABLE ENERGY CONSUMPTION AND ELECTRICITY PRELIMINARY 2007 STATISTICS (2008), *available at* http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/reec_080514.pdf. See Table 3 of this report for details of electricity generation from renewable sources. *Id.* at 11. The Mayors' report is right that massive job growth would accompany any significant increase in use of solar power to generate electricity just to install the photovoltaic panels necessary to reach even 1 percent of total electricity demand would take an extraordinary number of installers.

[116] MAYORS, *supra* note 1, at 7. The absolute numbers are much less impressive than the percentages. The Mayors' report concedes that production of photovoltaic cells increased only from 46,354 peak kilowatts of capacity to 337,268 peak kilowatts from 1997 to 2006, with employment in manufacturing growing from 1,700 to 4,000. *Id* at 8.

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problematic in a number of instances.[117] Moreover, given the subsidies for expanding these technologies, their expansion has been driven to an unknown extent by the subsidies rather than by technological promise alone. This appears to be the case for solar PV[118] and the U.S. corn-based ethanol industry, for example.[119]

Because the expansion of many green industries has occurred from such a small base and because of the considerable degree of policy-driven behavior, rather than market driven behavior, the reported large percentage increases are unreliable indicators of the future potential of these green technologies. Until these industries have developed a long-term track record of production of a significant share of electricity generation, it would be unwise to assume that they can readily scale up without encountering problems.

2. Huge growth rates

The spread of new green technologies is forecast by all green jobs proponents to proceed at remarkable rates. For example, the Mayors report assumes a 17-fold increase in wind power and a 621-fold increase in solar power between 2008 and 2038.[120] It predicts that there will be a 59-fold increase by 2018 alone. Yet the report contains no references to the massive solar-generation equipment and sites that would have to be under construction already for this to occur.

Overall, the Mayors report proposes that the share of "renewable" energy of our total electricity use to rise from 3 percent in 2008 to 40 percent by 2038, which is a transformation of more than 1 percent of the total each year.[121] Similarly, an ASES report projects an increase in wind energy employment of one million persons by 2030, up from the 39,600 people employed in 2007, about a 25-fold increase, based on a "push the envelope" policy to move to significant renewable energy by 2030.[122] The figures are based on a multiplier[123] of base employment in the

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[117] *See* Tom Wright, *India Windmill Empire Begins to Show Cracks*, WALL ST. J., Apr. 18, 2008, at A1, *available at* http://online.wsj.com/article/SB120846287761023921.html; Michael Connellan, *Spinning to Destruction*, GUARDIAN, Sept. 4, 2008, at 1, 1, *available at* http://www.guardian.co.uk/technology/2008/sep/04/energy.engineering (Danish government requires mandatory service checks on all windmills in country after cracking problems develop).

[118] *See* Figure 1 *infra.*

[119] *See infra* Part IV.B.

[120] MAYORS, *supra* note 1, at 12. The report, published in October 2008, estimated wind power generation in 2008 to be at 38,850 million Kilowatt hours (MW). The wind industry estimated operating capacity at the end of 2008 to be 25,170 MW, which represented an increase of 8,359 MW capacity over 2007, almost a 50 percent increase. Why the Mayors report would presume more than a doubling from 2007 to 2008 is not known. The report presumes an increase averaging over 18,000 MW per year from 2008 to 2018, which is way beyond the optimistic assumption of the wind trade association. The American Wind Energy Association claims 85,000 people were employed in the wind industry in 2008. Less than ten percent of those jobs were in construction; the total count includes "legal and marketing services and more." Press Release, American Wind Energy Ass'n, *Wind Energy Grows by Record 8,300 MW in 2008*, (Jan. 27, 2009), *available at* http://www.awea.org/newsroom/releases/wind_energy_growth2008_27Jan09.html. The AWEA noted that in 2009 employment was falling as production and construction was slowing due to financial problems.

[121] According to the Energy Information Administration, renewable energy sources accounted for 7 percent of power in 2007. How Mayors got this down to 3 percent is not clearly explained, but it obviously dropped big hydroelectric sources as the only hydropower it reports for 2008 and forward is "[i]ncremental Hydropower added since January 1, 2001." MAYORS, *supra* note 1 at 12. Apparently the Mayors report does not wish to include big Hydro, such as the Grand Coulee Dam, as such items are on the no-no list for some environmentalists, as we discuss later; the only hydro to be counted are new little hydro projects. Removing big hydro drops renewable source energy substantially, making the renewable energy development battle even more daunting.

[122] ASES, *supra* note 2; Robert H. Bezdek, AMERICAN SOLAR ENERGY SOC'Y, GREEN COLLAR JOBS IN THE U.S. AND COLORADO: ECONOMIC DRIVERS FOR THE 21ST CENTURY, 7, 25 (2009). This report is an update to the ASES report used throughout this article, but the primary change is the section on Colorado; the November 2007 report cited routinely here had a similar section on Ohio, although Ohio was not worthy of mention in the title unlike the Colorado version.

[123] The issue of multipliers, which is important since it runs the job count way up, will be discussed below in Section II.D at note 129 and associated text.

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industry, which, in the case of wind, was 17,300 direct jobs in 2007.

The Mayors report forecasts a 16-fold increase by 2038 in hydropower production, with a 4-fold increase by 2018.[124] Such rapid growth is implausible given the lack of existing hydropower projects and the ongoing elimination of existing hydropower sites due to environmental concerns. We are unaware of a single major new dam/hydropower project underway in the United States and the major hydropower-related activity in the United States is the *removal* of existing electricity-generating dams to improve water quality and fish habitat.[125] That "minor" detail of a decline in existing hydro power sources is ignored.

Despite the rapid growth estimates for hydropower, the Mayors report implies that big hydro (such as the Hoover Dam), which accounts for most hydropower generation, may decrease. Instead, "small hydro," is asserted to be the wave of the future. Citing a U.S. Department of Energy study, the Mayors state that if every state ramped up construction on "all potential" small hydro projects, a majority could double their hydro power.[126] But a doubling of hydro power is not remotely close to a 16-fold increase.

It is not just hydropower where such rapid growth rates are assumed. Geothermal power is to increase more than 14-fold by 2038 (5-fold by 2018).[127] Once again, no details about when and where this massive power increase is supposed to occur. Biomass energy is to increase 12-fold—again with no explanation.[128] The nation is already planted corner to corner in corn to produce ethanol—and corn prices were driven to record levels in 2008—so where will the biomass increase come from? And in this case, all this energy must be produced domestically since the Mayors report asserts that importing energy "is worse than a tax – for the money flows out of the country."[129]

The UNEP report has similarly optimistic assessments of the potential for growth among its favored technologies:

- Spending on wind power installations is expected to expand from $8 billion in 2003 and $17.9 billion in 2006 to $60.8 billion in 2016.[130]
- Markets for the manufacturing and installation of solar PV modules and components are slated to grow from $4.7 billion in 2003 and $15.6 billion in 2006 to $69.3 billion by 2016.[131]

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[124] MAYORS, *supra* note 1, at 12. The 2009 ASES study, seeing little future for hydro apparently, barely registers it as a bump on the employment chart for 2030. ASES, *supra* note 2, at 7.

[125] Peter Fimrite, *Steps Taken Toward Removing Klamath River Dams*, S.F. CHRON., Nov. 14, 2008, at A-1, *available at* http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/11/14/MNA21441S7.DTL. The plan includes a surcharge for customers of the electric utility, as it must find alternative electricity sources for the 70,000 customers the hydro sources serve. Solar and wind power would be considered. Hydro power sources are also being removed in Maine. *See, e.g.*, Colin Hickey, *Fort Halifax Dam Deal Rejected*, KENNEBEC J., June 29, 2007, http://kennebecjournal.mainetoday.com/news/local/4044480.html. There is no doubt dams have environmental consequences—as do the construction of any source of electricity.

[126] MAYORS, *supra* note 1, at 8.

[127] *Id.* at 12.

[128] *Id.*

[129] *Id.* at 3.

[130] The asserted expansion is in doubt. The largest project, a multi-billion dollar 2,700 wind turbine project in West Texas, had to put plans on hold because of the decline in oil and natural gas prices. *T. Boone Pickens puts Texas wind farm project on hold,* DALLAS MORNING NEWS, Nov. 12, 2008 (http://www.dallasnews.com/sharedcontent/dws/bus/stories/111308dnbuspickens.ae1b50.html?npc)

[131] UNEP, *supra* note 5, at 93.

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- The biofuels market of $20.5 billion in 2006 is projected to grow to more than $80 billion by 2016.[132]
- The markets for fuel cells and distributed hydrogen "might" grow from $1.4 billion in 2006 to $15.6 billion over the next decade, according to Clean Edge; Roland Berger Strategy Consultants project a $103 billion market for fuel cells by 2020.[133]
- Geothermal power "might" become a $35 billion industry by 2020.[134]
- Ocean wave power "could" become a $10 billion per year industry by 2012."[135]

These are astonishingly rapid expansions of a set of technologies of dubious technical practicality, let alone economic viability.[136]

No doubt assorted renewable energy sources can do more, but much of this is purely speculative. Hydropower is not going to come from dammed up rivers; that is as politically off-the-table as drilling for oil near Santa Barbara. As the UNEP Report notes, even in other parts of the world large-scale hydro projects are "problematic."[137] Some hope that new technologies that capture ocean and tidal energy might be developed.[138] Despite interest in this new area of hydropower, the UNEP report, like the Mayors report, asserts that "small-scale hydro" will dominate.[139] Small-scale is not ocean or tidal hydro.

The point is that these renewable energy advocates who make renewable a part of immediate green jobs programs appear to have little appreciation for or knowledge of the technical realities of renewable alternatives. For example, a significant increase in geothermal energy is a vague claim. It can only happen, at unknowable costs, after basic research is started since little is admittedly known of how it could work on the massive scale envisioned.[140] Nevertheless, the CAP report claims that geothermal is an "obvious option for rapid green investment."[141] To assert that geothermal and other renewable power sources output will increase significantly in the next decade and beyond is simply wishful thinking unless it is backed by a careful inventory of where such projects might actually be constructed and assessment of the technologies they might use (cost considerations aside). As the Cape Wind project in Nantucket Sound illustrates well, our existing regulatory structure is not designed to facilitate bringing alternative energy projects online quickly and politically powerful opponents are often able to block or significantly delay alternative energy programs.[142]

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[132] *See infra* note 171.

[133] UNEP, *supra* note 5, at 93.

[134] *Id.*

[135] *Id.*

[136] We discuss the current size of several of these sectors below.

[137] *Id.* at 60.

[138] ASES, *supra* note 2, at 36. At the World Economic Forum in Davos in 2009 there was a negative report on such possibilities. Lord Turner of the UK's Committee on Climate Change said there was "mounting skepticism over the Government's plans for a huge expansion of wind and tidal power." Robin Pagnamenta, *Scepticism grows over the viability of green projects*, SUNDAY TIMES, Jan. 29, 2009, http://business.timesonline.co.uk/tol/business/economics/wef/article5607996.ece

[139] UNEP, *supra* note 5, at 42.

[140] *Id.* at 37; the Mayors report sees a four-fold increase in the U.S. by 2018 and a ten-fold increase by 2028. MAYORS, *supra* note 1, at 12.

[141] CAP, *supra* note 10, at 6.

[142] Jonathan H. Adler, *Foul Winds for Renewable Energy*, NAT'L REV. ONLINE, Sept. 28, 2007, http://article.nationalreview.com/?q=Mjg1YWVjNDZjZTBkNDhlODUzZjVkZThmM2U0YjAwNjE=#more. The Cape Wind farm has some regulatory approvals after years of planning—are all such permit requirements to be swept aside? It was proposed in 01; by early 09 it only had some permits; but was not done yet. Cape Wind: America's First Wind Farm on Nantucket Sound, http://www.capewind.org/ (last visited Feb. 21, 2009). *See also* Wendy Williams & Robert Whitcomb, CAPE WIND: MONEY,

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The rapid expansion rates for new technologies in green job estimates are also often based on unrealistic assessments of potential. For example, the Mayors report asserts that four states with the most potential for wind power, North Dakota, Texas, Kansas and South Dakota, have the potential to generate 4,500 billion kWh of electricity, "enough to power the entire country."[143] Perhaps so, but wind power is unable to provide base load generation capacity because winds do not blow consistently when power is needed, even in North Dakota.[144] And a recent major technology effort to reduce wind power generation costs fell short.[145]

Policies that rely on rapid rollout of new technologies are inherently prone to error. We understand how long it takes to build railroad tracks, highways, and oil refineries because many have been built. But much less is known about building wind farms, solar panel arrays, and biomass generators, especially on the scale the reports discussed – a scale never before attempted. We have considerable experience with the reliability of coal, nuclear, and natural gas fired power plants, but much less experience with alternatives. The growth rates assumed in these reports do not take into account the uncertainties and difficulties in ramping up new technologies on such massive scales.

3. Selective technological optimism

The green jobs literature exhibits a selective technological optimism about favored technologies, but assumes no technological progress in disfavored ones. For example, the Mayors study asserted that "[t]he basic technology [for solar powered electricity generation] has existed for decades" while conceding that "widespread adoption has not occurred mostly because of high generation costs relative to fossil fuel-based power."[146] Similarly, one might note that the "basic technology" of landing people on the moon has existed for decades, but that commercial lunar tourism has failed to materialize because of high costs. What matters is technology at an affordable price.

While estimates about favored energy technologies are resolutely sunny or windy, predictions for conventional energy sources are dark and dreary. For example, the Mayors report estimates oil costs will be an average of $240 billion per year based on the consulting firm Global Insight's cost forecasts and "expectations for crude oil prices."[147] It asserts that this cost

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CELEBRITY, CLASS, POLITICS AND THE BATTLE FOR OUR ENERGY FUTURE ON NANTUCKET SOUND (2007). These rapid growth rates are assumed to be capable of transforming the economy at large as well. "[T]he creation of green employment in key parts of the economy has the potential to 'radiate' across large swaths of the economy, thus greening commensurately large sections of the total workforce. For example, providing clean energy supplies means that any economic activity has far less environmental impact than today, when fuels and electricity are still produced largely from dirty sources." UNEP, *supra* note 5, at 300.

[143] MAYORS, *supra* note 1, at 7.

[144] U.S. Dep't of Energy, NORTH DAKOTA WIND RESOURCE MAP, http://www.windpoweringamerica.gov/maps_template.asp?stateab=nd (last visited Feb. 21, 2009). Even a proposal by Stanford scientists for integrated wind farms capable of providing baseline electrical power would require more than a MWh of installed capacity per MWh of baseload capacity. Cristina L. Archer & Mark Z. Jacobson, *Supplying Baseload Power and Reducing Transmission Requirements by Interconnecting Wind Farms*, 46 J. APPLIED METEOROLOGY & CLIMATOLOGY 1701 (2007), *available at* http://www.stanford.edu/group/efmh/winds/aj07_jamc.pdf.

[145] *See* GE Wind Energy, LLC, NAT'L RENEWABLE ENERGY LABORATORY, REPORT NO. NREL/SR-500-38752, ADVANCED WIND TURBINE PROGRAM NEXT GENERATION TURBINE DEVELOPMENT PROJECT, (2006) (describing 7 year program to cut wind turbine generated electricity costs to $0.025/ kWh and inability to do so resorting to "high risk concepts" that were unmarketable).

[146] MAYORS, *supra* note 1, at 7. Astonishingly, just after conceding that photovoltaics are not yet in widespread use because of cost, the Mayors report asserts that "most areas receive enough sunlight for solar power to be economically viable." *Id.* at 7-8.

[147] *Id.* at 2

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"acts very much as a tax on the U.S. economy." Indeed, it is worse than a tax the report explains–for the money flows out of the country–it is not spent domestically in areas such as health care, education, or infrastructure."[148] This is incorrect on multiple grounds. Not only is the form of fuel used to generate energy irrelevant to the buyer after controlling for cost, but making payments for solar energy is just as much a "tax" as oil.[149]

The optimism in the green jobs literature is so omnipresent that there is almost no bad news anywhere except related to fossil fuels. For example, air travel will be greatly reduced by proposed environmental restrictions, reducing employment in the airline industry.[150] Yet the report does not see this as a problem because we will have an increase in employment in the virtual conferencing services.[151] New farming techniques are needed – not a cost, but an opportunity for more USDA extension agents to teach farmers how to grow crops with fewer capital inputs.[152] This optimism extends to the quality of the jobs these policies will produce – despite the dominance of existing green job growth by green secretarial and janitorial positions[153]– green jobs advocates are quick to assure the public that green jobs are not just jobs, but good jobs that pay high wages.[154] Even the lower-paying green jobs are good ones because they "offer career ladders that can move low-paid workers into better employment positions over time."[155]

Where green means fewer jobs, green jobs proponents punt. For example, the UNEP report notes that data limitations prevent accurate calculations for the steel industry: "Steel industry employment data are incomplete and data collection for many aspects of this industry are still in its infancy in many developing countries. This limits the extent to which even rough green jobs calculations can be undertaken beyond the numbers suggested here."[156]

Wind power is greatly touted for green energy expansion, as good technology exists. However, the position of the U.S. in wind power is much like, but the reverse, of the position of China with respect to the U.S. Consider the iPod. The U.S. captures most of the economic value from iPods, but China gets the assembly work, which is little more than one percent of its retail

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[148] *Id.* at 3.

[149] The predicted oil prices look unrealistic in the Mayors' October 2008 report in light of the collapse of crude prices at the time of its publication. Mayors, *supra* note 1, at 2-3 ("forecasting an average outflow of $240 billion per year, measured in 2006 dollars, to pay for imported oil through the year 2030 …acts very much as a tax… worse than a tax…" Gas prices fell from an average of over $4 per gallon in July, 2008 to well under $2 per gallon in February, 2009. Mark Gongloff, *Falling Gas Prices May Be Gone As a Stimulus*, WALL ST. J. C1 (Feb. 12, 2009)

[150] UNEP, *supra* note 5, at 149 ("A climate-sensitive transportation policy will need to reduce the number of such short haul flights and encourage passengers to switch to high speed rail instead, which produces only a fraction of the emissions [of air travel].").

[151] *Id.* at 150 ("Business travelers account for a substantial share of flights. In addition to making considered choices as to the mode of transportation when traveling to conferences and business meetings, they may be able to shift to increasingly capable virtual-conferencing services when face-to-face meetings are not essential. Such services also offer business and employment opportunities in their own right.").

[152] *Id.* at 236 ("High-input farming has reduced both biological and genetic diversity, but farmers could be encouraged to rotate and diversify their crops—thus reducing the need for pesticides and fertilizers. Here, the employment implications are also positive. This kind of farming is knowledge intensive and requires research and extension systems 'that can generate and transfer knowledge and decision-making skills to farmers rather than provide blanket recommendations over large areas.' Developing the ecological literacy of farmers could, therefore, create significant employment.").

[153] Bezdek et al, *supra* note 100, at 69.

[154] *See, e.g.*, CAP, *supra* note 10, at 11 ("Green investments generate … significant numbers of well-paying jobs…"); *Id.* at 12 ("The average pay of the green investment program is about 14 percent higher than that for the industries associated with household consumption.")

[155] *Id.* at 11.

[156] UNEP, *supra* note 5, at 186.

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value.[157] Wind turbines are much the same. The technology and patents are largely European. The United States imports most high-valued turbine parts. The largest maker, Vestas, is Danish, at about a quarter of the market. Gamesa from Spain and Enercon from Germany are next at about 15 percent of the market each. GE and Suzlon from India are next, but most of GE's components come from Europe. GE is not considered a strong player in the market, but is the only U.S. firm of significance in the production market.[158] Turbine technology is highly technical and not easy to replicate. Hence, most wind energy work in the U.S. consists of importing the key technology and performing the assembly work.[159]

We do have some evidence about how technology is changing. Hybrid electric-internal combustion vehicles are darlings of the environmental movement and their sales are growing, from 353,000 this year to a projected 578,000 in 2014.[160] A more efficient gasoline engine, using direct injection, will likely sell 5.1 million vehicles that same year, according to the same forecasting firm, up from 585,000 this year.[161] These engines can get up to 10 percent improved mileage at the fraction of the cost of a hybrid's 20 percent improvement.[162] Yet the green jobs forecasts rarely discuss the impact of such incremental improvements in existing technologies, relying instead on unknowable technological revolutions that will need to happen rapidly to expand the technologies they favor.

The selective technological optimism exhibited by the green jobs literature is evidence of important embedded assumptions within the literature. Before public resources are committed to promoting an economic vision based on these unstated assumptions, we must careful explore how realistic these assumptions are and how desirable policies based on them would be.

4. Unreliable underlying statistics

Estimates of future green jobs begin with estimates of existing green jobs. These estimates are problematic because they are based on opaquely calculated estimates by parties with an interest in the results, rather than more objectively and transparently calculated sources. For example, ASES estimates 16,000 jobs in wind turbine construction and maintenance in 2006 and 7,600 jobs in solar PV and solar thermal energy industries.[163] These numbers are derived from Bureau of Labor Statistics ("BLS") data using ASES's assumptions about how BLS categories

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[157] Hal R. Varian, *An iPod Has Global Value. Ask the (Many) Countries That Make It*, N.Y. TIMES, June 28, 2007, *available at* http://www.nytimes.com/2007/06/28/business/worldbusiness/28scene.html. The same is true of many "Made in China" products. A Chinese firm captured a trivial fraction of the market value for doing assembly work; the firms do not have the high-value technology.

[158] Market shares shift quickly; Chinese producers are expected to have a quarter of the market about 2009, but sales are likely to be domestic. Merrill Lynch, WIND TURBINE MANUFACTURERS; HERE COMES PRICING POWER (2007), *available at* http://www.ohiowind.org/InsideOWWG/ActionTeams/..%5C..%5Cpdfs%5CMerrill%20Lynch%20Wind%20Power%20Report1.pdf. Merrill Lynch predicted little entry into the industry despite growth. Interestingly, GE's wind business was acquired from Enron in its bankruptcy. *G.E. to Buy Enron Wind-Turbine Assets*, N.Y. TIMES, Apr. 12, 2002, at B2.

[159] Importing wind turbines is like importing oil; U.S. dollars go overseas. For a discussion of current wind market trends and events, *see* The "Who is Who" of Wind Energy, http://www.windfair.net/ (last visited Feb. 21, 2009).

[160] Matthew Dolan, *Gas Engines Get an Upgrade in Challenge to Hybrids*, WALL ST. J., Jan. 14, 2009, at B1. However, U.S. demand for the Prius fell as retail gas prices declined dramatically in 2008. Kate Linebaugh, *Toyota Delays Mississippi Prius Factory Amid Slump*, WALL ST. J., Dec. 16, 2008, at B1; Peter Haldis, *GM Cuts Production, Toyota Cancels U.S. Prius Production*, WORLD REFINING & FUELS TODAY, Dec. 16, 2008, at 6.

[161] Dolan, *supra* note 160.

[162] *Id.*

[163] ASES, *supra* note 2, at 24. The study states that the calculation is by ASES and its consultant, Management Information Services, Inc.

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could be subdivided as BLS does not separately collect data on these industries.[164] The method of derivation is unclear. A similar problem lurks in the UNEP estimates of worldwide green jobs -- 2.3 million in renewables, 300,000 in wind, 170,000 in solar photovoltaics, and 600,000 in solar thermal.[165] These are not numbers collected by a neutral statistical agency, but are estimates by the Worldwatch Institute, which has not only a vested interest in the outcome but a record of historical inaccuracy with respect to its forecasts.[166] Although the reports all attempt to use official statistics, virtually every calculation depends at some point on estimates made by organizations interested in the outcome and are simply not objective, verified numbers on which to base an analysis.

Moreover, the calculations are not transparent, with little detail provided about how the estimates were created, the assumptions of any models used, or the review process that checked the results. Since there are internal consistency problems for at least some of the calculations visible from the estimates themselves, this omission is particularly serious. For example, the Mayors report notes that electricity generation in the U.S. in 2008 is likely to be 4.1 trillion kilowatt hours (TKW) and should rise to 5.4 TKW by 2038.[167] More electricity will be needed for millions of new homes and business operations, among other things. While all the new energy sources are being developed and constructed, the report also predicts enhanced efficiency in residential and commercial buildings that will produce a decline from 2.7 TKW power use in 2008 to 1.8 TKW use in 2038 (a 35 percent decline in use over 30 years).[168] Hence, in 2008, 66 percent of total power use is residential and commercial (2.7 out of 4.1 TKW); by 2038 only 33 percent will be residential and commercial (1.8 out of 5.4 TKW). That means a doubling of total electricity usage, as a share of the total, in non-residential and non-commercial sectors by 2038. Trillions of kilowatt hours are missing from their analysis of the 2038 estimates, yet there is no explanation of where those kilowatts are going.

Further, existing green jobs are often the result of subsidy programs, not success in the marketplace. For example, the "success" of ethanol and biodiesel programs in the United States is presented as an indication of the potential for green jobs. The Mayors report notes that "[b]oth ethanol and biodiesel production are growing rapidly in the United States, with heavy investment in both types of facilities in recent years."[169] Similarly, renewable energy sources are currently heavily subsidized by the Federal government. This is particularly true in terms of the amount of subsidy per unit of production for wind and solar, as Table 2 indicates.

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[164] Bastian, *supra* note 90, at 38.

[165] UNEP, *supra* note 5, at 295.

[166] *See supra* note 7.

[167] MAYORS, *supra* note 1, at 12.

[168] *Id.* at 15.

[169] *Id.* at 11.

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Table 2 - Subsidies and Support to Electricity Production. [170]

Fuel/End Use	FY 2007 Net Generation (billion Kwh)	FY 2007 Subsidy and support (million 2007 $)	Subsidy and support per unit of production (2007 $/ Mwh)
Coal	1,946	854	0.44
Refined Coal	72	2,156	29.81
Natural Gas and Petroleum Liquids	919	227	0.25
Nuclear	794	1,267	1.59
Biomass and biofuels	*40*	*36*	*0.89*
Geothermal	*15*	*14*	*0.92*
Hydroelectric	*258*	*174*	*0.67*
Solar	*1*	*14*	*24.34*
Wind	*31*	*724*	*23.37*
Landfill Gas	*6*	*8*	*1.37*
Municipal Solid Waste	*9*	*1*	*0.13*
Unallocated Renewals	*NM*	*37*	*NM*
Renewables (subtotal)	360	1,008	2.8
Transmission and distribution	NM	1,235	NM
"Total	4,091	6,747	1.65

The response to subsidies is not indicative of the response to actual market conditions, making these numbers suspect as a basis for predicting market behavior. Further, the information available from the subsidized firms is itself questionable, since these firms have an incentive to report success to ensure their subsidies continue.[171]

Bias toward large numbers is embedded in the sources cited by the reports as well. For example, the UNEP cites as the basis for its calculations:

- forecasts from "Clean Edge," which it describes as a "U.S.-based research and advocacy

[170] Energy Info. Admin., U.S. Dep't of Energy, REPORT NO. SR/CNEAF/2008-01, FEDERAL FINANCIAL INTERVENTIONS AND SUBSIDIES IN ENERGY MARKETS 2007, at xviii tbl.ES6 (2008), *available at* http://www.eia.doe.gov/oiaf/servicerpt/subsidy2/pdf/subsidy08.pdf. Unallocated renewables include projects funded under Clean Renewable Energy Bonds and the Renewable. NM = not meaningful. The average U.S. electricity price was about $53 per Mwh at the wholesale level in 2006 and about $92 per Mwh to end users in all sectors in FY 2007

[171] John Ferak, *Ethanol Towns Also on Idle*, OMAHA WORLD-HERALD, Jan. 30, 2009, at 01D. Venita Jenkins, *Plans for Ethanol Plant Likely to Be Scrapped*, FAYETTEVILLE OBSERVER, Jan. 31, 2009. *But see* Tom LoBianco & Edward Felker, *Ethanol Producers Aim to Lift Cap on 10% as Gas Additive*, WASHINGTON TIMES, Feb. 4, 2009, at A01, *available at* http://www.washingtontimes.com/news/2009/feb/04/ethanol-industry-wants-10-per-gallon-of-gas-limit-/.

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group;"[172]

- a study by the "Blue-Green Alliance (a joint effort of the Sierra Club and the United Steelworkers union)" showing 820,000 jobs possible from renewable energy investments;[173]
- a report by the "Apollo Alliance"[174] that showed 420,000 jobs from a 10-year, $36 billion investment;[175]
- a study by the California Public Interest Group (CALPIRG) Charitable Trust that suggested demand in California could support 5,900 MW of renewable energy producing 28,000 person-years of work in construction jobs and 3,000 permanent operations jobs and 120,000 person-years of maintenance work;[176]
- Environment California Research and Policy Center's estimate of creating 200,000 person years of work, with more than a third from exports;[177]
- the Solar Initiative of New York estimates of 3,000 direct installation jobs and 10,000 "manufacturing and integration jobs" in New York from 2000 MW of solar power;[178] and
- a Union of Concerned Scientists study showing 185,000 jobs by mandating 20% of demand be satisfied by renewables.[179]

All of these sources are from organizations with strong interests in the outcomes. Such interests do not mean that these groups necessarily do bad work but they do mean that such estimates must be treated with caution.

These flaws are difficult to detect because the studies generally do not address alternatives to their proposals.[180] Also troubling is the tendency to assume results by using highly controversial

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[172] UNEP, *supra* note 5, at 94, 99. Ron Pernick and Joel Makower. HARNESSING SAN FRANCISCO'S CLEAN-TECH FUTURE: A PROGRESS REPORT. Clean Edge, Inc. (2005).

[173] *Id.* at 99. The Renewable Energy Policy Project published several reports (available at http://www.repp.org/) which collectively found that " 820,000 new good-paying manufacturing jobs could be created across the country." http://www.sierraclub.org/energy/bluegreenjobs/.

[174] The Apollo Alliance is "a coalition of business, labor, environmental, and community leaders working to catalyze a clean energy revolution in America to reduce our nation's dependence on foreign oil, cut the carbon emissions that are destabilizing our climate, and expand opportunities for American businesses and workers." Apollo Alliance, *Our Mission,* http://apolloalliance.org/about/mission/ (last visited Feb. 21, 2009). Its funding appears to be substantially based on left wing foundations and labor organizations. *See* Apollo Alliance, Funders, http://apolloalliance.org/about/funders/ (last visited Feb. 21, 2009).

[175] UNEP, *supra* note 5, at 99; NEW ENERGY FOR AMERICA: THE APOLLO JOBS REPORT: FOR GOOD JOBS & ENERGY INDEPENDENCE 16-17 (2004). (Investment in renewable energy markets and biofuels development yields expected to yield 419,042 jobs over ten years.) Available at http://apolloalliance.org/downloads/resources_ApolloReport_022404_122748.pdf. *See also* Jay Inslee, APOLLO'S FIRE: IGNITING AMERICA'S CLEAN-ENERGY ECONOMY (2008).

[176] UNEP, *supra* note 5, at 100. Brad Heavnor and Susannah Churchill, RENEWABLES WORK: JOB GROWTH FROM RENEWABLE ENERGY DEVELOPMENT IN CALIFORNIA, CALPIRG Charitable Trust at 2 (2002).

[177] UNEP, *supra* note 5, at 100. Peter Asmus, HARVESTING CALIFORNIA'S RENEWABLE ENERGY RESOURCES: A GREEN JOBS BUSINESS Plan, Center for Energy Efficiency and Renewable Technologies at 14 (2008) available at http://www.ceert.org/reports_pdf/Harvesting_California_Renewable_Energy_Resources_080815_FINAL_1st_Ed.pdf (last visited March 12, 2009).

[178] UNEP, *supra* note 5, at 100. NEW YORK'S SOLAR ROADMAP: A PLAN FOR ENERGY RELIABILITY, SECURITY, ENVIRONMENTAL RESPONSIBILITY AND ECONOMIC DEVELOPMENT IN NEW YORK STATE at 2 (2007).

[179] UNEP, *supra* note 5, at 100. Union of Concerned Scientists, CASHING IN ON CLEAN ENERGY, July, 2007, http://www.ucsusa.org/news/press_release/new-report-shows-economic-0046.html ("[A] 20% national renewable electricity standard would generate more than 185,000 renewable energy jobs nationally by 2020 in manufacturing, construction and other industries." The UUC released an updated report in October, 2007, assuming a 15% standard. http://www.ucsusa.org/clean_energy/solutions/renewable_energy_solutions/cashing-in-on-clean-energy-a.html

[180] CAP's estimates are notable for its efforts to compare the impact of spending on green jobs to alternatives. More studies should attempt something similar. CAP also benchmarked its proposal against the February 2008 "stimulus" package, which simply gave consumers some additional cash. Economic Stimulus Act of 2008, Pub. L. No. 110-185, 122 Stat. 613, *available at*

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assumptions to drive up the numbers of green jobs. For example, the Mayors report simply states that "we assume 40% of electricity generated in the United States [in 2030] must come from alternative resources. Qualifying alternative resources are wind, solar, geothermal, biomass and incremental hydropower."[181] The Mayors report's predicted percentages, based on linear projections,[182] differ dramatically from the Energy Information Administration's reference case for power sources, as Table 3 illustrates.[183] To take just one example, the Conference of Mayors' estimate of wind power's predicted share is 500 percent larger than the EIA's prediction.

Table 3 - Variations in Energy Projections

	Mayors	Energy Information Administration (EIA)	Difference: Mayors/EIA
Solar	8%	< 1%[184]	>800%
Wind	12%	2.4%	+500%
Biomass	12%	3.2%	+275%
Geothermal	4%	0.6%	+667%
Incremental Hydropower	4%	-1.3%[185]	+>500%
Coal	60%	54%	-30%
Natural Gas		14%	
Nuclear		18%	

Similarly, the Mayors report simply assumes that ethanol and biodiesel will provide 29 percent of transportation fuels for cars and light trucks by 2029.[186] Compare this assumption to the Energy Information Administration's estimate of 11 percent for light duty vehicles in

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_public_laws&docid=f:publ185.110.pdf. While we applaud the effort to benchmark, PERI's specific benchmark is deeply flawed. CAP compared spending $100 billion on "new oil and gas subsidies and subsidizing gasoline and oil prices" to green investments. CAP, *supra* note 10, at 10. But what CAP has done is convert a positive (the high efficiency of the domestic oil and gas industries) into a negative. "Relative to spending within the oil industry, the green investment program utilizes far more of its overall $100 billion in spending on hiring people, and less on purchasing machines and supplies." *Id.*at 11. CAP concedes that this is "the primary reason" why its proposal creates more jobs than the artificial alternatives it uses as benchmarks. *Id.* Of course any program that spends more on labor will hire more labor than will a program that spends less on labor. Dressing this up in a "model" is merely engaging in scientific mumbo-jumbo.

[181] MAYORS, *supra* note 1, at 12.

[182] *Id.* at 13.

[183] Energy Info. Admin., U.S. Dep't of Energy, REPORT NO. DOE/EIA-0384(2007), ANNUAL ENERGY REVIEW 2007, at 68-71 (2008), *available at* http://www.eia.doe.gov/aer/pdf/aer.pdf [hereinafter EIA ANNUAL].

[184] EIA projects that "Solar technologies in general remain too costly for grid-connected applications, but demonstration programs and State policies support some growth in central-station solar PV, and small-scale customer sited PV applications grow rapidly." *Id.* at 70. As a result, "Consumption of nonmarketed solar, geothermal, and wind energy also increases dramatically in the projections; however, it continues to account for less than 1 percent of all delivered energy use in the residential and commercial sectors." *Id.* at 58.

[185] EIA projects that hydropower will decline from 7.1 percent of capacity in 2006 to 5.8percent in 2030 because "environmental concerns and the scarcity of untapped large-scale sites limit its growth." *Id.* at 71.

[186] MAYORS, *supra* note 1, at 16.

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2030.[187]

The data used as the basis for green jobs estimates are thus of questionable value. Some come from interest groups, some are derived by opaque methods, and some are simply of unclear origin. Before undertaking billions in public spending on green jobs initiatives, we need better data.

5. False precision masking large variations across estimates

How many green jobs are there or could there be? The estimates vary considerably. The ASES report claims that they are not something simply on the horizon but here now, claiming that in 2006 there were 8.5 million direct and indirect jobs in renewable energy and energy efficiency.[188] Even more green jobs are on the horizon. With no change in policy, by 2030, ASES asserts that 16.3 million jobs will be attributed to renewable energy and energy efficiency. With ASES' favored policies, it claims 40.1 million jobs (one in four in the nation) will be attributable to those categories by 2030.[189]

The CAP report contends that a "green economic recovery program" -- which should be kicked off with $100 billion new federal spending for solar and wind power, biofuels, smart electric grid, mass transit, and building retrofitting -- will lower unemployment around the country by more than one percentage point by creating two million jobs.[190] The asserted result will be lower energy costs and more jobs. Each state will get its share of these new green jobs, according to CAP. For example, under the plan envisioned by CAP, Missouri would receive $1.8 billion and New Mexico would receive $599.9 million. The unemployment rate in Oregon would fall from 5.5 percent to 4.1 percent and in North Dakota from 3.6 percent to 2.5 percent.[191]

Not to be outdone, the Mayors report provides even more job details. However, while the ASES report claims 8.5 million green jobs exist already, the Mayors report finds only 751,051 to exist.[192] Give or take 7.75 million existing green jobs, the Mayors plan to force development of renewable energy sources and energy-efficiency programs that would add 2.5 million new green jobs by 2018 and greater numbers in the years after that.[193] According to the Mayor's calculations, everyone will share in the new green jobs. By 2038, Santa Barbara, California, will have 6,145 new jobs; Vero Beach, Florida, will have 719 new jobs; Portland, Maine, will have 6,145 new jobs; and Corpus Christi, Texas, will have 5,178 new jobs. The numbers are provided city by city.[194]

The UNEP report does not provide estimates of green jobs specifically for the United States and acknowledges that green job counts differ significantly.[195] But it estimates that by

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[187] EIA ANNUAL, *supra* note 183, at 4.

[188] ASES, *supra* note 2, at vii.

[189] ASES, *supra* note 2, at 7.

[190] CAP, *supra* note 10, at 1. How much of the stimulus packages is asserted to be for this purpose?

[191] *Id.* at 27.

[192] MAYORS, *supra* note 1, at 5.

[193] *Id.* at 17.

[194] *Id.* at 20-33. This is, of course, impossible unless Congress is going to order a freeze in the location of workers and economic activity, something the report does not mention. The notion that green jobs will be spread evenly in proportion to the existing population is rhetoric to generate political support for the agenda from every burg in the country. Americans are highly mobile; some locations are shrinking and others are growing. *See, e.g.*, Richard Florida, THE RISE OF THE CREATIVE CLASS (2002).

[195] UNEP, *supra* note 5, at 17 ("Different methodologies in tallying employment, plus different approaches and diverging labor intensities in materials collection and recovery, make it almost impossible to compare countries across the world or to compute a

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2030, worldwide there could be 2.1 million new jobs in wind energy, 6.3 million in solar, and 12 million in biofuels.[196]

As demonstrated here, despite the seeming precision of each of the estimates, the total green job count varies a great deal across the literature. Compare just the different estimates of the impact of a 20 percent renewable energy production mandate by 2020 made by different sources. The Union of Concerned Scientists estimated in 2004 that 355,390 jobs would be created by 2020 by such a requirement.[197] Such production would eliminate 197,910 jobs in the fossil fuel sector, for a net increase of 157,480 jobs.[198] Not only would net employment be created, but electricity and natural gas prices would drop, saving consumers $49.1 billion a year by 2020.[199] But things change quickly; three years later the same group estimated that the 20 percent renewable energy standard for 2020 would create a net increase of 120,000 jobs and result in annual consumer savings of $10.5 billion by 2020.[200] In contrast, a 2004 study from the University of California at Berkeley estimated that a 20 percent renewable energy policy for 2020 would produce a new increase in employment between 77,300 and 101,649 jobs depending on the mix of biomass, wind, and solar sources.[201] The authors of that study noted that a 2001 study published by the World Wide Fund for Nature estimated a net increase in employment from a 15 percent renewable energy by 2020 policy would result in a net increase in energy employment of 1,314,000.[202] A U.S. Department of Energy report estimated that, should the United States adopt a policy of achieving 20 percent electricity from wind generation, the result would be the creation of an average annual of 73,000 jobs between 2007 and 2030. The job measurement technique used in the report is the standard input-output analysis using multipliers.[203]

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reliable global total" in recycling); 36 ("different approaches result in findings that cannot simply be aggregated or extrapolated.")

[196] UNEP, *supra* note 5, at 8.

[197] Union of Concerned Scientists, RENEWING AMERICA'S ECONOMY: A 20 PERCENT NATIONAL RENEWABLE ELECTRICITY STANDARD WILL CREATE JOBS AND SAVE CONSUMERS MONEY 1 (2004), *available at* http://www.ucsusa.org/assets/documents/clean_energy/ACFoDbPiL.pdf.

[198] *Id.* at 1.

[199] *Id.* at 2.

[200] Union of Concerned Scientists, CASHING IN ON CLEAN ENERGY: A NATIONAL RENEWABLE ELECTRICITY STANDARD WILL BENEFIT THE ECONOMY AND THE ENVIRONMENT 1, 2 (2007), *available at* http://www.ucsusa.org/assets/documents/clean_energy/cashing-in-national.pdf.

[201] Daniel M. Kammen, Kamal Kapadia & Matthias Fripp, *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?*, RAEL REPORT, UNIV. CAL., BERKELEY 11 (2006), *available at* http://rael.berkeley.edu/old-site/renewables.jobs.2006.pdf.

[202] *Id.* at 15. A 2002 paper from the University of Illinois estimated that 200,000 new jobs would be created in a 10-state Midwest region by 2020 if there was a push for wind and biomass energy. Bezdek et al., *supra* note 100, at 66. Another 2002 study estimated that steady increases in energy efficiency and reductions in carbon emissions would produce an additional 660,000 net jobs by 2010 and 1.4 million net new jobs by 2020. *Id.* A 2004 study estimated that annual investments of $30 billion a year for ten years in renewable energy, energy efficient buildings and other infrastructure improvements would produce more than 3.3 million jobs and stimulate a $1.4 trillion increase in GDP. *Id.*

[203] The "direct impact" jobs would be in construction and manufacturing. Those jobs would support 66,000 more jobs by "indirect impacts" and 120,000 jobs by "induced impacts," for a total of 259,000 jobs per year. DOE, 20% WIND, *supra* note 112, at 205. The cumulative impact over 23 years is estimated to be $944 billion with a net present value of $358 billion. *Id.* That is similar to the job multiplier of 2.5 presumed for geothermal energy projects. *See* Cedric N. Hance, Geothermal Energy Ass'n, GEOTHERMAL INDUSTRY EMPLOYMENT: SURVEY RESULTS & ANALYSIS 7 (2005), *available at* http://www.geo-energy.org/publications/reports.asp. That is, each job created in the production and construction of wind turbines and related equipment would result in an additional 2.5 jobs. The indirect impact jobs are "in and payments made to supporting businesses, such as bankers financing the construction, contractors, and equipment suppliers;" induced impact jobs "result from the spending

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These varying estimates – a range from 77,300 to 1,314,000 – suggest that the calculation of green job estimates has a long way to go before the figures are reliable and, thus replicable. This is an immensely complex matter oversimplified by assertions such as the Mayors report's prediction of 291 new green jobs in Pine Bluff, Arkansas by 2038.[204] The difficulty in making such detailed projections is magnified by the ongoing creation and destruction of jobs as part of the normal evolution of the economy.[205]

6. Summary: unreliable forecasts

As political literature, the green jobs reports are masterpieces. They provide what on the surface appears to be scientific statistical backing for their recommendations, add an impressive array of tables and charts, and throw out remarkably precise numbers in their forecasts. The most egregious in this regard is the Conference of Mayors report, which provides detailed breakdowns of potential green employment for every town in the United States. The problems with the numbers underlying this seeming precision are immense. Taken as a whole, they make the forecasts in the green jobs literature an unreliable basis for policy making. We next turn to the problematic nature of the method of analysis applied to the statistics.

D. The inappropriate use of input-output analysis

While cost discussions tend to be thin, a common thread among advocates of renewable energy and related programs is that they will create new jobs. No doubt that promise has political appeal to help generate support from voters who hear that the programs will create clean energy and many new employment opportunities. Who can be opposed to jobs, especially green jobs? A significant problem is that the predictions are derived from an inappropriate technique. Using a forecasting methodology whose assumptions are not met by the conditions the green jobs itself assumes exist, renders the results unbelievable.

As we have seen**,** a standard claim by those advocating for green jobs is that the green programs will have an even larger impact than it would appear at first blush because of the additional jobs and other benefits created. This claim rests on "economic multiplier" analysis. Economic multipliers are familiar in the applied policy literature, having been used to advocate for public subsidies for industries,[206] sports stadiums,[207] higher education,[208] and other spending programs. Multipliers are based on the idea that an increase in activity by one firm will lead to an increase in activity by other firms and employees that receive payment from the first. The contractor for a new football stadium buys concrete, the concrete subcontractor buys new tires

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by people directly and indirectly supported by the project, including benefits to grocery store clerks, retail salespeople, and child care providers." DOE, 20% WIND, *supra* note 112, at 202.

[204] MAYORS, *supra* note 1, at 20.

[205] A study of 34 metropolitan areas found that during a three-year period the average job loss was 20.5 percent, with a minimum of 13.3 percent. The net employment change over that period ranged from a low of -8.2 percent to a high of 19.4 percent, with an average of 6.0 percent. Randall W. Eberts & Joe Allan Stone, WAGE AND EMPLOYMENT ADJUSTMENT IN LOCAL LABOR MARKETS tbl.2.3 (1992).

[206] Douglas P. Woodward & Paulo Guimarães, BMW IN SOUTH CAROLINA: THE ECONOMIC IMPACT OF A LEADING SUSTAINABLE ENTERPRISE 9 (2008), *available at* http://mooreschool.sc.edu/export/sites/default/moore/research/presentstudy/bmw/BMWReportSept2008.pdf.

[207] A critical review of the literature along with case studies of specific cities is provided in Roger Noll & Andrew Zimbalist (eds.), SPORTS, JOBS, AND TAXES: THE ECONOMIC IMPACT OF SPORTS TEAMS AND STADIUMS (1997) [hereinafter Noll & Zimbalist].

[208] John J. Siegfried et al., *The Economic Impact of Colleges and Universities*, CHANGE, Mar./Apr. 2008, at 24, *available at* http://www.carnegiefoundation.org/change/sub.asp?key=98&subkey=2552. The authors reviewed 138 college economic-impact studies completed since 1992 and concluded that they are "public-relations documents masquerading as serious economic analysis." One report on higher education in Michigan asserted that every dollar of state money spent on public universities generated $26 of economic impact. Not many investments yield a 2,600 percent rate of return!

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for its trucks, all the firms' workers go out to dinner, and so forth. There are several standard models of how these interactions promulgate through the economy.[209]

A fundamental question about these models is whether the multiplier is actually greater than zero. To see why this is a question, consider an economy at full employment. In such an economy, an increase in jobs in one industry must be offset by a decrease in jobs in another industry, so the multiplier equals zero. Of course, in the actual economy there are unused and underused resources. If investment that results in green jobs also induces some of these unused or underused resources to be put to good or higher-value use, then there could be an indirect effect that adds to the benefit.[210] Since the degree of unused resources varies with economic conditions, analyses using multipliers should include forecasts under a range of economic conditions. None of the green jobs analyses do so. Indeed, as U.S. economic conditions have changed dramatically over the past few years, what is most striking about the green jobs literature is that its predictions have remained constant.

In practice, multipliers are difficult to observe, and it is impossible to know them in advance. Therefore, they must be estimated by indirect means. The typical approach to constructing a multiplier is a technique known as "input-output analysis." This approach connects the ultimate destination of various products to their required components, and allows estimates of the increased economic activity in multiple sectors induced by an increase in activity in a single area, such as green energy.[211] In input-output analysis

> the structure of each sector's production process is represented by an appropriately defined vector of structural coefficients that describes in quantitative terms the relationship between the inputs it absorbs and the output it produces. The interdependence among the sectors of the given economy is described by a set of linear equations expressing the balances between the total input and the aggregate output of each commodity and service produced and used in the course of one or several periods of time.[212]

The vectors are calculated using data on various industries, thus making some of the problems with data on green jobs we pointed to earlier important, combined into a single representation of the economy being studied in a "matrix of technical input-output coefficients of all its sectors."[213]

Input-output analysis rests on two important assumptions. The first assumption is

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[209] A relatively transparent example of the use of such a model (IMPLAN) in the context of green jobs is found in S. Tegen, M. Milligan & M. Goldberg, NAT'L RENEWABLE ENERGY LABORATORY CONFERENCE PAPER NO. NREL/CP-500-41808, ECONOMIC DEVELOPMENT IMPACTS OF WIND POWER: A COMPARATIVE ANALYSIS OF IMPACTS WITHIN THE WESTERN GOVERNORS' ASSOCIATION STATES (2007). A literature review by staff of the International Monetary Fund provides both theoretical and empirical reasons to expect multipliers of various magnitudes. They conclude that multipliers will be larger and positive when increased government spending does not substitute for private spending, when it enhances the productivity of labor and capital, and government debt is low. When these conditions do not obtain, the multiplier will be smaller and perhaps even negative. *See* Richard Hemming, Michael Kell, and Selma Mahfouz, *The Effectiveness of Fiscal Policy in Stimulating Economic Activity: A Review of the Literature*, IMF Working Paper WP/02/208 (2002) at 35.

[210] Robert J. Barro, *Government Spending is No Free Lunch*, WALL ST. J., Jan. 22, 2009, *available at* http://online.wsj.com/article/SB123258618204604599.html (arguing that a multiplier of 0.8 is an upper bound for the impact of government spending).

[211] *See, e.g.*, Wassily Leontief, INPUT-OUTPUT ECONOMICS (2d ed. 1986).

[212] *Id.*, at 19.

[213] *Id.*

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constant coefficients production. In other words, the ratio of outputs to inputs is constant regardless of the scale of production or the time period. This assumption removes the possibility that inputs may be substituted for each other, either because of technical progress or because of changes in factor prices.[214] A typical assumption would be that if a dollar of energy was required to produce ten dollars of steel at the time the input-output table was created, the same would be true in the future. Of course, if the price of energy increases, the relation is likely to change as has been the case with steel.[215] Higher energy prices would induce steel producers to change production techniques to reduce the amount of energy used per unit of steel. Even if that is not possible, it is not likely that the producer can fully pass along all of the increased energy costs to customers, [216] so that the ratio of energy cost to steel cost would change.

The assumption of constant coefficients production is particularly problematic in industries whose existence and growth are based on the expectation of both rapid technological progress that will enable changes in the needed inputs in various sectors of the economy and significant increases in energy costs. Since green jobs proponents are advocating precisely such a change, input-output analysis is particularly inappropriate for use in estimating green jobs.

The second assumption on which input-output analysis rests is constant factor prices. This assumption was implicit in the lack of factor substitution already discussed, but it has an explicit role in the implementation of input-output analysis. In most cases, the relation between inputs and outputs is calculated using dollar values rather than physical quantities.[217] This approach is only valid if the physical quantities and the monetary values have a constant ratio. In other words, prices must be fixed. That is unlikely to be the case with respect to green jobs estimates. One of the underlying justifications offered for supporting green technology is that oil and coal will become more expensive, either for technological reasons or because of a tax based on carbon dioxide emissions.[218] Because of the pervasive role that energy plays, these types of changes will alter factor prices throughout the economy, making the input-output analysis invalid. The role of oil as a non-energy input into production of many materials such as plastic means that any changes in the price of oil must have a direct impact on prices beyond the induced effect on the price of energy. Again, green job estimates are precisely the sort of analysis where input-output analysis is inappropriate.[219]

Suppose that we have overcome the difficulties in the kinds of data necessary to create a good multiplier. In general, targeting subsidies to a particular area or industry, as the green jobs literature advocates, has not been supported by peer reviewed analysis. A survey of the evidence concluded "targeting is based on poor data, unsound social science methods, and faulty economic reasoning and is largely a political activity."[220] Subsidy policies are driven more by

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[214] Tegen, Milligan & Goldberg, *supra* note 209, at 9-10.

[215] *See* notes 351 to 353 *infra* and associated text.

[216] The ability to cost shift depends on relative elasticities of supply and demand. Harvey Rosen, PUBLIC FINANCE 283 (6th ed. 2002).

[217] Leontief, *supra* note 211, at 14 ("In the case of a particular industry, we can easily compute the complete table of its input requirements at any given level of output, provided we know its input ratios. By the same token, with somewhat more involved computation, we can construct synthetically a complete input-output table for the entire economy.")

[218] *See, e.g.*, UNEP, *supra* note 5, at 92.

[219] Leontief, *supra* note 211, at 165 ("Each sector or industry thus has its own 'cooking recipe.' The recipe is determined in the main by technology; in a real economy it changes slowly over the periods of time usually involved in economic forecasting and planning.")

[220] Terry Buss, *The Case Against Targeted Industry Strategies*, 13 ECON. DEV. Q. 339, 339 (1999). In a fundamental contribution to the literature, Prof. Paul Courant outlined conditions under which subsidies can be theoretically justified: If (1) the economy exhibits diminishing marginal returns to factors, (2) taxes on mobile factors are levied on the benefit principle, (3) there is no

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concerns about redistribution – a political issue – than by a true concern about enhancing economic efficiency.[221] The next question is to what that multiplier should be applied. The green jobs literature's approach is to apply the multiplier to the gross amount of jobs in the green energy sector.[222] However, this is likely to be an overestimate for two reasons: (1) the use of gross rather than net jobs and (2) the failure to account for deadweight losses.[223]

The deadweight loss problem is also serious as it reveals that the green jobs literature also incorrectly treats the financing of the billions it advocates spending. Many of the green jobs reports start with the assumption that spending public money is the best method to induce additional economic activity. But that spending must be paid for, in some fashion, by higher taxes now or in the future. Because people engage in activities to avoid taxation, the cost of the tax exceeds the revenue yielded by the tax, a phenomenon known as deadweight loss.[224] Including deadweight loss in the analysis will reduce the net benefit to which any multiplier

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non-frictional unemployment, and (4) the costs of local economic development are locally borne. Otherwise, any policy that subsidizes politically-favored business activities must reduce welfare in the economy. Paul Courant, *How Would You Know a Good Economic Development Policy If You Tripped Over One? Hint: Don't Just Count Jobs*, 47 NAT'L TAX J. 863, 867 (1994). In practice, one or more of these conditions is almost always violated.

[221] The emphasis on efficiency is not only theoretically justified but empirically validated. After surveying the literature, one influential researcher concludes, "Although there is uncertainty in current research, I would argue that we do know some useful things: tax incentives for economic development are not self financing, but have significant costs per job created; some programs that promote productivity appear to be effective." Timothy J. Bartik, *Jobs, Productivity, and Local Economic Development*, 47 NAT'L TAX J. 847, 852, 859 (1994).

[222] This is the approach taken in the three of the four studies that we most closely analyze and which estimate induced employment resulting from green jobs. *See* CAP, *supra* note 10, at 24-26; MAYORS, *supra* note 1, at 12-17; and ASES, *supra* note 2, at 30, 39, 46.

[223] Theoretically, the efficiency of employment "subsidy schemes is questioned because of the existence of non-additional employment and deadweight spending." Pierre M. Picard, *Job Additionality and Deadweight Spending in Perfectly Competitive Industries: The Case of Optimal Employment Subsidies*, 79 J. PUBLIC FIN. 521, 522 (2001). There is an additional technical flaw in much of the economic development literature, from which the green jobs literature also suffers. The discussion assumes that jobs are an unmitigated benefit, so that all of the wages should be considered as a net increase. In practice, there are unpleasant aspects to work, so that only the wages above some reservation amount should truly be considered an increment to welfare. Courant, *supra* note 220, at 872; Noll & Zimbalist, *supra* note 207, at 61 75. They go on to provide an example of incorrect analysis leading to vast overestimate of impact. *Id.* at 497-498; *see also* William T. Bogart, DON'T CALL IT SPRAWL: METROPOLITAN STRUCTURE IN THE TWENTY-FIRST CENTURY 107 (2006) (on example of economic impact of new Cowboys stadium in Arlington not acknowledging spillovers from existing Cowboys stadium in Irving).

[224] A textbook exposition of deadweight loss can be found in Harvey Rosen & Ted Gayer, PUBLIC FINANCE (8th ed. 2008). *See also* David Bradford, UNTANGLING THE INCOME TAX 135 (1986) (defining deadweight loss as "the effective waste of purchasing power owing to the distorting effects arising from the effort to avoid tax"). Because these effects are typically unobserved, their existence is sometimes doubted. Bradford illustrates the concept by hypothesizing a $1 million per pack tax on cigarettes. Such a tax would collect very little revenue – probably zero. Thus, the tax would seem to have no impact. However, there is the lost pleasure of law-abiding smokers who no longer can obtain cigarettes. There might also be considerable activity by private citizens raising and curing tobacco for their own use, all stimulated as a result of this measure. Another example is the result of the imposition of a door and window tax in France during the French Revolution and maintained until 1917. "Its originator must have reasoned that the number of windows and doors in a dwelling was proportional to the dwelling's size. Thus a tax assessor need not enter the house or measure it but merely count the doors and windows. As a simple, workable formula, it was a brilliant stroke, but it was not without consequences. Peasant dwellings were subsequently designed or renovated with the formula in mind so as to have as few openings as possible. While the fiscal losses could be recouped by raising the tax per opening, the long-term effects on the health of the rural population lasted for more than a century." James C. Scott, SEEING LIKE A STATE: HOW CERTAIN SCHEMES TO IMPROVE THE HUMAN CONDITION HAVE FAILED 47-48 (1999).

Subsidies, too, can have a deadweight loss as people alter their behavior to become eligible for the subsidy. James Sallee, *The Incidence of Tax Incentives for Hybrid Vehicles* (Harris School, University of Chicago, Working Paper No. 08.16, 2008), *available at* http://harrisschool.uchicago.edu/About/publications/working-papers/pdf/wp_08_16.pdf (showing that the imposition and expiration of tax incentives for purchase of hybrid vehicles led to the delay (waiting for imposition) or acceleration (prior to expiration) of purchases of Toyota Prius automobiles). A more recent example of behavior modification was the rush of financial institutions to be classified as banks and thereby become eligible for bailout funds.

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should be applied.[225] The green jobs literature does not incorporate estimates of deadweight losses into their analyses and so does not provide net jobs calculations.

The net jobs problem is a serious one. The issue is jobs that would have been created had a subsidy not caused resources and jobs to be shifted elsewhere. "For example, construction jobs are touted as new jobs in targeting—say—an industrial park. But they are not; these construction workers would have been working on other projects if not reallocated to an industrial park by subsidies."[226] The proper measure is not total jobs that exist in an area receiving a subsidy but additional *net* new employment—jobs that would not otherwise have existed.

This will be a problem here because green jobs are substitutes for other jobs. An increase in electricity generation from wind, solar, or other sources will substitute for energy from, say, coal-fired generation, which in turn will reduce employment in coal mining and processing. The net impact on employment (before the multiplier) will depend on the relative labor intensity of energy production in the respective sectors at the margin of added or subtracted production.

Ignoring these issues renders the input-output analyses unconvincing. For example, studies that looked at jobs that were due to non-additional employment or deadweight spending in other government projects, out of the total employment in a subsidized area, found that between 40 and 90 percent of the jobs should be classified as simply displacing existing jobs.[227] That is, only between 10 and 60 percent of the jobs that the reports claimed to have been created by a subsidy actually could be classified as jobs that might not otherwise have existed.

Even that measure does not consider the opportunity cost of the subsidy. Where else in the economy could the funds have been used more efficiently? The measure used here only concerns jobs that would have existed anyway, but were falsely attributed to the subsidy, and to "windfall gains" captured by firms that received subsidies. Studies of the job creation resulting from public projects have shown that the job creation that results often is of dubious value, because the cost-per-job-created is high. For example, Camden Yards, the Baltimore Orioles stadium, was billed as a job creating project.[228] However, the estimated cost per job created was $127,000.[229] Similarly, in France one study noted that subsidies for the French fishing fleet were commonly justified by job "multipliers in the range of 3-5 jobs per seaman" but detailed analysis showed that only 1.4 to 1.5 on-shore jobs existed for every fishing fleet job.[230]

Even that more reasonable estimate does not get to the matter of the cost imposed on the economy as a whole by subsidizing a job with low economic value. To keep the fleet afloat, resources are sucked from the pockets of every French taxpayer; money that they could have spent on higher-valued goods and services of their own choosing and so created jobs in suppliers

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[225] A counterargument might be that the public investment represents money allocated from another source, so that the total tax revenue does not go up. However, the reduced spending in the other area would have multiplier impacts that could mitigate the multiplier effects of increased spending on green energy. Whether the source of the subsidy is higher taxes or altered government spending, there is a cost that reduces any net positive impact.

[226] Buss, *supra* note 220, at 347.

[227] Picard, *supra* note 223, at 522 tbl.1 (citing Foley).

[228] Proponents of stadium projects tout increased employment from tourism, construction jobs, and increased localized spending. Richard W. Schwester, *An Examination of the Public Good Externalities of Professional Athletic Venues: Justifications for Public Financing?*, PUB. BUDGETING & FIN., Sept. 2007, at 89, 90 ("A review of the literature shows that stadiums and arenas are insignificant in terms of creating employment . . . .").

[229] Buss, *supra* note 220, at 347. In contrast, a review of 48 studies found that reducing state and local taxes resulted in greater business activity. On average, a ten percent tax cut resulted in a three percent increase in business activity which, of course, included new jobs that were voluntarily created. Bartik, *supra* note **Error! Bookmark not defined.**, at 856.

[230] Benoit Mesnil, *Public-aided crises in the French fishing sector*, 51 OCEAN & COASTAL MGMT. 689, 697 (2008).

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of those goods and services.

In another well-studied example, BMW, which has an assembly plant in upstate South Carolina, commissioned a study that reported it has a job multiplier of 4.3.[231] There were 5,400 direct BMW employees and 17,650 induced and indirect jobs for suppliers to BMW and local jobs created by economic activity of BMW employees. While the BMW plant is wonderful, the fact is that had it not been built there it would have been built somewhere else in the country, so the net job issue is irrelevant for the nation as a whole.[232] Job creation is a common argument for government subsidies of many projects around the world. Politicians find it to their advantage to cater to special interest groups, while imposing the costs on taxpayers at large, all the while claiming to be increasing economic output and jobs.

These problems outlined here of input-output analysis point to a major flaw in the green jobs literature. In addition to the theoretical incoherence of the definition of "green" and the issues with the statistics used for its forecasts, its basic forecasting methodology is fundamentally flawed and largely discredited from its use in prior forms of economic planning.[233] If the promised benefits are derived from input-output analysis, and premised on technology that disrupts the relationship upon which the input-output analysis depends, the resulting data are unreliable. Perhaps most damningly, these issues are not discussed in the green jobs literature, even though they are widely known among economic analysts. What the input-output analyses do is clothe the proposals in the garb of scientific respectability. What they do not do is provide any confidence that the results are reliable.

E. Promoting inefficient use of labor

Green jobs proponents have a curious attitude toward efficiency. On the one hand, they tend to see efficient use of non-labor inputs such as energy and raw materials as crucial to creating a green economy. For example, the UNEP report states that "[g]reater efficiency in the

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[231] Woodward & Guimarães, *supra* note 206, at 9.

[232] Even if it had been built in Canada rather than in the U.S., it does not mean that those who earn their living in jobs related to BMW assembly in South Carolina would have had no alternatives. For all we know, employment opportunities may have been worse, the same, or better, making the job multiplier claims little more than happy talk.

[233] There are multiple analyses that discredit such studies. For example, Bruce Seaman's study of job claims in Atlanta, found that the estimated average economic impact of several sports and cultural industries (commercial music, universities, professional sports) was $233 million in 1984, while the total personal income in the Atlanta metropolitan area was $32 billion. Bruce Seaman, *Arts Impact Studies: A Fashionable Excess*, in ECONOMIC IMPACT OF THE ARTS: 'A SOURCEBOOK 43, 48 (Anthony J. Radich & Sharon Schwoch eds., 1987). Thus, there could be at most 138 industries in the region before the entire income is accounted for.

Dennis Coates & Brad Humphrey, *Professional Sports Facilities, Franchises and Urban Economic Development*, 3 PUB. FIN. & MGMT. 335, 335-357 (2003), survey the evidence on the impact of sports teams on local economic activity. Most of the new construction of stadiums is accompanied by claims that their presence will boost the overall level of economic activity and especially employment. "Despite these claims, economists have found no evidence of positive economic impact of professional sports teams and facilities on urban economies." *Id.* at 335. There are four main reasons for this finding. First, spending on sports is easily substitutable for spending on other leisure activities. Thus, the increase in spending on professional sports in Oklahoma City, say, as a result of the relocation of an NBA team, is almost entirely accounted for by a decrease in spending on movie tickets, greens fees, restaurant meals, and so on. Second, the attention paid to local sports teams could reduce worker efficiency as they spend time discussing the game rather than working. Third, the money spent on sports teams and facilities might reduce the amount spent on other public facilities and services. Because roads, fire protection, and other local government services can improve productivity, a reduction in spending on them could reduce productivity and thus overall economic activity. Fourth, the multiplier on spending for sports might be smaller than the multiplier for other activities. Because most of the money spent by sports teams reflects salaries to wealthy individuals who might not even reside in the region, it is unlikely to have the same impact that a similar amount of spending that directly affected local workers would have.

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use of energy, water, and materials is a core objective"[234] of a green economy. On the other hand, green jobs proponents see *increasing* the use of labor as a virtue, not a cost. For example, the UNEP report argues that a negative feature of today's economy is that it has increased labor productivity and so reduced the amount of labor necessary to deliver goods and services: "Any effort to create green jobs in food and agriculture must confront the fact that labor is being extruded from all points of the system, with the possible exception of retail."[235] Likewise, the same report criticizes the steel and oil industries for increasing labor productivity.[236]

Low labor productivity has critically important consequences. First, a society of low labor productivity jobs is an impoverished society in which output is restricted by the failure to make use of capital and in which wages are low by definition, for employees can receive only the value they generate absent transfer payments. Second, because green jobs proponents promise high wage jobs, they will have to force compensation higher than the competitive wage, producing permanent high unemployment. This is not a matter of theory; a comparison of European and North American labor markets over the past 50 years reveals that promoting high wage, low labor productivity jobs produces high structural unemployment.[237]

The ASES report asserts that "the net effect within a carbon-constrained energy economy is positive, creating roughly five jobs for each job lost,"[238] meaning that to produce the equal value in production of a given quantity of energy, five times as many bodies will be required. That implies a massive drop in productivity and, therefore, standard of living. Unsurprisingly, at such low levels of efficiency, as much as a quarter of the entire workforce may have to be involved in this enterprise.[239] Similarly, the Renewable and Appropriate Energy Laboratory at the University of California at Berkeley found it a positive feature of alternative energy that "renewable energy creates more jobs per kilowatt hour than traditional energy sources."[240] Again, this is simply a fancy way of stating that renewable energy is more costly in labor terms than alternatives – hardly a virtue to anyone asked to pay for the energy produced.

Increasing labor productivity is what makes societies wealthier and better able to satisfy their wants and needs, ranging from better education to better access to health services and

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[234] UNEP, *supra* note 5, at 4. The UNEP report discusses the cement industry and notes

> Energy efficiency in the [cement] industry is gained as new cement plants are built. Inefficient, outdated processes are mainly found in small, regional plants. Manufacturers in countries or regions with stagnant levels of demand still rely on inefficient technologies, such as small-scale vertical kilns and the wet production process. Efficiency improvements are generally being made in countries with an increasing demand for cement. More-efficient rotary kilns utilize the dry production process and are replacing inefficient vertical shaft kilns. New plants built in developing countries are larger, cleaner, and more efficient than those built 10 to 30 years ago in developed countries.

Id. at 197.

[235] *Id.* at 228.

[236] *Id.* at 184 ("[t]oday steel is no longer a labor-intensive industry. It is marked by rising globalization, ongoing consolidation, substantial gains in labor productivity through automation and computerization, and strong competition, particularly from Asian producers."). A similar criticism is made of the oil industry. *Id.* at 92 ("almost 40 percent of U.S. oil-refining jobs disappeared between 1980 and 1999; another 8 percent decline occurred between 2001 and 2006.").

[237] *See* Charles L. Schultze, OTHER TIMES, OTHER PLACES: MACROECONOMIC LESSONS FROM U.S. AND EUROPEAN HISTORY 27-33 (1986) (comparing US and European labor productivity and economic policies).

[238] ASES, *supra* note 2, at 14.

[239] ASES notes that, by 2030, forty million workers in the U.S. "about one in every four working Americans," could be in the renewable energy and energy efficiency areas. *Id.* at iv.

[240] Bastian, *supra* note 90, at 38.

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medicines, and allows them to have more leisure time.[241] Moreover, reducing the labor component of obtaining any energy service would, all else equal, reduce overall costs to consumers because for most services the cost of labor generally exceeds the cost of materials, as anyone who has had the misfortune of getting a car, computer, or cell phone repaired can attest.

This glorification of inefficient labor practices captures a frequent mistake in the green jobs literature – mistaking the means for the end. For example, the UNEP study complains that "[e]conomic systems that are able to churn out huge volumes of products but require less and less labor to do so pose the dual challenge of environmental impact and unemployment."[242] As a result, the study is critical of carbon capture and sequestration efforts because they are "capital intensive, and therefore the jobs created per million dollars of investment can be expected to be low,"[243] in contrast to the greater labor intensity of biofuels harvesting.[244] The higher operating efficiency of coal power plants compared to solar power plants is portrayed as a *negative* feature of the coal plants, because coal plants produce fewer jobs per delivered megawatt of power since a greater peak capacity is needed by a solar PV facility to produce the same amount of delivered power.[245] As a result, more construction jobs are created by a need for delivery of a megawatt of power from solar PV than from coal, because a greater solar peak capacity is required to deliver the same amount of energy.[246] The study criticizes extractive industries generally for not employing large numbers of people.[247] Indeed, even increased labor productivity in green industries such as rail transportation is characterized as a problem rather than as a benefit. [248] This is so even though cutting labor costs would speed expansion of the green industry by lowering costs.

As a result, green jobs advocates often promote technologies that are inefficient users of labor precisely because the technologies are inefficient. For example, in discussing "bus rapid transit" ("BRT") systems, the UNEP report notes:

> In BRT systems, the frequency of service is carefully calibrated, and therefore bus breakdowns and other operational failures need to be minimized. This in turn implies that buses must be kept in excellent condition. Hence BRT systems offer a substantial number of maintenance jobs. Maintaining high-quality service also means it is critical to ensure good working conditions for drivers, who need to be well trained and are expected to take responsibility for their performance. Thus,

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[241] Indur M. Goklany, THE IMPROVING STATE OF THE WORLD: WHY WE'RE LIVING LONGER, HEALTHIER, MORE COMFORTABLE LIVES ON A CLEANER PLANET 44-48, 82-85 (2007).

[242] UNEP, *supra* note 5, at 6.

[243] UNEP, *supra* note 5, at 9.

[244] *Id.* at 120 ("The labor intensity of biofuels harvesting compares favorably with conventional fuels. On average, biofuels require about 100 times more workrs per joule of energy content produced than the capital intensive fossil fuel industry.")

[245] *Id.* at 102 (citing Kammen, Kapadia & Fripp, *supra* note 201).

[246] *Id.* at 102.

[247] *Id.* at 91 ("Extractive industries – the fossil fuel sector and other mining industries – do not employ many people."). The study also objects to the growth of capital intensive farming at the expense of labor intensive farming. *Id.* at 230 ("The trend towards consolidation and the growing market power of retailers that is occurring in the United States is also happening at the global level, and in some cases even more obviously so. Small 'greener' farmers are losing out to large capital intensive producers and suppliers. This process has contributed to rural unemployment and accelerated urbanization.").

[248] *Id.* at 169 ("China's rail network grew by 24 percent in 1992-2002, but due to boosted labor productivity employment was cut almost in half . . . India's network grew only 1 percent, but due to radically different policies, employment stayed almost the same. . . . Increased labor productivity [in Africa] has led to reduced railway employment.").

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jobs for drivers and mechanics must be decent and well paying.[249]

Increasing the number and skill level of employees makes the BRT systems *more* expensive and *less* competitive relative to other means of transportation, such as personal automobiles or less labor-intensive bus systems, if the BRT must cover costs. It is a problem preventing the adoption of such systems, not a benefit, that they require more skilled labor than alternatives to deliver the same amount of transportation services.

The selection of maximizing labor use as the measure of success presents several major problems. First, the ultimate goal of economic activity is not the employment of labor or of other resources, but instead is the production of goods and services that satisfy human needs and wants. Higher labor productivity makes societies wealthier and better able to satisfy their wants and needs ranging from better education to better access to health services and medicines. It also allows them to have more leisure time and provides them the resources to enjoy that leisure.[250]

A new method of production that uses fewer inputs to produce the same outputs as an existing method frees up inputs for use in addressing additional human needs and wants. A prime example of this is agriculture. The labor intensity of agriculture in the United States has plummeted over the last 200 years, as farmers adopted mechanization, increased agricultural knowledge, and developed higher yield seeds. Merely 1.4 percent of the U.S. workforce is engaged in agriculture today compared to over 21 percent in 1929,[251] yet production today is much higher.[252] The people who left agriculture are now employed in alternative occupations, creating goods and providing services that would be unavailable if those people had remained employed in agriculture. Under the definitions of green jobs used in these reports, however, this transition is a negative change in the "greenness" of American agriculture.

Second, even assuming that some substitution of capital and other inputs for labor has negative environmental consequences, it does not follow that such substitutions generally are either net negative contributions to the environment or inappropriate. Again, agriculture provides an example. Agriculture is a dangerous occupation, with farming "among the most hazardous of industries in terms of number of fatalities, fatality rates, number of non-fatal injuries, and non-fatal injury rates."[253] Much agricultural labor was previously devoted to backbreaking, low productivity, unpleasant work that broke people down. New techniques that free people from dangerous, unpleasant work, and that increase production of food crops, have benefits that offset the claimed negatives of more capital intensive farming methods identified in these reports. As Martin Wolf notes "[s]ubsistence farming is among the riskiest of all human strategies, since starvation is one harvest away."[254] Whether particular techniques are better or worse for the environment or for the individuals engaged in the labor is thus not an issue that can be settled by assuming that all labor-intensive methods are to be preferred to all capital-intensive ones.[255] Yet

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[249] *Id.* at 166.

[250] Goklany, *supra* note 241, at 44-48, 82-85.

[251] U.S. Census Bureau, STATISTICAL ABSTRACT OF THE UNITED STATES 50 tbl.HS-29 (2003), *available at* http://www.census.gov/statab/hist/HS-29.pdf (1929 figures); U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES tbl.600 (2009), *available at* http://www.census.gov/compendia/statab/tables/09s0600.pdf (2007 figures).

[252] *See, e.g.*, U.S. Census Bureau, 2009 STATISTICAL ABSTRACT: HISTORICAL STATISTICS, Table HS-45 (comparing 1900 production in corn (2,662 mil. bu. vs. 9,008 mil. bu.), wheat (599 mil. bu. vs. 1,616 mil. bu.), and cotton (10,124 thousand bales vs. 17,100 thousand bales).

[253] J. Paul Leigh, et al., *Costs of Occupational Injuries in Agriculture*, 116 PUB. HEALTH REP. 235, 236 (2001).

[254] Martin Wolf, WHY GLOBALIZATION WORKS 196 (2004).

[255] If, as some green jobs advocates insist, labor-intensive agriculture produces a desirable lifestyle, one would expect to find people volunteering to do that for a living. But you can't keep Johnny down on the farm. Prohibiting capital intensive agriculture

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this is precisely what the green jobs literature does.

Third, even in the favored green industries, increasing labor efficiency has been an important component in making the technologies more commercially viable. For example, corn-based ethanol cost reductions in the United States over time have been driven in part by "upscaling farms" (i.e., introducing economies of scale) and the advanced technology necessary to convert corn into ethanol.[256]

Increasingly efficient use of labor was a significant factor in the remarkable economic growth of the United States' economy during the nineteenth century. That growth was attributable to a significant degree to conditions of labor scarcity and a relentless drive to reduce the need for labor across industries. Labor scarcity led to high wages for American workers relative to workers elsewhere (an indicia of a good job, according to the UNEP report[257]). This then meant that, as an English investigative commission noted in 1854, "the whole energy of the people is devoted to improving and inventing labour-saving machinery."[258]

Labor was scarce in 19th century America because of the abundance of cheap, fertile land in United States that made agricultural output per man high and made it harder to lure people from agriculture into industry.[259] Labor scarcity meant that American manufacturers needed to organize their employees efficiently. For example, comparing English and American workers in the nineteenth century textile industry, "[t]he most conspicuous example of efficient use of labour is the training that the American manufacturers gave to their workers so that each was able to handle more looms."[260] Moreover, the increased training and skill levels of American workers then equipped those same workers to improve on the technology they used.[261] Again, all these are indicia of good jobs according to the UNEP report and all are the result of high labor productivity, not low labor productivity.

The green jobs literature's focus on inefficient labor use thus embodies three highly peculiar assumptions about human wellbeing. First, it assumes that increasing labor productivity,

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would indeed cause more labor to shift to agriculture as more people pick up hoes for a living, but the crash in standards of living from the loss of capital-intensive technology would not mean high-paying jobs.

[256] W.G. Hettinga, et al., *Understanding the reductions in US corn ethanol production costs: An experience curve approach*, 27 ENERGY POL'Y 190, 201 (2008).

[257] UNEP, *supra* note 5, at 4 ("good jobs which offer adequate wages"); 22 (praising green certification programs for leading to "increased wages"); 65 (green jobs need to be "decent with regard to wages").

[258] H. J. Habakkuk, AMERICAN AND BRITISH TECHNOLOGY IN THE NINETEENTH CENTURY: THE SEARCH FOR LABOUR-SAVING INVENTIONS 101 (1967) (quoting 50 Parliamentary Papers 51 (1854)); Douglass C. North, THE ECONOMIC GROWTH OF THE UNITED STATES, 1790-1860 173 (1966) ("The constant concern with laborsaving machinery was considered by the [British] commissioners [investigating US industry in 1850s] to be a fundamental explanation of the indigenous development of such innovations, and the relatively high price of labor was considered the driving force. Important innovations developed in every industry, frequently in small shops and firms at the hands of mechanics with little or no formal scientific training."); George Rogers Taylor, THE TRANSPORTATION REVOLUTION, 1815-1860 224 (1977) ("Americans excelled especially in inventions increasing the speed of machine operation and making processes so automatic that they required less and less attention from the operatives.").

[259] Habakkuk, *supra* note 258, at 13; Paul Wallace Gates, THE FARMER'S AGE: AGRICULTURE, 1815-1860 271 (1968) ("In the early decades of the nineteenth century, the greatest difference between farming in the Old World and farming in the New was that in American agriculture labor was scarce and its cost relatively high."); *Id.* (in 1840 the Massachusetts Commissioner of Agricultural Survey noted that "the price of labor is enormous.")

[260] Habakkuk, *supra* note 258, at 47.

[261] *Id.* at 51 (more changes in production methods came spontaneously from the workers in America than in England; "particularly when the worker had been self-employed earlier in life, and most of all when he had been a farmer, for he carried over into industry the inclination to seek his own methods of doing his job better.").

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which increases output, should be discouraged. This reduces human welfare by reducing the goods and services available to people. While many environmentalists have promoted reductions in consumption for decades,[262] adopting a policy of reducing the goods and services available to the general population should be done through open debate not by smuggling it in through a green jobs policy. Such a policy will condemn those already poor to eternal poverty.

Second, low labor productivity produces low wages, as each factor of production receives its marginal productivity in a competitive economy. Since the green jobs literature insists that jobs must be high paying, creating a world of high-paying, low-productivity jobs requires an aggressively interventionist economic policy to shift rewards from high-productivity inputs (capital and resources) to low-productivity inputs (labor). Not only is such a policy inconsistent with an open market economy,[263] but the payment of a wage above what productivity justifies will lead to unemployment.[264] Again, an aggressive set of policy measures will be required to sustain such a shift in any economy competing with economies that have not adopted measures favoring low labor productivity.

Finally, subsidizing labor at the expense of capital is likely to delay the development of technologies that increase the efficiency with which scarce resources are used. For example, petroleum refining today is a highly capital intensive process, but these increases in capital intensity have yielded dramatic increases in the amount of fuels and specialty chemicals obtained from a barrel of crude oil.[265] By increasing the yield from crude oil, these innovations have boosted the efficiency of use of natural resources. Biasing production away from capital intensity reduces the incentive to produce such innovations that raise standards of living. Moreover, because environmental protection is itself often capital intensive (to the extent that it requires additional capital equipment to reduce emissions),[266] such a bias would likely increase the harm to the environment from the production that continued.

F. Assessing green job estimates

The problems with the methodologies of green jobs studies that we have identified are grounds for caution in accepting their policy proposals. Before trillions of dollars in public and private resources are directed into promoting "green jobs," we need to have a better understanding of the details of how such programs will transform our economy. What jobs will be considered "green" and why? Who will decide which jobs are green "enough"? Decision makers need to be skeptical about projections based on small base numbers and rapid expansion of technologies not well developed. We should worry about proposals that glorify low labor productivity, the modern version of the Luddites.[267]

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[262] *See, e.g.*, Ernst Friedrich Schumacher, SMALL IS BEAUTIFUL: ECONOMICS AS IF PEOPLE MATTERED (1973) (the best seller of its day).

[263] The green jobs proponents have a long way to go to demonstrate the viability of a scheme of higher-paying jobs for most of humanity in the absence of capital that increases productivity. This turns economic theory—and human experience—upside down.

[264] *See* Schultze, *supra* note 237.

[265] Petroleum products are used in some chemical and pharmaceutical products. David S. J. Stan Jones and Peter R. Pujadó, eds., HANDBOOK OF PETROLEUM PROCESSING (2006), at 1. A 42-gallon barrel of crude oil yields over 44 gallons of petroleum products, including asphalt, petrochemical feedstock and lubricants. U.S. Government Accountability Office, MOTOR FUELS: UNDERSTANDING THE FACTORS THAT INFLUENCE THE RETAIL PRICE OF GASOLINE (2005), at 1.

[266] *See, e.g.*, Waste Management Authority, THE DUTCH WASTE PROFILE 1990-*2005* 7 (2006) ("The environmental regulations lead to increased capital intensity, increase in scale of the installations and economy of scale.").

[267] *See* Kirkpatrick Sale, *Avowedly Low-tech: America's New Luddites*, LE MONDE DIPLOMATIQUE, Feb. 1997 (John Howe trans., English ed.), *available at* http://mondediplo.com/1997/02/20luddites (describing efforts to create coalition including environmentalists "to establish the legitimacy of resisting technological change.").

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Our survey of problems in the green jobs literature is not merely methodological nit-picking, although we do have many methodological issues with the literature. All of the issues we have identified have a common theme: the masking of critically important policy choices beneath a series of questionable assumptions and definitions. Before billions, or perhaps trillions, of dollars are committed to an effort to remake human society on the basis of these assumptions, Americans deserve a full and open debate informed by the best data and analytical methods. Thus far the push for green jobs has provided neither. In addition to these problems, there are problems with how the green jobs literature approaches economic issues. We now turn to considering these.

III. Mistakes in economic analysis

As just reviewed, the green jobs literature contains highly problematic assumptions about the economics of employment. In this section we examine some of the peculiar assertions about economics in general. First, the literature rejects the existence of comparative advantage, suggesting a need to avoid trade. Second, the literature makes inappropriate calculations of consumer surplus, giving misleading results with respect to the benefits of the proposed policies. Third, the green jobs literature frequently confuses responses to mandates with market responses, improperly extrapolating from the former to predict the latter. Fourth, the literature neglects consideration of the opportunity costs of the resources it proposes to devote to green jobs programs. Opportunity costs are key to understanding the net benefit of a proposal, since the value of the alternative uses of the resources must be deducted from the gains created by the green jobs policies. Finally, green jobs analyses do not take into account how market incentives operate with respect to energy efficiency, instead using an incorrect model of behavior in which energy efficiency results only from government mandates.

By failing to take into account the incentive effects on energy consumption, green jobs analyses overstate the energy that is used in the absence of proposed mandates and thereby overstate the benefits of their proposals. Using data on improved energy efficiency over past decades, we show that the market produces substantial increases in energy efficiency without the drastic measures proposed by the green jobs literature.

That the literature contains so many basic economic errors is not accidental but instead reveals that much of the green jobs literature manifests a thinly concealed hostility to market ordered societies, a hostility which strongly influences its policy recommendations.[268] Taken together, these flaws in economic reasoning reveal fatal flaws in the green jobs literature's analysis of the economics of green job policies.

A. Rejecting comparative advantage

Nobel laureate Paul Samuelson once termed the theory of comparative advantage that underlies the economic analysis of trade an insight from economic theory that was both "nontrivial and nonobvious."[269] It is certainly not obvious in the green jobs literature, since green jobs reports routinely treat comparative advantage as false and view trade as a harm, rather than a benefit, to trade partners. This is problematic for two reasons. First, voluntary trade produces

[268] Those who advocate central planning of economic activity because they believe markets to be deeply flawed have an intellectual and moral obligation to demonstrate that government planning can produce superior results. A century-plus of extensive literature on the topic produced a contrary result that cannot be dismissed merely by putting a green cloak on central economic planning and asserting that this time around it will produce a richer world.

[269] Michael Szenberg et al., PAUL SAMUELSON: ON BEING AN ECONOMIST 44 (2005).

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benefits or it would not occur. Second, the assumption that trade is a net loss to an economy is hidden within the green jobs literature, not stated openly. As a result, the policies stated as intended to promote environmental and employment goals are also policies designed to reverse by implication long-standing public policies in favor of increasing trade.

The green jobs literature often simply asserts that green jobs are not subject to comparative advantage and will be distributed abundantly everywhere. For example, CAP reports that green jobs will be created "in every region and state of the country,"[270] while the Conference of Mayors takes pains to describe with an illusory precision in a 14-page appendix how the green jobs will be distributed among all metropolitan areas and "are not restricted to any specific location, so cities and their metropolitan areas across the country can and are expected to compete to attract this job growth"[271] Similarly, the UNEP report argues that comparative advantage should not apply, as "[p]ublic policy can and should seek to minimize disparities among putative winners and losers that arise in the transition to a green economy, and avoid these distinctions becoming permanent features" by protecting workers and communities that are dependent on non-green industries and companies from the consequences."[272]

Even looking only at the reports' internal descriptions of green industries, it is questionable whether or not these predictions of uniform benefits could be accurate, since these reports do recognize at times that green industries are not currently uniformly distributed. For example, a third of current world production of solar PV cells and wind turbines are German made.[273] As a result of this market dominance, any rapid increase in PV installations will have to involve German firms if it is to succeed.

Regardless of whether local content strategies are attainable, however, the green jobs literature uniformly regards them as desirable. For example, CAP touts the domestic content aspects of its program as a plus:

> In general, about 22 percent of total household expenditures will go to imports. With the green infrastructure investment program, only about 9 percent purchases imports. This is a critical benefit of a green economic recovery program: Investments are focused primarily on improving domestic infrastructure and making both local markets and the national economy more efficient over the long term.[274]

Similarly, the UNEP report concludes that green jobs' high local content is desirable since local content means "a more equitable distribution of wealth since the money saved is invested back into the local economy."[275] Where a purely local strategy cannot be followed, the green jobs literature is critical of the role of trade. An example is the UNEP report's discussion of biofuels where the main flaws are the potential sacrifice of "the interests of local communities" and that

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[270] CAP, *supra* note 10, at 5.

[271] MAYORS, *supra* note 1, at 18, 19-33, app.

[272] UNEP, *supra* note 5, at 4. To its credit, the UNEP report does also note that "there is also a potential contradiction between renewables as global source of jobs and renewables as a part of national competitive economic strategies. Although this does not have to be a zero-sum game, a stellar export performance by a handful of countries does imply more limited opportunities elsewhere on the planet." *Id.* at 9.

[273] *Id.* at 96. The UNEP report notes disapprovingly that this has come about in part because Germany has followed "low wage strategies" in producing solar equipment. *Id.* at 98. The assertion of "low" wages in Germany would come as a shock to employers in Germany and to most employees around the world.

[274] CAP, *supra* note 10, at 11. No citation is provided for this incredibly precise measure of hugely complex portions of economic activity.

[275] UNEP, *supra* note 5, at 136.

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"human needs, especially of the poor and marginalized, all too easily lose out to profit interests."[276]

This anti-trade attitude embedded throughout the green jobs literature is part of a larger criticism of the global economy. The UNEP report is among the most explicit in stating its overall anti-trade agenda. The report argues:

> Particularly with regard to trucking services, however, there is a need to reassess the way in which the global economy is developing. So called "just in time" production systems are biased toward frequent, precisely timed deliveries of materials and parts to factories instead of warehousing of supplies. And both production and consumption now depend on shipments of raw materials, intermediate goods, and final products over ever longer distances. Highly complex production, shipping, and retailing networks have emerged on an increasingly global scale, with varied impacts on employment, wage levels, and the economic viability of communities and regions.
>
> The onslaught of ever-growing transportation volumes threatens to overwhelm gains from improving fuel efficiency and limiting pollutants on a per-vehicle basis. Companies like Wal-Mart (with its policy of global sourcing and especially its policy of searching for cheap products, with potential negative impacts for labor and the environment) are major drivers and symptoms of this phenomenon. When products are shipped around the world in "sending coals to Newcastle" fashion, improving the efficiency of vehicles or planes—or improving the energy efficiency of stores, as Wal-Mart has pledged to do—can only have limited impact. Ultimately a more sustainable economic system will have to be based on shorter distances and thus reduced transportation needs. This is not so much a technical challenge as a fundamental systemic challenge.[277]

The UNEP report goes on to argue that globalization is a particular problem with respect to food production, claiming that "there are many farmers' organizations, NGOs, and others in civil society who regard the existing global food system as fundamentally unsustainable and who propose a more radical change of course—a course that recognizes that traditional knowledge and skills of farmers are the key to solving the major problems of the existing food system and to meet the challenges of increasing demand."[278]

Despite citing United Nations statistics that show that per capita food production has increased by 25 percent and real food prices fallen by 40 percent over the last forty years, the

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[276] *Id.* at 119.

[277] *Id.* at 162.

[278] *Id.* at 223. The report contrasts this with the vision of the World Bank and WTO "who view the present liberalized and increasingly global food system as providing a path from poverty for hundreds of millions of rural dwellers, but who nonetheless recognize that it is a system that needs to do much more in order to become truly environmentally and socially sustainable." *Id.* The romantic view of traditional knowledge and happy peasants does not square with historical fact. By the 1950s and 1960s, traditional agriculture in the developed world seemed destined to lose the battle to feed the masses in many parts of the developing world. This led to dire predictions about coming famines that would inevitably decimate populations. *E.g.*, Paul R. Ehrlich, THE POPULATION BOMB (1968); William Paddock, FAMINE, 1975!: AMERICA'S DECISION: WHO WILL SURVIVE? (1967). However, it was the Green Revolution — a distinctly nontraditional form of agriculture — that saved the day. Not only has the Green Revolution helped reduce hunger and malnutrition in developing countries, it has also saved more land from conversion in the developing world than has been set aside in all the areas that have been fully or partly set aside for conservation. *See* Goklany, *supra* note 241, at 161-163.

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UNEP report nonetheless sees an equivalence in the two perspectives, warning that as population increases and diets move toward more meat and processed foods that global food production will need to triple by 2050 without using more land or water.[279] Moreover, as noted earlier, it sees the increased labor efficiency of agriculture as a problem, concluding that "[t]he industrial model of agriculture, along with rich country subsidies to agribusiness, has been identified as one of the primary drivers of urbanization globally, which then spurs a cycle of urban unemployment or underemployment when economic development does not keep up with the growing urban labor supply. Policies that keep farmers on their land, and facilitating green production practices, could generate employment and income both in agriculture and in non-farm occupations."[280]

The point is not simply that trade is beneficial to human welfare. The problem is that the green jobs literature fails to acknowledge that its anti-trade assumptions are contested.[281] By burying critical assumptions on which exists considerable contradictory evidence and which are inconsistent with existing economic and trade policies (e.g. countries' commitments to the World Trade Organization),[282] the green jobs literature is smuggling in an economic policy in the guise of an environmental policy.

The anti-trade agenda is a fundamental tenet shared by many environmental organizations.[283] As this section's discussion makes clear, the green jobs literature has embedded in it many of these strong anti-trade assumptions, which are contradicted by both economic theory and the experience of the world economy. These unarticulated but central assumptions need to be clearly debated before accepting the green jobs literature's policy recommendations.

B. Consumer surplus

The green jobs literature asserts benefits of green jobs policies using a flawed conception of improvements in human welfare. In economics, policies are evaluated by the calculation of the net social benefits based on both consumer and producer surplus.[284] The green jobs literature contains almost no mention of consumer surplus, focusing almost exclusively on costs and benefits to favored producers. For example, the UNEP report criticizes increased agricultural trade between the United States and Mexico because "cheap corn from the United States has hurt Mexican farmers who grow maize on small- to medium-sized plots in difficult environments using low levels of technology."[285] No mention is made of benefits of cheaper corn to consumers

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[279] UNEP, *supra* note 5, at 224.

[280] *Id.* This assertion does not square with historical experience. All countries that have enjoyed rising standards of living have seen a shift in their economies such that they are less dependent on the agricultural sector in terms of its contribution to the economy and total employment. *See, e.g.*, Goklany, *supra* note 241, at 109.

[281] Although it is enthusiastically practiced in North Korea under its Juche method of economic organization. *See* Juche Idea Study Group of England, http://www.korea-dpr.com/users/jisge/ (last visited Feb. 22, 2009) (compiling links to documents on the benefits of this method of anti-trade organization).

[282] Sean Higgins, *"Buy American" Policy Now Law as Critics Fear Global Reaction; Final Wording Spares EU, Japan, and Canada; Brazil Mulls WTO Case*, INVESTOR'S BUSINESS DAILY A1 (FEB. 18, 2009).

[283] Wolf, *supra* note 254, at 188 ("It is widely accepted among critics of market-driven globalization that it is inherently inimical to protection of the environment. To the extent that it is not inherently inimical, they argue, it is so *de facto* because of the way the World Trade Organization operates. These propositions, though frequently repeated, suffer from a simple drawback: they are, where not altogether wrong, at least greatly exaggerated.") Wolf systematically demolishes the link between trade and environmental problems. *Id.* at 188-194.

[284] Consumer surplus is the difference between the price that consumers are willing and able to pay for a good and the value they place on a good (the highest price they would be willing to pay). Producer surplus is the difference between the price received by a producer when a good or service is sold and the lowest price the producer would have been willing to accept and still engage in the exchange. The existence of such surpluses is the reason exchange occurs—both parties gain. *See, e.g.*, Michael Mandel, ECONOMICS 398 (2009); Roger L. Miller & Roger E. Meiners, INTERMEDIATE MICROECONOMICS 581-82 (1986, 3rd ed.).

[285] UNEP, *supra* note 5, at 225.

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worldwide, only the costs to uncompetitive domestic producers are considered.

The benefits of trade are not just assertions from other-world economic theorizing. Trade has real-life consequences that affect the quality of life, such as by providing more food at lower cost to billions of people.[286] That is a huge consumer surplus. More generally, the report criticizes expanded trade in foodstuffs because:

> [t]he growth of supermarkets in the global South is having a marked effect on farmers, and some maintain that this effect is bigger than that of trade liberalization. Leading supermarket chains have shifted away from wholesale markets where small farmers make their living, and toward procuring food through a few medium-to-large firms that can deliver a consistent quality product at large volumes.[287]

As a result, the UNEP report complains that:

> [T]he consolidation of retail has meant that farmers and producers often receive dwindling returns on their produce, as large retailers are in a position to lay down 'take it or leave it' conditions. Retailers are also in a position to dictate terms to processors and distributors and even large food manufacturers, which results in manufacturers being more concerned to serve the interests of retailers and less concerned to maintain a good relationship with farmers.[288]

These passages are typical of the results-driven nature of the green jobs literature's calculations of social costs and benefits. Economic concepts that the organizations sponsoring the reports do not like (e.g. markets, trade, lower prices for many consumers) are simply assumed to produce net costs. Yet, those economic concepts that the sponsoring organizations like (e.g. small holding agriculture, local production, and solar power) are assumed to produce net benefits. By counting only the benefits from the favored technologies and activities, and only the costs from the disfavored ones, the green jobs literature produces a distorted outcome.

Obviously, the benefits and the costs must be counted from both before an accurate comparison can be made. In particular, careful estimates of consumer surplus are necessary to

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[286] It also affects the stability of governments as evidenced by the demonstrations in about a dozen countries, including Mexico and Haiti, in the first half of 2008 to protest the escalating food prices. Kent Garber, *The Growing Food Cost Crisis*, U.S. NEWS & WORLD REP., Mar. 17, 2008, at 33, 33, *available at* http://www.usnews.com/articles/news/2008/03/07/the-growing-food-cost-crisis.html ("Then there is the elephant in the room: ethanol. Most experts agree that the race among western countries to produce this grain-based alternative fuel is responsible, in significant part, for the rising costs. Their logic is simple: When countries put corn aside for energy, the amount available for food is in greater demand, and prices rise. If demand is already high, the effect is amplified."); *see also* Elisabeth Malkin, *Thousands in Mexico City Protest Rising Food Prices*, N.Y. TIMES, Feb. 1, 2007, at A6, *available at* http://www.nytimes.com/2007/02/01/world/americas/01mexico.html?_r=1&scp=1&sq=Mexico+tortilla+riots&st=nyt&oref=slogin; Opinion, *The misguided politics of corn ethanol*, INT'L HERALD TRIB., Sept. 19, 2007, at 8, *available at* http://www.iht.com/articles/2007/09/19/news/edethanol.php. The price hike was partly due to the diversion of food crops such as corn, soy, and palm oil to meet the demand for ethanol created by subsidies and mandates in developed countries for biofuels to reduce dependence on foreign oil and greenhouse gas emissions. *See* Indur M. Goklany, *Fuels vs. Food*, N.Y. POST, Apr. 17, 2008, http://www.cato.org/pub_display.php?pub_id=9337 ("[F]ood riots resulting partly from the United States' alternative energy policies have arrived at our front door. Crowds of hungry demonstrators swarmed the presidential palace in Haiti last week to protest skyrocketing food prices."); *Mexicans Stage Tortilla Protest*, BBC NEWS, Feb. 1, 2007, http://news.bbc.co.uk/2/hi/americas/6319093.stm.

[287] UNEP, *supra* note 5, at 233.

[288] *Id.* at 234. This evinces a lack of understanding that "the interests of retailers" is consistent with that of their customers. Wal-Mart has been a champion at driving down prices by cutting tough bargains with suppliers, thereby allowing consumers, especially lower-income consumers, to enjoy more value for their scarce dollars.

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compare the policies' impacts. This avoidance of the consideration of benefits from disfavored policies and costs of favored policies is not an accidental oversight – the elimination of the benefits of market competition from the green jobs literature represents its sponsors' rejection of modern economics and, thus, the basis for the world's economy today.[289] Debating these precepts is a necessary step before accepting the literature's claims about how a future economy would work.

C. Mandates vs. markets

Many green jobs programs are built around proposed government mandates to promote favored technologies over those chosen in a competitive marketplace.[290] The rationale for doing so is that without these mandates, market actors would not make the choice to use the green technology because they would not receive all of its benefits and/or would bear all the costs of using green alternatives. The argument is not just the usual one made concerning pollution – that the net social cost-benefit calculation is positive while the net private cost-benefit calculation is negative, requiring a subsidy or mandate to persuade private actors to adopt socially beneficial but privately costly measures. In a number of cases, the green jobs literature asserts that mandates are necessary to persuade individuals, firms, and local governments to adopt policies that will provide a net private benefit as well as a net social benefit, such as weatherization. Why mandates are necessary to encourage economic actors to act in their own benefit is unexplained.

Moving from markets to mandates introduces a qualitative change that requires careful consideration in any analysis for three reasons. First, a competitive market disciplines firms that make mistakes. For example, a firm that chose an inefficient technology over an efficient one would have higher costs than a rival that adopted the efficient technology. However, no such pressures apply to political choices of technologies. Thus a policy that depends on a political process designating particular technologies as "green" and directing investment to them lacks an important check.

Second, the shift of decisions about selecting technologies to a political process introduces new considerations unrelated to the merits. Does a firm that produces this technology have a plant in a key political figure's district?[291] Will a particular technology spoil the view from a senator's vacation home?[292] Choices made on political grounds are unlikely to maximize either economic efficiency or environmental benefits.[293]

Third, markets exert continual pressure for improvement. Mandates, on the other hand, tend to lock in technological choices. For all these reasons, mandates cannot be assumed to

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[289] The view taken by green jobs advocates harkens to a book that enthralled the previous generation at the time of a similar debate. Schumacher began with the "insight" that man is small, therefore small is beautiful. Schumacher, *supra* note 262. He advocated an end to modern technology and production in favor of "Buddhist economics." E. F. Schumacher, BUDDHIST ECONOMICS (1999), *available at* http://www.smallisbeautiful.org/pdf/buddhist_economics/english.pdf (last visited Feb. 22, 2009). In this world he imagined "a multitude of vibrant, self-sufficient villages which, from their secure sense of community and place, work together in peace and cooperation." *See* The E. F. Schumacher Soc'y, Buddhist Economics, http://www.smallisbeautiful.org/buddhist_economics.html (last visited Feb. 22, 2009).

[290] UNEP, *supra* note 5, at 24 ("On the basis of current experience in various areas – from vehicle fuel economy to carbon trading—it appears that a purely market-driven process will not be able to deliver the changes needed at a scale and speed demanded by the climate crisis.").

[291] *See, e.g.*, Alan K. Ota, *Bioenergy Investors Flexing Political Clout*, CONG. Q. TODAY, Nov. 16, 2007, http://public.cq.com/docs/cqt/news110-000002630067.html (describing ethanol industry's political connections).

[292] *See, e.g.*, Robert Whitcomb & Wendy Williams, CAPE WIND: MONEY, CELEBRITY, CLASS, POLITICS AND THE BATTLE FOR OUR ENERGY FUTURE ON NANTUCKET SOUND (2007).

[293] *See, e.g.*, Bruce Yandle, *Coase, Pigou, and Environmental Rights*, *in* WHO OWNS THE ENVIRONMENT? 119, 119-52 (Peter Jensen Hill & Roger E. Meiners eds., 1998).

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produce positive outcomes but must be carefully and regularly scrutinized.

Mandating the use of particular technologies will certainly increase employment related to the mandated technology.[294] For example, it is true that requiring all public buildings to be retrofitted or offering "strong financial incentives" to private building owners to engage in retrofitting, as CAP proposes, would create some jobs.[295] Of course, so would requiring all public buildings to be painted purple or offering tax incentives to private building owners to paint their buildings purple. Painting jobs would increase, paint manufacturers would increase production of purple paint, paint stores would likely hire additional sales and delivery help, paint brush manufacturers would increase production, and so forth.

The question is not whether the mandate would spur some economic activity. The real question is: What would have happened to the resources used to meet the mandate or reap the incentive in the absence of the government program? The answer is that those resources would have been put to the building owners' highest and best use, and those uses would have also created demand for additional goods and services, even if not for purple paint. This is the same with the retrofitting mandates proposed in the green jobs reports.

Explanation of the costs of proposed green job strategies are vague, which is another key issue with the reports. The Mayors and ASES reports both say little more than costs will be incurred. The CAP report primarily cites another study that contends that all educational buildings, government offices and hospitals in the United States could be retrofitted for energy savings at a cost of about $26 billion, which would result in an annual energy cost saving of $5 billion per year.[296] The UNEP study notes that building retrofitting to improve energy usage "can be done on the basis of existing technology with little or no net cost."[297]

How could it be that a massive program such as retrofitting buildings is possible at no net cost but is not occurring in the absence of government mandates? The implication of the necessity of a mandate is that profit-seeking building owners are too foolish to make investments in energy saving despite the short-term paybacks. Consistently in the UNEP report, and at least assumed implicitly by the domestic reports, green job proponents assert that money could be made if only profit seekers were smart enough to recognize the opportunities: "Green innovation helps businesses … hold down costs by reducing wasteful practices."[298] One study cited by the UNEP asserted that "green building" improvements are "paid back over 2-7 years."[299] Another claimed that a $9 billion investment in energy savings would generate $28 billion in savings over 17 years and generate 58,400 new jobs.[300] In short, the UNEP believes that one wonderful profitable opportunity after another is missed by profit-seeking corporations. Similarly, the Union of Concerned Scientists (UCS) claims that the auto makers could easily save themselves, if only they produced more fuel efficient cars. Since they will not on their own, the UCS advocates a federally imposed 35 mpg fuel standard that it claims would generate 241,000 more

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[294] A classic episode in this regard is the Clean Air Act. *See* Bruce A. Ackerman & William T. Hassler, CLEAN COAL/DIRTY AIR: OR HOW THE CLEAN AIR ACT BECAME A MULTI-BILLION DOLLAR BAIL-OUT FOR HIGH-SULFUR COAL PRODUCERS (4th ed. 1981).

[295] CAP, *supra* note 10, at 6-7.

[296] CAP, *supra* note 10, at 16.

[297] UNEP, *supra* note 5, at 131.

[298] *Id.* at 24.

[299] *Id.* at 139.

[300] *Id.* at 134.

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jobs by 2020 and save consumers $37 billion per year.[301] If only GM, Ford and Chrysler would take this path, their futures would be secure. Unfortunately, contrary evidence is ignored.[302]

Green jobs proponents argue not only that for-profit businesses are missing obvious opportunities to make money. They also contend that requiring or directing investment into their favored programs will yield a wide range of benefits beyond simply creating jobs. Green job proponents believe the required investments will change the direction of the economy. For example, CAP argues that mandating (public) and incentivizing (private) building retrofits will create:

> new markets for energy-saving technology, and could serve as a foundation for administering rapid federal investment. They could become the active starting point for constructing a more ambitious national program of public building retrofits that … could provide needed funds directly to cities and rural communities to invest in greater energy efficiency and reduced global warming pollution.[303]

In short, the mandated retrofit programs appear to be better than voluntary energy reduction measures because they are government programs.

Further, green jobs reports also allege that more jobs are created by green investments than by alternatives. Mandates are justified because they will produce higher employment than privately directed investment. For example, CAP claims that "[p]ublic spending directed toward a green recovery program … would result in more jobs than spending in many other areas, including, for example, within the oil industry or on increasing household consumption, which was the primary aim of the April 2008 stimulus program."[304] Note that CAP is comparing public green spending to voluntary private spending, with green public spending "better" only because CAP's input-output model says it is. As we described earlier, CAP's model (and others' models as well) rests on crucial assumptions that dictate the outcome. For example, in the appendix describing the model, CAP notes that it used a "synthetic representation" of green industries because the larger government input-output model on which it based its calculations did not include those industries as separate sectors.[305]

Moreover, CAP examined the impact of spending, rather than energy production, within each energy sector.[306] In other words, CAP's model focused on the number of jobs an additional $1 million spent on solar energy would produce compared to $1 million spent on oil. Yet, as CAP notes, $1 million spent on solar energy would currently produce considerably less energy than $1 million spent on oil,[307] precisely because of the relative inefficiency of alternative energy

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[301] *Id.* at 159.

[302] *See, e.g.*, hybridCARS.com, Annual Hybrid Sales Drop for First Time, http://www.hybridcars.com/news/annual-hybrid-sales-drop-first-time-25388.html (last visited Feb. 22, 2009) ("The best-selling hybrid, the Toyota Prius, posted 158,884 sales in 2008, a drop of 12.3 percent from 2007. In mid-year when gas prices spiked above $4 a gallon, customers joined long waiting lists for the Prius. Those waiting lists, and general demand for hybrids, evaporated as gas prices plunged, falling below $2 a gallon by the end of the year.").

[303] CAP, *supra* note 10, at 6-7.

[304] *Id.* at 9. CAP continues to report such benefits, in detail, from the 2009 stimulus plan. Will Straw, Center for American Progress, *The Nationwide Allocation of Recovery Funding: An Interactive Map on the Final House-Senate Compromise*, http://www.americanprogress.org/issues/2009/02/compromise_map.html (last visited Feb. 22, 2009).

[305] CAP, *supra* note 10, at 20.

[306] *Id.* at 21.

[307] *Id.* at 21. CAP considered using a constant energy output model, an approach it noted was "most consistent with the idea that we are attempting to proceed to a low-carbon economy without having to make significant sacrifices in the total amount of

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technologies. Solar and wind currently have capital costs per kWh generated that are sufficiently greater than costs of coal-fired and natural gas-fired power plants to make the cost of the electricity they produce uneconomic compared to conventional fuel-generated power. An investment in alternative energy would therefore produce less energy than a similar investment in fossil fuels.

More jobs per dollar might be created with alternative forms of energy, but there would not be as much energy, and what would be available will cost more, directly or indirectly, because of the subsidies and mandates embedded in their production. This would be true even if consumers are not presented with the bill for the subsidies and mandates at the gas pump or in their utility bills. The resulting loss in the quality of life of the American consumer, due to inefficient use of labor and other resources, is not accounted for in the CAP analysis.

In addition, CAP used a high multiplier for the indirect effects of the money paid to the individuals working as a result of the expenditures on alternative energy. Although CAP noted that estimates in the literature of such multipliers range from negative to 2,[308] it assumed a multiplier "closer to the high end estimates" because CAP's proposal "is designed specifically to generate a large induced expansion of jobs" by spending "focused on domestic industries rather than imports" and "stimulating private-sector investment rather than relying on government spending" and will "help control the upward movement in the price of oil."[309] CAP then adjusts its estimate downward to be "conservative," concluding that indirect job creation will only be one third of direct job creation.[310]

While mentions of the costs of alternative energy sources are vague in the reports advocating their adoption, the advocacy groups do agree that the costs should be considered. For example, the UNEP argues that "[t]o the extent that government mandates that such alternatives [such as solar power] be given equal access to the [electricity] grid, higher costs will be passed on to the consumers," but, "as renewables mature technologically … cost disadvantages disappear and may turn into a cost advantage."[311] Implicit in this discussion is that the utility companies are too short sighted to make investments in renewable energy projects that would produce profits. That premise is seriously at odds with the desire of a number of utilities to be allowed to sink large amounts of capital to build nuclear plants that take a decade or more to build and have a long recoupment period. If the people who make their living in the industry do

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energy we consume." *Id.* Such an assumption would be a fantasy indeed. CAP rejected it because "under this approach our employment estimates become highly sensitive to the current state of technology and energy costs in each energy industry. This would have produced highly inflated employment figures for solar power and other forms of renewable energy, where, at present, the costs of generating a given supply of BTUs is much more expensive than traditional energy sources." *Id.*

[308] Richard Hemming, Michael Kell & Selma Mahfouz, THE EFFECTIVENESS OF FISCAL POLICY IN STIMULATING ECONOMIC ACTIVITY: A REVIEW OF THE LITERATURE (2002); CAP, *supra* note 10, at 21. They refer to the IMF study cited in note 209 *supra.*

[309] CAP, *supra* note 10, at 21.

[310] *Id.* at 22. Similarly, virtually all green jobs reports point to the growth of ethanol and biodiesel in the United States, in response to public mandates and subsidies, as evidence that properly targeted incentives and rules can produce green jobs. *See, e.g.*, *id.* at 8 ("public and private sector growth is already picking up pace, with renewable energy technology supporting sustained double digit rates of growth nationwide."); MAYORS, *supra* note 1, at 11 ("National and state energy policies have encouraged increased usage of ethanol branded blended with gasoline in recent years. That, combined with rising petroleum prices making biofuels more economically palatable, has led to dramatic growth in their usage."); UNEP, *supra* note 5, at 93 (citing estimate that biofuels market could grow $80 billion by 2016). But they also conclude that not enough spending is occurring. CAP notes that "an unstable policy environment and the lack of long term incentives have hurt the investment climate for these technologies, preventing them from realizing even greater growth." CAP, *supra* note 10, at 8. More investment is needed in "infrastructure for next-generation biofuels." *Id.*

[311] UNEP, *supra* note 5, at 47.

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not see the wisdom of investing in massive wind and solar farms, unless they are heavily subsidized, then the economic feasibility of such green projects is much more dubious than the political promoters assert them to be.

Further, the premise that reorienting our economy in a "greener" direction by shifting to "sustainable" energy production will increase net employment in the economy is not true because the bulk of jobs in renewable energy sectors are not self-sustaining without subsidies. In particular, most jobs in solar PV energy and wind energy rely heavily on direct subsidies (via favorable tax treatment) or mandates (e.g. renewable portfolio standards). A study done for the American Wind Energy Association (AWEA) and the Solar Energy Research and Education Foundation (SEREF) in early 2008 estimated that if the investment tax credit for solar PV projects and the production tax credit for wind energy were not to be renewed at the end of 2008, then together those industries could lose 77 percent of their jobs. Specifically, in 2009, jobs in the solar PV industry could drop by 57 percent (from 69,000 jobs to 29,600 jobs), while jobs for the wind energy industry could decline by 93 percent (from 82,300 to 5,700 jobs).[312] Further, a report prepared for the Center for American Progress itself notes that, "Lapses in federal production tax credits, occasional one- to two-year extensions, and uncertainty about the future of these credits have led to a 'boom and bust' cycle in the development of wind power."[313] See Figure 3. For example, the production tax credit (PTC) expired in 2003 and additions to wind power capacity fell from 1,687 megawatts in 2003 to 389 megawatts in 2004. The result: "when the tax credits were renewed in 2005, wind capacity rose sharply, by 2,431 megawatts."[314]

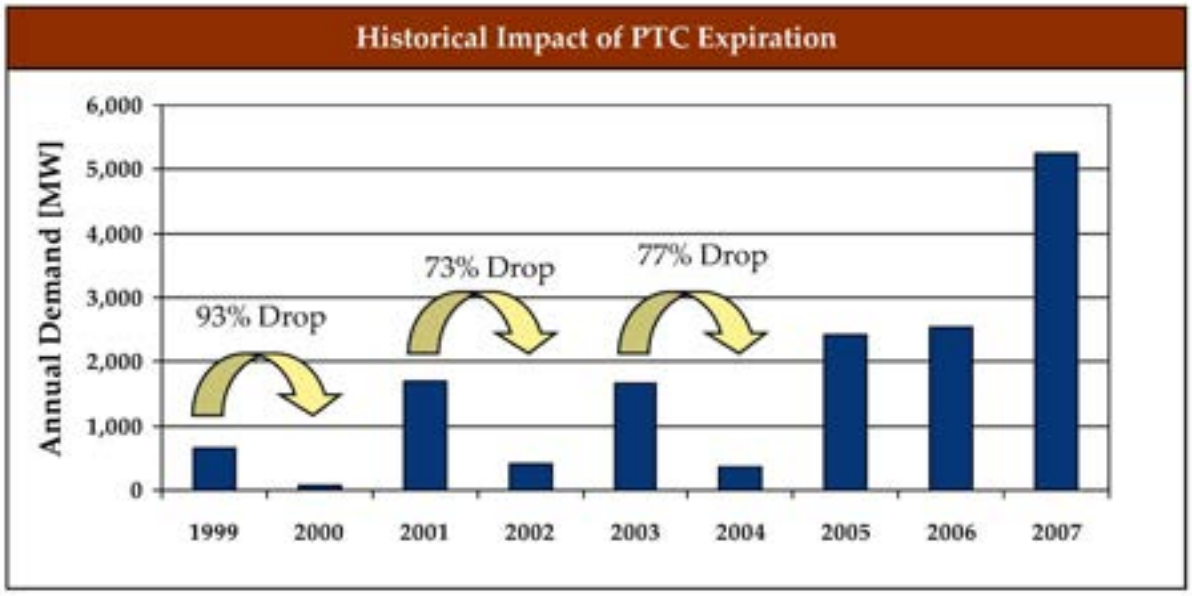

Figure 3 - Historical impact of the expiration and reinstatement of production tax credits (PTCs) for wind energy. PTCs expired in 1999, 2001 and 2003, which resulted in sharp reductions in wind projects in the following years. [315]

[312] Navigant Consulting, Inc., ECONOMIC IMPACTS OF THE TAX CREDIT EXPIRATION (2008), *available at* http://www.seia.org/galleries/pdf/Navigant_Tax_Credit_Impact.pdf (prepared for the American Wind Energy Association and the Solar Energy Research and Education Foundation).

[313] CAP, *supra* note 10, at 16.

[314] *Id.*

[315] Navigant Consulting, Inc., *supra* note 312.

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In fact, U.S. subsidies for renewable energy projects are so attractive that in November 2008, BP announced that it has dropped all plans to build wind farms and other renewable projects in Britain; instead it is shifting its renewables programs to the United States, where government incentives for clean energy projects provide "a convenient tax shelter for oil and gas revenues," and a BP spokesman said "the best place to get a strong rate of return for wind is the U.S."[316] The following month Royal Dutch Shell announced that it was also abandoning wind energy projects in Britain in favor of the United States.[317] These developments lend support to the idea that renewable energy — including wind energy, the renewable source for electricity generation deemed most likely to become cost-competitive with fossil fuels — is viable only because of subsidies and mandates.

D. Neglecting opportunity costs

As the above examples illustrate, a constant in the green jobs literature is the idea that maximizing employment, not attempting to maximize human welfare with the resources at hand, is the goal. Indeed, the UNEP study goes so far as to refer to the creation of jobs from spending on environmental projects as the "double dividend."[318] What is missing from these analyses is consideration of the opportunity cost of the public and private expenditures sought.[319] For example, the CAP study asserts that if $100 billion is spent on assorted green activities that 935,200 jobs would be directly created,[320] implying a cost of $107,000 per new job created. Most people could go to a modestly priced college or university full time for four years for that sum.[321] The opportunity costs are real. Either the funds for these programs were taken from the pockets of people who have $100 billion less to spend on other things, causing an economic contraction in those other areas, or it means a bill passed on to the grandchildren of today's taxpayers through deficit spending, who will thus have less to spend.

The lack of consideration of opportunity costs can be seen in the UNEP report's consideration of a study of German tax and transit policy which suggested higher gasoline taxes, the revenue from which would be split evenly between "new infrastructure and financial support for public transport, and thus jobs in mass transit" and lowered taxes in other areas. The increased consumer spending from the tax cuts (financed by higher gasoline taxes) was predicted to produce three-quarters of the total net jobs produced by the policy. However, if that money were spent on reducing labor costs "by reducing employers' social security contributions" instead of being returned to taxpayers through tax cuts, "the net employment effects were

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[316] Terry Macalister, *Blow to Brown as BP Scraps British Renewables Plan to Focus on US*, GUARDIAN, Nov. 7, 2008, at 37, *available at* http://www.guardian.co.uk/business/2008/nov/07/bp-renewable-energy-oil-wind.

[317] Danny Fortson, *Shell to Quit Wind Projects*, SUNDAY TIMES, Dec. 7, 2008, at 2, *available at* http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article5299195.ece.

[318] UNEP, *supra* note 5, at 10.

[319] CAP does give some consideration to the issue. CAP asserts that more jobs will be created by the "green investment" program than if the money was used in other ways. The report notes that if $100 billion was spent on domestic oil industry jobs only 542,000 jobs would be created—far fewer than the 935,200 their proposal would generate. Why? The oil industry would spend a lot of money "purchasing machines and supplies." CAP, *supra* note 10, at 11. Apparently capital equipment is a bad, as are the jobs creating the equipment, compared to the more labor-intensive green jobs.

[320] *Id.* at 9.

[321] We are not arguing that a college education would necessarily be a better use of that much money (despite our self-interest in the growth of the higher-education industry), but the report gives no evidence that their prescription for the expenditure is better than the same amount spent on education or some other area of activity. Full tuition at York College of Pennsylvania in 2008-09 is $13,680. See http://ycp.edu/admissions/208.htm. Full tuition for an in-state student at Penn State in 2008-09 is $13,014 for a freshman or sophomore and $14,070 for a junior or senior. See http;//tuition.psu.edu/Rates2008-09/UniversityPark.asp.

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thought to range as high as 400,000 new jobs."[322] No consideration appears to have been given to the increase in the satisfaction of human needs and wants possible by leaving the tax revenues with taxpayers. This can also be seen in the negative attitude toward even environmental improvements that reduce demand for labor.[323]

The UNEP report, unlike domestic reports, does note that the push for green jobs means that some workers will move from declining areas such as fossil fuels to renewable fuels (substitute jobs). Some jobs will be eliminated as disfavored practices, such as certain packaging materials, are prohibited. Other traditional jobs will be transformed. Plumbers will become green job plumbers as "work methods … are greened."[324] Crucially, however, this estimate does not consider either the alternative use of nearly $1 trillion over that time period nor does it estimate how many jobs would be destroyed.[325] In other words, no *net* job estimate was developed.

If $1 trillion is spent on wind energy generation projects, then there is $1 trillion less to spend on solar energy, education, health-related research and development, or any other activity. Jobs that could have been created in alternative sectors will not be created. Further, since the goal is to replace a portion of existing power generation with wind energy, then fewer people will be employed in energy production from coal and other fossil fuel sources.[326] A "job demultiplier," which is likely at least as large as the multiplier assumed to be 2.5, and perhaps more, for reasons discussed below, would need to be applied to the lost jobs in those sectors. If a worker simply transfers from a job at a coal-fired electric plant to one at a wind-turbine electric plant, there is no job impact at all. This does not mean that wind energy production may not be a good idea, but that the job creation claims assume there is no alternative use for the resources devoted to this activity. It is likely that the net impact on employment is much lower and thus could even be an overall negative impact on the economy as we move away from the allocation of resources based on highest valued use in a competitive economy to allocation determined by political fiat.

Ignoring these net effects, green job estimates often claim credit for converting existing jobs into a "green" job. Retrofitting existing buildings, for example, is frequently cited as a major source of green jobs. The Mayors report predicts that:

> traditional contractors will develop their skill sets and expand their knowledge bases in ways that will allow them to transform large numbers of ordinary buildings into some of the most energy efficient in the world. The existing stock of energy inefficient buildings offers an opportunity to reduce total electricity demand and create jobs for these workers.[327]

This type of reasoning is endemic in the green jobs literature. Consider how it deals with the benefits of retrofitting existing buildings to higher energy efficiency standards. The CAP report

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[322] UNEP, *supra* note 5, at 170-171.

[323] *Id.* at 185 ("Making steel mills greener and more competitive is a must for job retention. At the same time, it must also be acknowledged that more energy efficient mills do not necessarily employ many people. In the United States, electric arc furnaces (which require far less energy than blast furnaces) are characterized by a lean workforce.").

[324] *Id.* at 3.

[325] ("The results do not reflect the net impacts of construction or operation of other types of electricity-generating power plants or replacement of existing power generation resources to meet growing needs.") DOE, 20% WIND, *supra* note 112, at 203.

[326] The UNEP report occasionally considers job losses, but generally finds them to be a positive effect. *See, e.g.*, UNEP, *supra* note 5, at 150 ("In a sustainable economy, there will be fewer jobs in airplane manufacturing and air travel services than today. But from a macro-economic perspective, this is not necessarily a negative development. Many jobs in the aviation industry are effectively heavily subsidized, via exemptions from fuel duty, value added tax, and duty-free rules.").

[327] MAYORS, *supra* note 1, at 10.

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argues that retrofitting would enable replacing "at least" the 800,000 construction jobs lost due to the housing downturn between July 2006 and July 2008[328] and so should be required by the government for "all public buildings" and induced in private buildings by "strong financial incentives including both loan guarantees and tax credits."[329]

The UNEP concedes that "exact figures are unknown" but nonetheless states that "it is easy to imagine that a worldwide transition to energy-efficient buildings could create millions or even tens of millions of jobs and would green existing employment for many of the estimated 111 million people already working in the sector."[330] These jobs get counted as "new" because, as the UNEP report states, "[r]etrofitting buildings directly increases employment because without an attempt to make the building more efficient, the work would not have been done. Types of jobs that are likely to be created directly in the retrofitting process are auditors, engineers, estimators, project managers, and various jobs in the construction trades including pipe fitters, sheet metal workers, HVAC technicians, engineers, electricians, and general construction workers."[331] This assumes that these workers have no alternative employment. Removing them from doing whatever it was they would have done otherwise – unless they were all unemployed – eliminates jobs and production in those other areas.

E. Ignoring incentive effects

The green jobs literature focuses heavily on public policies intended to induce greater energy efficiency, both to reduce greenhouse gas emissions from power generation and because it generally seeks to shift expenditures away from fossil fuels. However, energy efficiency occurs naturally as a result of market processes even without expensive government programs. Because the literature ignores this trend, which has occurred in multiple industries over many decades, the green jobs literature overstates the benefits of its conservation measures by claiming credit for conservation that would occur even without such measures.[332]

Because energy is costly, market forces provide incentives to produce and consume using less energy. These forces have produced real change: from the late 1970s to 2000, energy utilization per dollar of real GDP produced fell by 36 percent.[333] Total energy usage increased because of economic growth over that time, but efficiency increased more than growth in all major energy-using sectors.[334] This trend has meant that past efforts to forecast future energy use have consistently overestimated future energy demands. During the 1970s the United States had grave concerns about the sufficiency of energy sources. Oil prices hit an all time high. Part of the problem was caused by an Arab oil embargo, and the domestic problem was exacerbated by price controls imposed by the Nixon Administration, causing concern that the energy crunch

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[328] CAP, *supra* note 10, at 2.

[329] *Id.* at 6-7.

[330] UNEP, *supra* note 5, at 12. Similarly, the UNEP report notes that "New green construction does allow for the possibility of some new jobs due to the increased investment in the construction phase. But most of the jobs created through green building practices are likely to occur from energy savings and reinvestment." *Id.* at 138. The literature also notes that retrofitting would "stimulate jobs in the manufacturing of green building components and systems" for buildings and wind, solar, etc. *Id.* at 143.

[331] *Id.* at 140.

[332] Most measured technological progress has occurred in about the last 200 years and much of it has to do, one way or another, with increases in efficiency.

[333] Paul L. Joskow, *Energy Policies and Their Consequences After 25 Years*, ENERGY J., Oct. 2003, at 17, 37.

[334] *Id.*

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could inflict major economic harm as far into the future as could be seen. Would there be sufficient energy to drive the economic engine?[335]

Knowledgeable researchers in the late 1970s looked ahead to estimate energy use by 2000. Their conclusion was disturbing. It showed significant increases in energy would be needed.

Looking back, we know that the estimates of that time proved to be 60 to 80 percent too high compared to actual use by 2000.[336] In other words, the experts, who knew efficiency would increase, still greatly underestimated technical progress in efficiency. Further, the apparent incentive to conserve energy should have been lessened because oil prices turned out to be much lower by the mid-1980s than were anticipated by scholars in the late 1970s based on that decade's oil shock. The situation is no different today. We find no good reasons to be concerned about energy security in the future, but the future will not look like today because of innovations that emerge and that cannot now be known.

Given the bias against many technologies in the green jobs literature, as we documented earlier, we would expect the predictions made in it to be even more likely to incorrectly discount the chances of improvements in energy efficiency caused by market forces. Predictions of future energy efficiency depend on forecasts of technological change. But technical progress is a perpetual process, difficult to measure and difficult to force.

The green jobs literature is not the first time that government mandates have been proposed to reduce energy consumption. Mandatory energy savings have been popular since the oil shocks of the 1970s. Utilities were required at that time to engage in assorted "negawatt" programs that would result in less electricity being required over time.[337] Either due to political pressure to show good results, or simply due to poor ability to comprehend costs, the savings from the programs that emerged after the 1970s energy shock were vastly overstated or, conversely, the costs were underestimated "by a factor of two or more on average."[338] The claims in the green jobs literature should be evaluated keeping in mind this record of failure by political planners of energy policy. Proponents of new policies bear the burden to explain how their proposals will succeed where past efforts did not.

Market competition creates incentives for firms to find more efficient ways to achieve results.[339] There is potential profit in what is commonly viewed as waste. One of the first

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[335] Some were convinced that could not be possible, so doom was on the horizon. *See* Ehrlich, *supra* note 278.

[336] *Id.* at 35.

[337] *See* Fred Sissine, Cong. Research Serv., REPORT NO. IB10020, ENERGY EFFICIENCY: BUDGET, OIL CONSERVATION, AND ELECTRICITY CONSERVATION ISSUES, at CRS-1 to CRS-3 (2006), *available at* https://www.policyarchive.org/bitstream/handle/10207/744/IB10020_20060120.pdf?sequence=23 (discussing background and origins of energy efficiency programs).

[338] Paul L. Joskow & Donald B. Marron, *What Does a Negawatt Really Cost? Evidence from Utility Conservation Programs*, ENERGY J., Sept. 1992, at 41, 41-74.

[339] While the review that follows focuses on several areas, we must emphasize that waste reductions (improvements in efficiency) are pervasive. A decade ago, the Federal Reserve Bank of Dallas estimated that a bank transaction in person cost a bank $1.14 (this ignores the bank customer time and cost of traveling to the bank) while an online transaction cost one cent. *See* FED. RESERVE BANK OF DALLAS, THE NEW PARADIGM: 1999 ANNUAL REPORT 15, *available at* http://www.dallasfed.org/fed/annual/1999p/ar99.pdf. A few decades ago there were many more bank jobs because many more tellers were needed. Those productive resources, humans, were released to other activities. The same report noted that Wal-Mart reduced truck operating costs by 20 percent by using computers, GPS, and cell phones in trucks and that Amoco's use of new seismic processes and computer analysis reduced the cost of finding oil from about $10 per barrel in 1991 to about $1 per barrel in 1999. *Id.* at 14. Weyerhaeuser's use of scanners and computers in log milling increased yields by 30 percent in less than a decade and "precision farming" technology using computers, sensors on machinery, and GPS systems reduced agricultural costs

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extensive works to document this was by the business and technology journalist Peter Lund Simmonds who, in a 400-page study published in 1862, noted that "[i]n every manufacturing process there is more or less waste of the raw material, which it is the province of others following after the original manufacturer to collect and utilize."[340] He reported on such work involving cotton, wool, silk, leather, and iron. Even Karl Marx grudgingly acknowledged this productive feature of competition:

> With the advance of capitalist production the utilization of the excrements of production and consumption is extended. . . . The general requirements for the re-employment of these excrements are: A great quantity of such excrements, such as is only the result of production on a large scale; improvements in machinery by which substances formerly useless in their prevailing form are given another useful in reproduction; progress of science, especially of chemistry, which discovers the useful qualities of such waste.[341]

Other, less earthy, economists of that era discussed the wonders of the Chicago meat packing industry where there were developments "of tallow, glue, soap, felt, bone meal, glycerin, knife handles, buttons and countless other articles whose main inputs were previously wasted blood, feet, heads and other non-edible animal parts."[342] Later, Henry Ford built his Dearborn, Michigan, River Rouge complex with waste reduction in mind. Among many innovations, a cement plant was built next to the car factory to be able to dispose of tons of blast furnace slag; some of the cement was used in Ford construction activities, the rest was sold.[343] The process of technological innovation is continuous and usually so gradual we do not appreciate the extent of improvements.

Over the long term, market forces in conjunction with technological change have increased the efficiency of energy processes remarkably.[344] Table 4 shows the technological progress in delivering energy for heating, stationary power, electricity, transportation and lighting since the start of the Industrial Revolution around 1750. Although most of the data are from the United Kingdom, they are qualitatively applicable to the United States. The table shows that, compared to 1900, each unit of energy input in 2000 could provide four times as much useful heat, move a person 550 times farther, provide 50 times more illumination, and produce 12 times as much electricity. Much of the improvements occurred prior to 1950, that is, before the advent of the regulatory era in either the United Kingdom or the United States.

More importantly, after taking into consideration the changes in fuels, fuel mixes and energy conversion technologies, these forces have decreased the cost of energy services —

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and raised yields. *Id.* at 12. The list of improvements seem endless but, living amid it all, we often do not see the forest for the trees.

[340] Peter Lund Simmonds, WASTE PRODUCTS AND UNDEVELOPED SUBSTANCES; OR, HINTS FOR ENTERPRISE IN NEGLECTED FIELDS 2 (1862).

[341] Karl Marx, CAPITAL: A CRITIQUE OF POLITICAL ECONOMY: VOL. III – PT. I: THE PROCESS OF CAPITALIST PRODUCTION AS A WHOLE ch. 5, at 120-121. (Friedrich Engels ed., Cosimo Classics 2007).

[342] Pierre Desrochers, *Did the Invisible Hand Need a Regulatory Glove to Develop a Green Thumb?*, 41 ENVTL. & RESOURCE ECON. 519, 526 (2008).

[343] Pierre Desrochers, *By-product Development Before the Modern Environmental Era*, 8 ENTERPRISE & SOC'Y 348, 353-54 (2007).

[344] *See supra* tbl.1; *See also* Jesse H. Ausubel, *Technical Progress and Climate Change*, 23 ENERGY POL'Y 411, 411-416 (1995), *available at* http://phe.rockefeller.edu/tech_prog/.

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namely, the provision of heat, stationary power, transport and lighting — to the consumer by an order of magnitude or more (see Table 4). As Fouquet and Pearson note:

> In [the] last two hundred and fifty years, the cost of generating useful heat has fallen more than 10-fold. To generate a unit of power costs 50 time less. To travel one kilometre is 150 times cheaper. To produce the same quantity of light, it costs us 8,000 times less.[345]

These improvements occurred when there was an upward trend in average energy prices during the latter half of the nineteenth century and much of the twentieth century, a period that witnessed massive changes in energy systems and substitutions towards more expensive but higher "quality" fuels, such as petroleum for transport, and natural gas and electricity for other uses.[346]

[345] Fouquet & Pearson, *supra* note 347, at 11.

[346] *Id.* at 1.

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Table 4 - Long-Run Trends in the Energy Technologies, UK or US, 1750-2000. [347]

ENERGY SERVICE	AREA	YEAR					
		1750	1800	1850	1900	1950	2000
Heating (% energy converted to heat)	UK	11	11	13.5	21	41	86
Stationary power (% thermal efficiency converted to power; includes power derived from electricity.**)**	UK	0.5	4.6	10	15	20	
Thermal power plant (Watt-hours of electricity produced per thousand BTU of heat input**)**[348]	USA				8.3	71.3	98.0
Transport (Passenger-kilometer per tonne of oil equivalent.**)**	UK		10	24	36	11,700	20,000
Lighting (Lumen-hours per kilowatt-hours.**)**	UK	29	36	190	500	11,600	25,000

[347] Goklany, *supra* note 241, at 144; EIA ANNUAL, *supra* note 183, at 364 tbl.A6; Roger Fouquet & Peter J.G. Pearson, *Long Run Trends in Energy Services, 1300-2000*, (Dep't of Econ. Univ. of the S. Pac., Fiji, Ctr. for Envtl. Policy Working Paper, 2005), *available at* http://www.webmeets.com/files/papers/ERE/WC3/154/HisEnS10.pdf.

[348] The figure for 1900 is taken from 1899. Goklany, *supra* note 241, at 144. 1950 and 2000 figures are from the Energy Information Administration. EIA ANNUAL, *supra* note 183, at 364 tbl.A6.

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Table 5 - Long-Run Trends in the Price of Energy Services, UK or US, 1750-2000.[349]

ENERGY SERVICE	AREA	YEAR					
		1750	1800	1850	1900	1950	2000
Heating (Constant (2000) pounds sterling per tonne of coal equivalent of *effective* heat.**)**	UK	1,400	700	500	460	380	130
Stationary Power (Constant (2000) pence/kilowatt-hour.**)**	UK	140	35	35	20	4	2.5
Electricity, residential (Constant (2000) cents/kilowatt-hour**)**[350]	USA				267	17.4	8.2
Transport (Constant (2000) pence per passenger-kilometer.**)**	UK	15	5	1	0.38	0.16	0.1
Lighting (Constant (2000) pounds sterling/millions of lumen-hours.**)**	UK	13,690	6,630	1,175	276	10	1.7

In the following subsections, we examine U.S. energy consumption trends in some specific energy-intensive sectors and with respect to some specific energy consuming technologies to demonstrate both how this process operates and its importance in energy consumption.

1. Iron and Steel

The iron and steel industries are crucial industrial sectors, therefore "greening" jobs in these areas is a high priority for green jobs advocates.[351] If one only read the green jobs literature, you would be left with a strong sense that these are remarkably energy-inefficient industries. The reality is that iron and steel production has become much more energy-efficient without the sort of programs advocated by green jobs proponents. For example, the amount of energy consumed per ton of U.S. produced steel declined by over 60 percent from 1980 to 2006, and 29 percent

[349] Bureau of the Census, U.S. Dep't of Commerce, HISTORICAL STATISTICS OF THE UNITED STATES: COLONIAL TIMES TO 1970 (1976); EIA ANNUAL, *supra* note 183; Fouquet & Pearson, *supra* note 347; Bureau of Econ. Affairs, U.S. Dep't of Commerce, All NIPA Tables, http://www.bea.gov/national/nipaweb/SelectTable.asp (follow "Table 1.2.4. Price Indexes for Gross Domestic Product by Major Type of Product (A) (Q)" hyperlink) (last visited Feb. 22, 2009).

[350] 1900 figure is taken from 1902 data and calculated from Department of Commerce data. Bureau of the Census, *supra* note 349, at 211, 827; EIA ANNUAL, *supra* note 183; Bureau of Econ. Affairs, *supra* note 349.

[351] UNEP, *supra* note 5, at 15 ("making steel mills greener and more competitive is a must for job retention."); 49 (higher energy and materials productivity is "particularly critical" in industries like steel that consume a great deal of energy and natural resources.)

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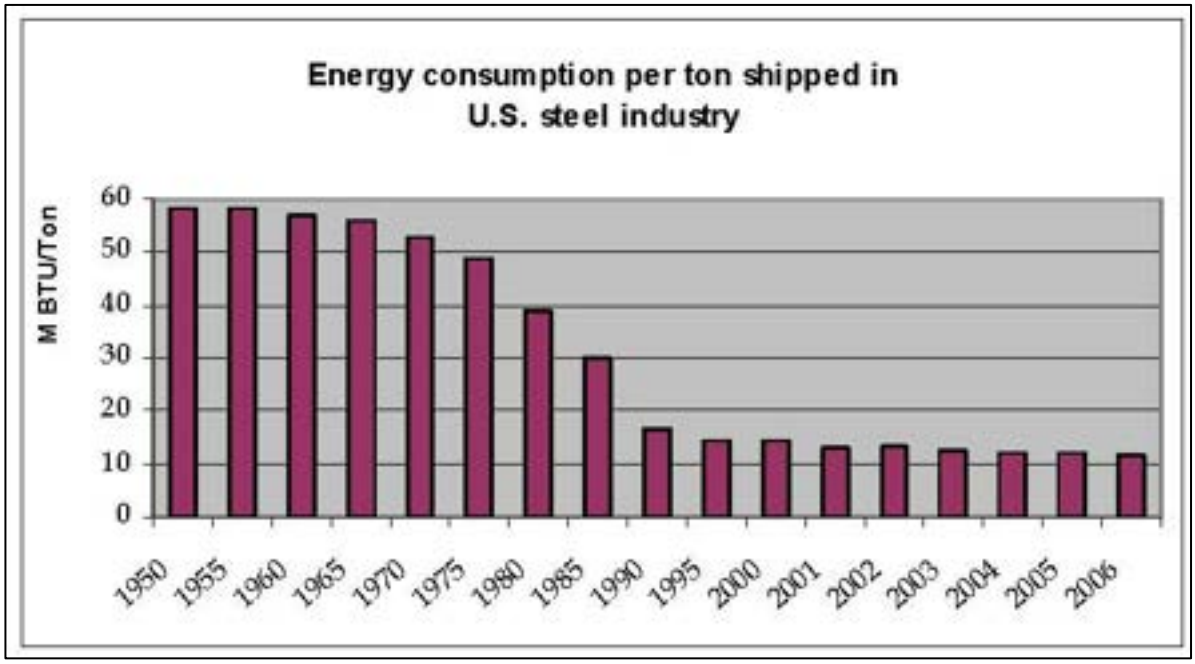
from 1990 to 2006.[352] These improvements were driven by the need to stay competitive in a tough business environment, which led to restructuring of the industry through the bankruptcies in the 1990s and early 2000s, closure of older and inefficient operations, and increases in the proportion of scrap iron and steel recycled via electric arc furnaces.[353] Not reflected in Figure 4 is the fact that today's steels are thinner and stronger, which means that for the average application, the decline in energy intensity is even greater than reflected on the figure.



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2. Aluminum

Based on data for 2000, it takes 44,700 Btu to produce one pound of primary aluminum in the United States, which makes it the most energy intensive major material manufactured.[354] On the other hand, secondary aluminum (that is, recycled aluminum) requires only 6 percent of the energy necessary to manufacture primary aluminum.[355] Between 1960 and 2000, secondary aluminum as a share of total aluminum production increased from 18 percent to 47 percent.

In addition to reduced energy consumption from recycling, primary aluminum production also became more efficient. Between 1960 and 2000 the energy required for smelting a kilogram of the primary ore, a key energy intensive operation necessary to produce the primary metal,

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[352] American Iron & Steel Inst., *US Steel Industry: World Leaders in Energy Efficiency*, http://www.steel.org/AM/Template.cfm?Section=Environment1&CONTENTID=21986&TEMPLATE=/CM/ContentDisplay.cfm. (last visited Feb. 22, 2009).

[353] U.S. Envtl. Prot. Agency, ENERGY TRENDS IN SELECTED MANUFACTURING SECTORS: OPPORTUNITIES AND CHALLENGES FOR ENVIRONMENTALLY PREFERABLE ENERGY OUTCOMES, at 3-53 to 3-54 (2007), *available at* http://www.epa.gov/sustainableindustry/pdf/energy/report.pdf.

[354] William T. Choate & John A. S. Green, U.S. ENERGY REQUIREMENTS FOR ALUMINUM PRODUCTION: HISTORICAL PERSPECTIVE, THEORETICAL LIMITS AND NEW OPPORTUNITIES, at B-1 app. B (2003), *available at* http://www.secat.net/docs/resources/US_Energy_Requirements_for_Aluminum_Production.pdf (prepared by BCS Corp. for the U.S. Dep't of Energy).

[355] *Id.* at 59.

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declined by 35 percent. As a consequence, the total energy intensity of aluminum production in the U.S. declined by more than 58 percent over this period (see Figure 5).[356]

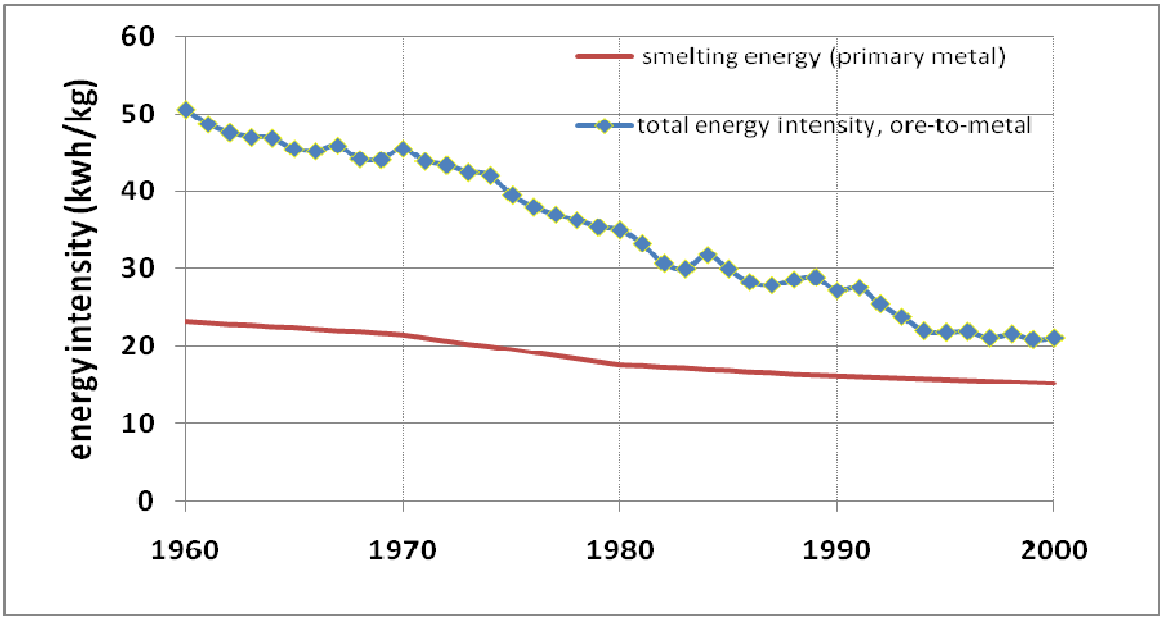

Figure 4 - Energy intensity for US aluminum production, 1960-2000.[357]

3. Ammonia

Ammonia production is the third most energy intensive production process, after aluminum, and pulp and paper production (12,200 Btu per pound).[358] As was the case with iron and steel, and aluminum, ammonia production became steadily more efficient during the twentieth century. Newer ammonia factories use 30 percent less energy than plants from the 1970s,[359] and are approaching the theoretical minimum based on the processes that are in use today (see Figure 6). Note that most of the efficiency gains preceded the modern regulatory era and so were the result of competition, not government mandates.

[356] *Id.* at app. L.

[357] *Id.*

[358] This isn't just your mother's household cleanser; in 2006 146.5 million tons were produced as it is a common ingredient in a wide range of products. Ammonia – Wikipedia: The Free Encyclopedia, http://en.wikipedia.org/wiki/Ammonia (last visited Feb. 22, 2009).

[359] Int'l Fertilizer Indus. Ass'n, FERTILIZERS AND CLIMATE CHANGE 2 (2008), *available at* http://www.fertilizer.org/ifa/Home-Page/SUSTAINABILITY/Climate-change (follow "Download the entire module as a PDF file" hyperlink).

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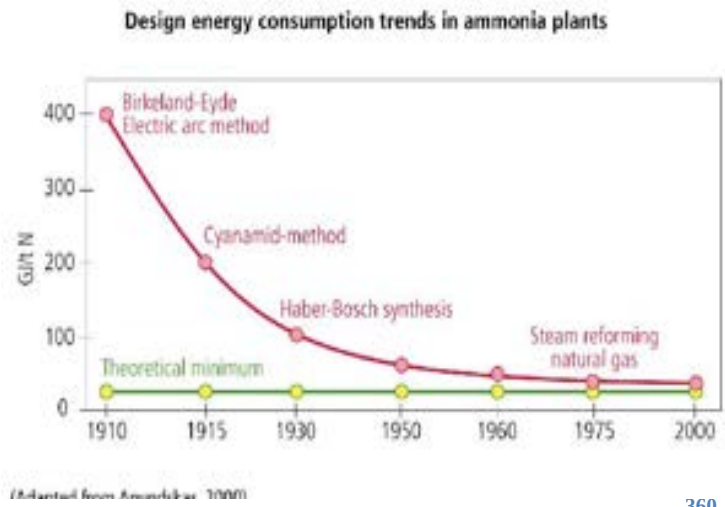

Figure 5 - Design energy consumption in ammonia plants, 1910-2000.[360]

4. Pulp and Paper

The second most energy intensive industry after aluminum is production of paper and paper board (15,100 Btu per pound).[361] Typically, two-thirds of the energy used by this industry is in the form of heat, with the remainder being consumed as electricity.[362] Unfortunately, the energy efficiency story in this industry is not as happy - the International Energy Agency (IEA) notes that the United States is the largest chemical pulp producer in the world, and has one of the world's most energy intensive pulp and paper industries, "at least partly due to the old age of [its] pulp and paper mills."[363]

Why has the pulp and paper industry not modernized its equipment and adopted more energy efficient production methods? A major part of the problem is that U.S. environmental regulations applicable to new sources act as a deterrent to replacing old plants and equipment. That is, a regulatory bias against new sources ("new source bias") leads to an "old plant effect," whereby companies would rather retain old inefficient plants by patching them up occasionally instead of replacing them with more efficient, but more capital intensive, new plants which would be made even more expensive because of the need to meet tighter regulatory standards.[364]

5. Appliances

The preceding sections describe both increasing energy efficiency in production of important goods and how regulatory barriers sometimes impede market forces pushing firms to adopt more efficient methods of production. We now turn to consumer goods, where increasing

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[360] *Id.*

[361] Int'l Energy Agency, WORLDWIDE TRENDS IN ENERGY USE AND EFFICIENCY: KEY INSIGHTS FROM IEA INDICATOR ANALYSIS 35 (2008), *available at* http://www.iea.org/Textbase/Papers/2008/Indicators_2008.pdf [hereinafter IEA].

[362] *Id.*

[363] *Id.* at 37.

[364] Jonathan Remy Nash & Richard L. Revesz, *Grandfathering and Environmental Regulation: The Law and Economics of New Source Review*, 101 NW. U. L. REV. 1678, 1708-1712; *see also id.* at 1691, 1692, 1694; Bruce Yandle, *Public Choice and the Environment*, POLITICAL ENVIRONMENTALISM 31, 36 (Terry L. Anderson, ed., 2000) ("The technology approach uses a batch process that is information-intensive and time-sensitive; it induces momentary discoveries then freezes the chosen technology.")

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energy efficiency has been an important policy goal for decades.

California began setting energy efficiency standards for appliances as early as 1978.[365] Beginning in 1980, a Federal labeling program for major household appliances ("EnergyGuide"), enacted into law in 1975, went into effect. In 1988, Department of Energy (DOE) started imposing federal standards under the National Appliance Energy Conservation Act (NAECA) of 1987[366] which was enacted, in large part, to preempt a multiplicity of state standards.[367] NAECA established minimum efficiency standards for many household appliances, such as refrigerators, refrigerator-freezers, and freezers; room air conditioners; fluorescent lamp ballasts; clothes washers and dryers; dishwashers; kitchen ranges and ovens; pool heaters; television sets (withdrawn in 1995);[368] and water heaters.[369] Congress set initial federal energy efficiency standards and established schedules for DOE to review these standards.[370] The Energy Policy Act of 1992 (EPAct) added standards for additional devices and systems, such as some fluorescent and incandescent reflector lamps, plumbing products, electric motors, commercial water heaters, and heating, ventilation, and air conditioning (HVAC) systems, and allowed the future development of standards for several other products.[371] It also provided for voluntary testing and consumer information programs for office equipment, luminaries, and windows.[372] The existence of a federal standard for energy or water conservation products generally preempts state standards, unless the state standard is identical to the federal standard.[373] These standards provide an opportunity to test the efficacy of the sort of mandates for energy efficiency proposed by green jobs advocates.

Among home appliances, refrigerators are among the largest energy consumers (see Figure 7). The U.S. experience with refrigerators is a way to test the home appliance standards' effectiveness.

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[365] IEA, ENERGY LABELS AND STANDARDS 107 (2000), *available at* http://www.iea.org/textbase/nppdf/free/2000/label2000.pdf; Regulations for Appliance Efficiency Standards Relating to Refrigerators, Refrigerator-Freezers and Freezers (adopted Nov. 3, 1976.). Available at http://www.energy.ca.gov/appliances/appl_regs_1976-1992/1977_12_22_Appl_Regs.pdf

[366] Lawrence Berkeley Nat'l Lab., U.S. Dep't of Energy, ENERGY EFFICIENCY STANDARDS: THE STANDARD SETTING PROCESS, *available at* http://ees.ead.lbl.gov/node/2 (last visited Feb. 22, 2009); National Appliance Energy Conservation Act of 1987. Pub. L. 100-12, Mar. 17, 1987, 101 Stat. 103).

[367] Lawrence Berkeley Nat'l Lab., *supra* note 366; *see also* National Appliance Energy Conservation Act of 1987 Pub. L. No. 100-12; IEA, *supra* note 365, at 173-75; Senate Report No. 100-6, at 2-3. Reprinted in U.S.C.C.A.N., 100th Cong.., 1st Sess., vol. 2, at 52-54.

[368] Bldg. Tech. Program, U.S. Dep't of Energy, 2008, Appliances and Commercial Equipment Standards: History of Federal Appliance Standards, http://www1.eere.energy.gov/buildings/appliance_standards/history.html (last visited Feb. 22, 2009); Weatherization Assistance Program Technical Assistance Ctr., Weatherization Program Notice 00-5, http://www.waptac.org/sp.asp?id=6897 (last visited Feb. 22, 2009) [hereinafter WAPTAC]; Lawrence Berkeley Nat'l Lab., *supra* note 366; *see also* National Appliance Energy Conservation Act of 1987 Pub. L. No. 100-12, Section 3 (amending section 322(a) of the Energy Policy and Conservation Act, 42 U.S.C. 6292(a)(1)-(13)).;

[369] Bldg. Tech. Program, *supra* note 368; WAPTAC, *supra* note 368; 42 U.S.C. 6292(a)(4) (water heaters).

[370] Bldg. Tech. Program, *supra* note 368; WAPTAC, *supra* note 368; Energy Conservation Standards, Section 5, Pub. L. 100-12.

[371] Bldg. Tech. Program, *supra* note 368; Energy Policy Act of 1992, Pub. L. 102-486, 102 Stat. 2776.

[372] *Id.*

[373] Bldg. Tech. Program, *supra* note 368; Preemption of State Regulations (Energy Conservation Program for Consumer Products) 10 C.F.R. 430.33 (2009) ("Any State regulation providing for any energy conservation standard, or water conservation standard… or other requirement with respect to the energy efficiency, energy use, or water use… of a covered product that is not identical to a Federal standard in effect under this subpart is preempted by that standard….").

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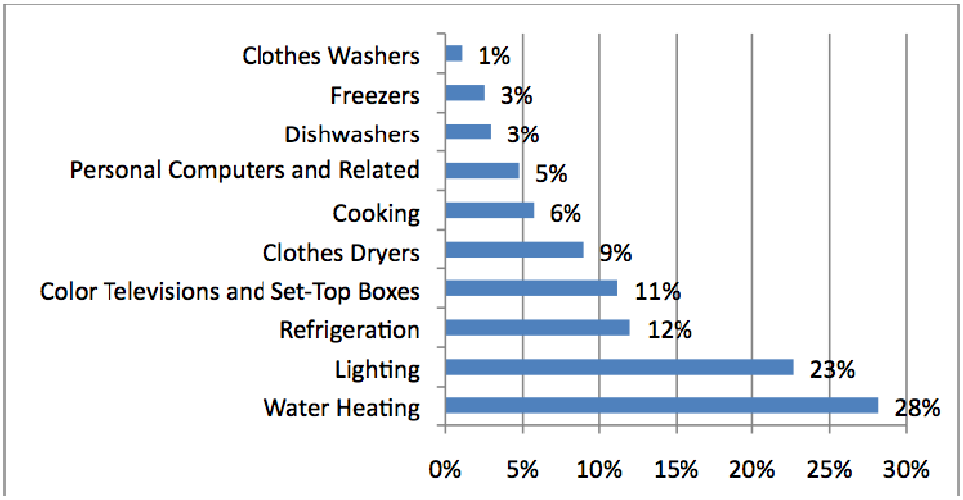

Figure 6 - Breakdown of energy consumption for home appliances listed above for 2007. Note that heating, ventilation and air conditioning are excluded. [374]

The first thing we notice in examining refridgerator energy efficiency is that the efficiency of household refrigerators has been increasing steadily at least since the mid-1970s (see Figure 8). Several analysts claim that "the majority of efficiency gains have been driven by the introduction of regulatory policies."[375] If true, this would support the introduction of the sort of mandate policies advocated by green jobs proponents.

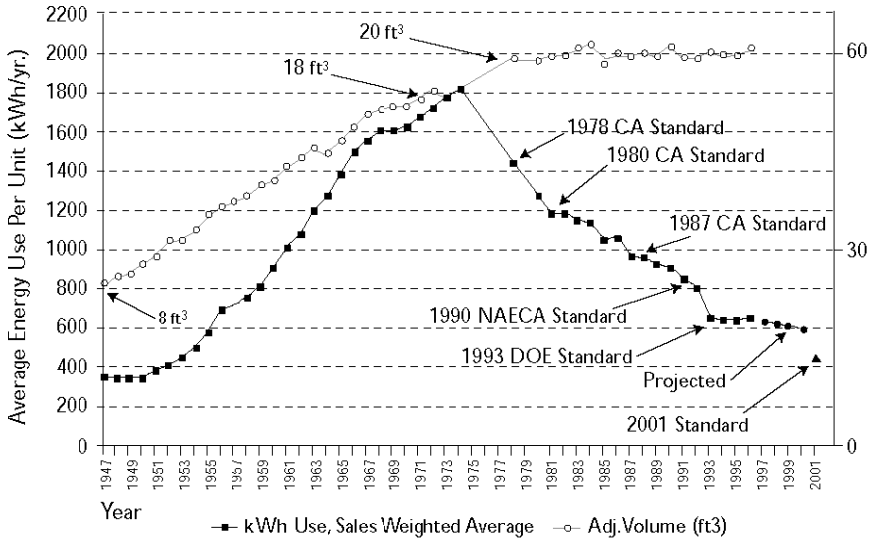

Figure 7 - Average energy use per unit, 1947-2000. [376]

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[374] Energy Info. Admin., U.S. Dep't of Energy, REPORT NO. DOE/EIA-0383(2009), ANNUAL ENERGY OUTLOOK 2009 EARLY RELEASE app. A, at 9, tbl.A4, *available at* http://www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf (full report forthcoming early 2009).

[375] Mark Ellis et al., *Do Energy Efficient Appliances Cost More?*, at 1129 (2007) (conference proceeding of ECEEE 2007 Summer Study: Saving Energy — Just Do It!), *available at* http://www.leonardo-energy.org/drupal/node/4038 (follow "Download" hyperlink); IEA, *supra* note 365, at 107-08.

[376] IEA, *supra* note 375, at 108.

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There are a number of reasons to believe that the improvements in refridgeration efficiency have not been due to the mandates. First, as Figure 8 shows, more than half the improvements preceded the imposition of Federal standards. Instead the change in slope of the line in Figure 8 appears in response to the first oil shock of 1973, which was reinforced by the run up in energy prices from 1979 to 1985.[377] Since the slope reverses prior to the policies, the policies cannot be the cause of the change. Second, even the post-federal policy efficiency improvements in the early- to mid-1980s can be ascribed to high energy prices reinforced by the ready availability of information to the consumer, via labeling requirements (that is, the EnergyGuides available for each appliance) rather than the efficiency guidelines. Third, a portion of these improvements particularly since the 1980s can be attributed to broader use of microchips and electronic controls, and the drop in in the price of such controls.[378] These factors were probably driven as much, if not more, by consumer desires and increased competition in the market place heightened by globalization and trade than by mandates.[379]

Moreover, the increase in the energy use per unit prior to the mid-1970s was not due to increased energy inefficiency in home refrigerators. Rather it was caused by increases in the sizes of refrigerators (see Figures 8 and 9), and progressive improvements in their features over time. These features include increases in the relative size of freezer sections, advent and greater penetration of frost free/ frost-proof units, and icemakers.[380] In short, consumers were getting more and better refrigerators for their money which, however, required greater energy to maintain and use. At a time of cheap energy prices, it is unsurprising that the market provided consumer goods that used energy to eliminate unpleasant chores such as defrosting freezers or enabled consumers to economize by storing food in larger freezer units.

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[377] EIA ANNUAL, *supra* note 183, at xxiv fig.20.

[378] W.J. Spencer & T.E. Seidel, *International Technology Roadmaps: The U.S. Semiconductor Experience*, *in* PRODUCTIVITY AND CYCLICALITY IN SEMICONDUCTORS: TRENDS, IMPLICATIONS, AND QUESTIONS -- REPORT OF A SYMPOSIUM 135, 135-136 (Dale W. Jorgenson & Charles W. Wessner eds., 2004); Nadejda M. Victor & Jesse H. Ausubel, 2002, *DRAMs as Model Organisms for Study of Technological Evolution*, 69 TECH. FORECASTING & SOC. CHANGE 243, 243-262 (2002).

[379] This was an era in which made-in-America goods were under increasing pressure from made-in-Asia goods, first from Japan, then Taiwan and Korea, and currently, China, Thailand, and Malaysia. Appliance manufacturing was part of this general trend. This led to greater pressures to improve the quality of products and reduce their cost to consumers.

[380] *See e.g.*, Ass'n of Home Appliance Mfrs, *Appliance Milestones*, http://www.aham.org/consumer/ht/a/GetDocumentAction/id/1408 (last visited Feb. 22, 2009); Electrolux Int'l Co., History of Frigidaire, http://www.frigidaire-intl.com/history.asp (last visited Feb. 22, 2009); *see also* Frigidaire Co., Frigidaire: 85th Anniversary, http://www.frigidaire.com.hk/download/~Frigidaire%20history%20-%2085th%20anniversary%202004.pdf (last visited Feb. 22, 2009).

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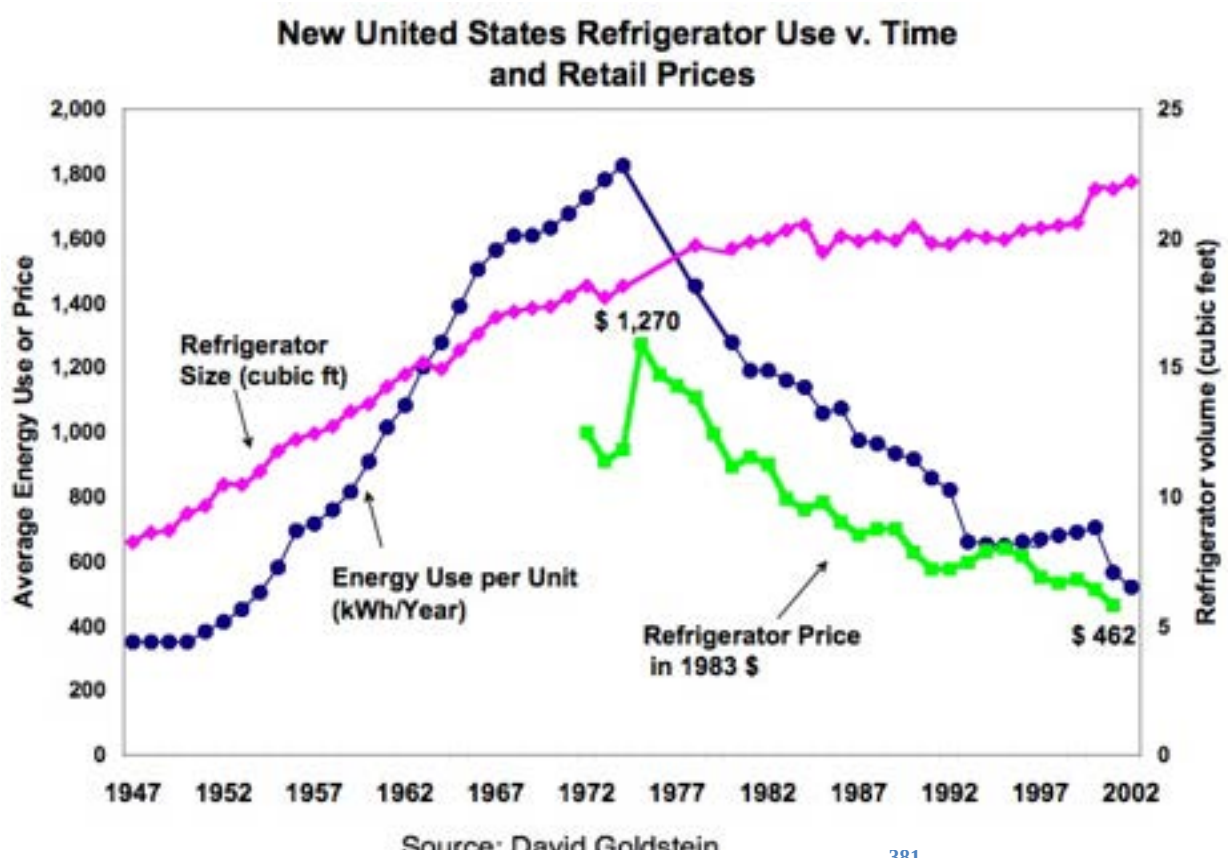

Figure 8 - New U.S. refrigerators: average annual energy use and retail prices, 1947-2002. [381]

Moreover, national refrigerator sales data indicate that following the introduction of refrigerator standards, real prices decreased, even after adjusting for changes in refrigerator size and amenities (see Figure 9). Normalised to food and freezer volumes, real refrigerator prices declined 8 percent from 1987 to 1993.[382] It has been argued, therefore, that energy standards have little or no effect on appliance prices. This, of course, is probably a testament to the price-lowering effects of competition (see Tables 4 and 5). It is possible that the price may have dropped further but for the standards. Alternatively, the price may not have been much different because reduced energy consumption is an amenity that the manufacturers would, in a competitive free market system, have provided of their own volition to consumers sooner or later regardless of the existence of any standards (as Tables 4 and 5 suggest).

Our analysis is consistent with the findings of the IEA examination of similar data across countries:

> Analysis … for 16 IEA countries shows that improved energy efficiency has been the main reason why final energy use has been decoupled from economic growth. Without the energy efficiency improvements that occurred between 1973 and 2005 in 11 of those countries, energy use would have been 58%, or 59 EJ, higher

[381] Arthur H. Rosenfeld, Cal. Energy Comm'n, *From the Lab to the Marketplace to Standards 22* (Mar. 21, 2007) (presentation to Berkeley Energy Res. Collaborative, Univ. of Cal., Berkeley), *available at* http://www.energy.ca.gov/2007publications/CEC-999-2007-014/CEC-999-2007-014.ppt.

[382] INT'L ENERGY AGENCY, *supra* note 375, at 109.

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> in 2005 than it actually was. However, since 1990 the rate of energy efficiency improvement has been much lower than in previous decades.
>
> These findings provide an important policy conclusion — that the changes caused by the oil price shocks in the 1970s and the resulting energy policies did considerably more to control growth in energy demand and reduce CO2 emissions than the energy efficiency and climate policies implemented in the 1990s.[383]

Our examination of energy consumption across both producer and consumer goods demonstrates three important lessons relevant to the evaluation of the claims of green jobs advocates. First, market forces provide a powerful incentive that drives greater efficiency with respect to costly inputs. This suggests that the net gains from green jobs policies mandating conservation are likely to produce fewer gains than the advocates claim since some, all, or even more than the efficiency gains claimed would occur even in the absence of mandates due to rising energy prices. Second, regulatory policies have, at least some of the time, slowed or blocked energy efficiency gains through unintended consequences. Adopting mandates is thus not risk free with respect to energy efficiency. Third, the green jobs literature does not even discuss the extensive data, including that summarized here, on increases in energy efficiency over time in the very industries they propose to regulate. This ahistorical approach casts serious doubt on the credibility of the green jobs literature. The authors of this paper are not experts on aluminum or refrigerators. Yet we were able to find from widely distributed, publicly available sources, extensive data on a crucial issue in the green jobs literature that is completely ignored by that literature. Such gaps suggest a need for great skepticism in evaluating the claims.

F. Market hostility

As we have shown in the preceding sections, underlying much of the green jobs literature is a deep hostility to market societies that favor voluntary and decentralized decision making over centralized decision making. There is a clear preference for centrally-directed programs built on mandates. The unprecedented increase in human welfare resulting from the industrial revolution is dismissed as "[t]he story of economic change is, however, also a story about political choices. More often than not, these choices have put the accumulation of wealth before the needs of the majority."[384] For example, the UNEP report insists that there is an:

> urgent need to make economies far more sustainable and thus to re-examine the prevailing production and consumption model. Concepts such as dematerialization, remanufacturing, 'zero-waste' closed-loop systems, durability, and replacing product purchases with efficient services (such as 'performance contracting') have been discussed for some time and tested in some instances, but by and large have yet to be translated into reality.[385]

In the eyes of green jobs proponents, the answer to a problem is almost always a massive public expenditure or regulation[386] rather than less intrusive interventions.

For example, although the UNEP report identified the obstacle to green building techniques as due in large part to an information problem—people's overestimation of the

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[383] IEA, *supra* note 3622, at 15.

[384] UNEP, *supra* note 5, at 278.

[385] *Id.* at 6.

[386] *Id.* at 278 ("Fortunately, the effort to create a Just Transition can draw encouragement from the long tradition of social and labor legislation put in place to protect the poor and disadvantaged, to facilitate the creation of socially necessary work, and to embed social solidarity in the fabric of economic life.").

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additional cost of green techniques—the recommendation is government action instead of the provision of information.[387] Perhaps nothing captures the contempt for improving the lives of ordinary people that is rampant in the green jobs literature better than the UNEP report's suggestion that rickshaws could become a significant form of transportation in a green economy.[388] This rejection of the basic principles underlying decentralized, market-based societies leads to a focus on mandates and conceptual errors that render the results of these studies untrustworthy.

The point of our critique in this section is not simply that the green jobs literature contains important methodological and conceptual errors, although we believe it does. The most important problem is that these errors are part of a systematic bias toward a society based on centrally-directed, politically-determined choices and away from one based on decentralized decision-making in the free marketplace.

Energy is involved in every aspect of our lives – energy policy analyst Robert L. Bradley, Jr. labels it "the master resource" – and the green jobs proposals to remake the energy industry will touch every corner of Americans' lives for generations if enacted. The sweeping proposals to alter free trade policies that have existed since the end of World War II and return to the devastating protectionism of the 1920s and 1930s will impoverish both Americans and our trading partners around the world. The redefinition of economic welfare to exclude consumer surplus – an economically incoherent approach – will lead to higher prices for virtually all goods. Before such a radical restructuring of the economies at home and abroad is undertaken, it needs to be openly debated and discussed. We believe that any such debate would result in an overwhelming rejection once the consequences are widely understood. Such changes should occur only after an open debate, not as the result of hidden assumptions.

IV. Ignoring technical literatures

We next examine three issues across the studies where the green jobs literature routinely ignores important technical literatures that raise issues that cast doubt on some of the assumptions underlying the green jobs program. We first examine the treatment of mass transit. Then we turn to the literature's examination of biofuels. Finally, we address the analysis of electricity generation. In each case, the literature consistently ignores important facts that cast doubt on its claims and engages in the sort of selective technological optimism we described earlier.

A. Mass transit

Green jobs proponents often advocate investment in expanding public transportation as a means of creating jobs with an environmentally friendly purpose. For example, CAP argues that building light rail and subway systems will produce "job growth in engineering, electrical work, welding, metal fabrication, and engine assembly sectors" and such investment in "both urban and rural communities … can be an engine for far broader economic activity."[389] More money for

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[387] *Id.* at 139 (UNEP notes that "Despite the overall social, economic, and environmental benefits, sustainable building practices remain a niche market. The cost of green building or the perceived cost is still a major barrier." People overestimate the costs of green building as 17 percent rather than 2-5percent or at most 10%, with 2-7 year paybacks.)

[388] *Id.* at 14 ("bicycles and modern bicycle rickshaws offer a sustainable alternative and create employment in manufacturing and transportation services."). The romantic view of happy workers pulling or peddling rickshaws for a joyful life in service to others is provided by wealthy UN employees who may ride in them when visiting poor countries to dispense wisdom.

[389] CAP, *supra* note 10, at 7-8.

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freight rail would "yield some immediate job gains in similar professions, creating substantial employment through both construction operations, alongside a down payment on more job creation over two years through improved maintenance and expansion of services."[390] In the short run, CAP advocates more bus and subway services, reducing public transportation fares, increasing federal support for mass transit "to deal with increased ridership," increased federal subsidies for employer-based mass transit incentives, and "[h]igher funding for critical mass transit programs currently bottlenecked for lack of federal dollars to encourage new ridership and more transportation choices."[391]

Similarly, the UNEP study contends that "a more sustainable system will have to be based on shorter distances. Reduced distances and greater density of human settlements enables a re-balancing of transportation modes—giving greater weight to public transit systems, as well as walking and biking. A modal shift away from private vehicles and toward rail and other public transport can generate considerable net employment gains, while reducing emissions and improving air quality."[392] The reason for this position is that it is an article of faith in the environmental community and government circles that mass transit (including different forms of rail travel) is more energy efficient than automobiles.[393] A cursory examination of the amount of energy used to move one passenger one mile (a "passenger mile") reinforces this belief.

Table 6 shows the energy needed per passenger mile for different modes of travel, arranged in the order of increasing efficiency. Data for the Toyota Prius are shown at the very end to provide a sense of the possibilities of increasing efficiencies for automobiles. This table shows that bus transit is generally less efficient than automobiles in general, while rail transit is more efficient than automobiles. However, Table 6 is misleading in several important respects. First, the raw numbers do not account for the fact that for rail transit to function, it is necessary to have an extensive bus feeder system that moves people to the rail stops. Taking this into account reduces, and may even eliminate, the savings in energy or reductions in CO2 emissions suggested by Table 6.

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[390] *Id.* at 8.

[391] *Id.* at 7.

[392] UNEP, *supra* note 5, at 13. Remember that "net employment gains" generally means higher costs due to lower productivity. Lower standards of living do not produce a greater level of sustainability for humans.

[393] *Id.* (UNEP: "Railways are more environment-friendly and labor intensive than the car industry."); *id.* at 164 ("Public transit is less energy and carbon-intensive than automobiles.") .

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Table 6 - Modal Energy Consumption and CO2 Emissions per Passenger Mile.[394]

Mode	**Energy Expended (BTUs)**	**Emissions (lbs. of CO_2)**
Ferry Boats	10,744	1.73
Automated Guideways	10,661	1.36
Light Trucks	4,423	0.69
Motor Buses	4,365	0.71
Trolley Buses	3,923	0.28
All Automobiles[395]	3,885	0.61
Light Rail	3,465	0.36
Passenger Cars	3,445	0.54
All Transit	3,444	0.47
Heavy Rail	2,600	0.25
Commuter Rail	2,558	0.29
Toyota Prius†	*1,659*	*0.26*

As O'Toole explains, transit agencies, to get people to the rail stations, typically increase bus service. Bus routes that used to serve the rail corridor are turned into feeder bus routes for the rail. However, since many people drive to rail stations, the average passenger load of the feeder buses tends to be smaller than it used to be for the corridor buses they replaced. Consequently, the advent of new rail transit lines could increase fuel usage because the average loads of the buses is reduced. For example, in 1991, before St. Louis built its light rail system its buses averaged more than 10 riders and consumed 4,600 BTUs per passenger mile. After the light-rail line opened, average bus loads in 1995 declined to 7 riders and energy consumed per passenger-mile increased to 5,300 BTUs. CO_2 emissions increased from 0.75 pounds to 0.88 pounds per passenger mile. Similarly, energy and CO_2 performance also deteriorated for Sacramento and Houston after rail transit was implemented.[396]

Second, even if rail transit results in a net reduction in energy use and CO_2 emissions, these improvements may be more than offset by the energy required to construct the rail system, and any resulting emissions. For example, Portland's North Interstate light rail line is estimated to save about 23 billion BTUs per year while its construction is estimated to consume 3.9 trillion BTUs, that is, it would take 172 years to offset the extra energy needed for construction.[397] Not

[394] Randal O'Toole, *Does Rail Transit Save Energy or Reduce Greenhouse Gas Emissions?*, POL'Y ANALYSIS, Apr. 14, 2008, at 4, *available at* http://www.cato.org/pubs/pas/pa-615.pdf.

[395] This figure includes passenger cars and light trucks.

[396] O'Toole, *supra* note 394, at 14-15.

[397] *Id.* at 15.

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only would this exceed the lifespan of the line, "long before 172 years, automobiles are likely to be so energy efficient that light rail will offer no savings at all."[398]

Similarly, Seattle's North Link light-rail line is estimated to save about 346 billion BTUs of energy in 2015 and 200 billion BTUs in 2030.[399] The energy savings will not repay the construction energy cost of 17.4 trillion BTUs until 2095.[400] Despite the claim that the light rail project should have about a 100-year lifespan, experience from the Washington and Bay Area metro systems indicate that the expected lifespan is probably closer to 40 years, before which additional capital and energy investments would need to be made to rebuild or replace the system.[401] Of course, any alternative to rail transit will also consume energy and emit CO_2. However, highways are likely more efficient than rail transit because, compared to the latter, each mile of urban highway typically carries far more passenger-miles. For instance, the average mile of light-rail line moved only 15 percent as many passenger miles as the average lane mile of urban freeway in rail regions.[402] Highways also carry millions of tons of freight that can share the cost of construction.[403]

Moreover, contrary to the claims of disproportionate spending on highways, mass transit already receives more than its share (as measured by passenger-miles) of government funds. Data for 2001-2003 from the Bureau of Transportation Statistics indicate that although mass transit is responsible for less than 1 percent of the total passenger miles moved in the United States, it receives about 23 percent of the Federal Transportation Grants (in dollars).[404] By contrast, highways which are responsible for almost 90 percent of the passenger miles, receive about 70 percent of the grants.[405]

Such disproportionate spending on transit might be justifiable were mass transit to provide net social value. However, studies indicate that most transit systems may not be socially desirable.[406] As Winston and Maheshri observe:

> Despite a decline in its mode share, investment to build new urban rail transit systems and extend old ones continues… [Based on estimates of] the contribution of each U.S. urban rail operation to social welfare based on the demand for and cost of its service….[w]e find that with the exception of BART in the San Francisco Bay area, every system actually reduces welfare and is unable to become socially desirable even with optimal pricing or physical restructuring of its network. We conclude rail's social cost is unlikely to abate because it enjoys powerful political support from planners, civic boosters, and policymakers."[407]

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[398] *Id.*

[399] *Id.*

[400] *Id.*

[401] *Id.*

[402] *Id.* at 16.

[403] *Id.*

[404] Bureau of Transp. Statistics, U.S. Dep't of Transp., NATIONAL TRANSPORTATION STATISTICS 2008, tbls.1-37 & 3-30b (William H. Moore ed., 2008), *available at* http://www.bts.gov/publications/national_transportation_statistics/pdf/entire.pdf. This ratio is consistent with the 2009 stimulus bill; it allocates $27 billion for highway projects and $12 billion for rail and mass-transit projects. Bob Johnson, *For Road Crews, Stimulus Promises More Opportunity*, WASH. POST, Feb. 15, 2009, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2009/02/15/AR2009021500551.html?hpid=sec-business.

[405] Bureau of Transp. Statistics, *supra* note 404, at tbls.1-37 & 3-30b.

[406] Clifford Winston & Vikram Maheshri, *On the Social Desirability of Urban Rail Transit Systems*, 62 J. URBAN ECON. 362, 362-383 (2007); O'Toole, *supra* note 394.

[407] Winston & Maheshri, *supra* note 406, at 362.

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They go on to note that:

> Unfortunately, transit systems have been able to evolve because their supporters have sold them as an antidote to the social costs associated with automobile travel, in spite of strong evidence to the contrary.[40] As long as rail transit continues to be erroneously viewed in this way by the public, it will continue to be an increasing drain on social welfare.[408]

To summarize, with regard to reduced energy usage and lower greenhouse gas emisions, mass transit provides few if any benefits over the automobile. In fact, it may even be counterproductive if one adds in the energy consumed during construction. Consequently, it makes little sense to continue to subsidize this form of transportation for the masses, and even less sense to add to these subsidies. In other words, it is the wrong sort of infrastructure on both economic and environmental grounds.

One logical fallacy in much of the discussion about private cars is the asymmetric treatment of innovation, which we have identified, is a consistent problem in the green jobs literature. It is logically inconsistent to assume that technological progress will solve the current problems in generating and transmitting wind or solar power while simultaneously assuming no progress in solving problems of powering private automobiles.[409] The rapid diffusion of hybrid vehicles and the projected introduction of fully electric vehicles is evidence that technological innovation is not necessarily biased against automobiles.

In the historical record, mass transit is an anomaly, occupying a dominant role for the brief period when its greater speed was enough to outweigh its inconvenience. Further, mass transit's most lasting effect was to facilitate the *decentralization* of metropolitan areas by allowing individuals to live farther than walking distance from their place of employment.[410]

Even in the unlikely event that households suddenly reduced their reliance on private automobiles, their switch to mass transit will have no dramatic effect on the metropolitan structure. A study of the various explanations of metropolitan decentralization in the United States found that a 10 percent reduction in households owning one or more cars would only reduce the size of a metropolitan area by about 0.5 percent. [411] For a typical metropolitan area of about 160 square miles, this implies a reduction in size of less than 1 square mile, hardly the source of a substantial new demand for buses, much less biking and walking.

B. Biofuels.

Green jobs proponents put a great deal of emphasis on developing biofuels to replace petroleum. For example, the CAP report mentions several time the need to "invest" huge sums of taxpayers' money in "next-generation biofuels," "advanced biofuels," and "low-carbon" and

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[408] *Id.* at 381.

[409] There is a bit of schizophrenia in the green policy view. Cars are should be eliminated in favor of mass transit and rickshaws because they are dreadful polluters, but that the same time they should increase their miles per gallon of gasoline consumed. The green policy advocates are positive the car companies can do much better, if only they put their minds to it.

[410] Bogart, *supra* note 223, at 41.

[411] Robert Wassmer, *Causes of Urban Sprawl in the United States: Auto Reliance as Compared to Natural Evolution, Flight from Blight, and Local Revenue Reliance*, 27 J. POL'Y ANALYSIS & MGMT. 536, 536 (2008).

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"cellulosic biofuels"[412] without further explanation than the terms just quoted.[413] The UNEP report notes that the issue is not so clear: "There is vigorous and contentious debate over the economic and environmental merits of biofuels, including the question of direct competition with food production."[414] While the UNEP report addresses some concerns, the others presume biofuels to be the wave of the future. The discussions exhibit technological optimism about "advanced" biofuels, while continuing technological pessimism about fossil fuels, and generally ignore important issues revealed by the history of the efforts to develop biofuels. These problems are particular evident with biofuels because we already know a great deal about how government programs to expand biofuel production operate.

[412] "The term "cellulosic biofuel" means renewable fuel derived from any cellulose, hemicellulose, or lignin that is derived from renewable biomass and that has lifecycle greenhouse gas emissions, as determined by the Administrator, that are at least 60 percent less than the baseline lifecycle greenhouse gas emissions." 42 U.S.C. 7545(o)(1)(E) (2009). This problem is noted in some of the literature itself. *See, e.g.* UNEP, *supra* note 5, at 33 ("Many studies that lay out pathways toward a sustainable economy declaim a future of green jobs—but few present specifics. This is no accident. There are still huge gaps in our knowledge and available data.").

[413] CAP, *supra* note 10, at 2, 5, 8 & 25 ("next-generation"); *id.* at 6, 8 & 9 ("advanced"); *id.* at 29 ("low-carbon" and "cellulosic").

[414] UNEP, *supra* note 5, at 118. This report dedicates ten pages to the issue at this point, noting that increased use of biofuels threatens the affordability of food for the poor and may cause increased cultivation of land. So there are a host of economic and environmental tradeoffs. Of greatest concern is that biofuels will come from mechanized agriculture; the report advocates using labor-intensive methods of cultivation of the plants devoted to such use.

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Table 7 - Energy subsidies not related to electricity production. [415]

Fuel category	Fuel consumption (quadrillion Btu)	FY 2007 subsidy and support (million 2007 $)	Subsidy per million Btu (2007 $)
Coal	1.93	78	0.04
Refined coal	0.16	214	1.35
Natural gas and petroleum liquids	55.78	1,921	0.03
Ethanol/Biofuels	0.57	3,249	5.72
Geothermal	0.04	1	0.02
Solar	0.07	184	2.82
Other renewables	2.50	360	0.14
Hydrogen	n.a.	230	NM
Total fuel specific	60.95	6,237	NM
Total Non-Fuel Specific	NM	3,597	NM
TOTAL END-USE & NON-ELECTRIC ENERGY	NM	9,834	NM

NOTE: NM = not meaningful

In Fiscal Year 2007, ethanol and biofuels received federal subsidies and support of at least $3.25 billion in the United States alone.[416] (See Table 7). Note that this estimate does not include the value associated with the Renewable Fuel Standard (RFS) mandate and so underestimates the total subsidy. Since then, Congress, with one minor downward adjustment, has greatly expanded the scope and level of biofuel subsidies in the future. Under the 2008 Farm Bill, gasoline suppliers will receive 45 cents per gallon of ethanol, down from 51 cents per gallon. However, it provided special subsidies for cellulosic ethanol which, at the time of passage of the Farm Bill, had yet to be manufactured commercially.[417] Under it, refiners will get $1.01 per gallon of ethanol, and growers will get $45 per ton of biomass.[418] In addition, domestic

[415] Source: Energy Information Administration, FEDERAL FINANCIAL INTERVENTIONS AND SUBSIDIES IN ENERGY MARKETS 2007. Report #:SR/CNEAF/2008-01 (2008)available at http://www.eia.doe.gov/oiaf/servicerpt/subsidy2/index.html.

[416] Energy Info. Admin., *supra* note 170, at xviii.

[417] Tom Capehart, CONG. RESEARCH SERV. REPORT NO. RL34738, RENEWABLE ENERGY POLICY IN THE 2008 FARM BILL, at CRS-4 (2008), *available at* http://assets.opencrs.com/rpts/RL34738_20081107.pdf. I.R.C. Section 40(h)(2) (2008).

[418] *Id.*; I.R.C. Section 40(b)(6)(B) (2008) (Cellulosic biofuels credit). 7 U.S.C. 8111(d)(2)(B) ($45 per ton maximum biomass assistance).

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suppliers of ethanol continue to be protected from imports via an import duty of 54 cents per gallon.[419]

The changes in the Farm Bill followed the upward revision of the Renewable Fuels Standard (RFS) under the Energy Independence and Security Act of 2007.[420] Under the Energy Policy Act of 2005, the RFS required the amount of renewable fuel in gasoline to increase from 4 billion gallons in 2006 to 7.5 billion gallons in 2012. The 2007 EISA increased this from 9 billion in 2008 to 36 billion gallons by 2022.[421] Corn ethanol's share of the RFS is effectively capped at 15 billion gallons per year.[422] The EISA also specifically mandates the use of 16 billion gallons of cellulosic biofuel by 2022 and 1 billion gallons of biomass-based diesel fuel annually by 2012, although the EPA Administrator has the authority under certain conditions to waive these requirements in whole or part.[423] Recently, the request for a waiver from the Governor of Texas to reduce the effect of the RFS on food and feed prices (and the Texas economy) was denied by the Administrator.[424]

Support for subsidizing biofuels (including ethanol) is based on one fact and many oversights. The fact is that that biofuels are the products of photosynthesis, that is, they are derived from vegetation that takes carbon dioxide from the atmosphere and converts it into biomass which then may be processed into liquid or gaseous biofuels (such as ethanol) that, when burnt, provide energy to meet human needs while returning the carbon dioxide to the atmosphere. Thus, in theory, from the perspective of greenhouse gases, the production and consumption of a biofuel should be part of a closed loop system, with no net emissions of CO_2, the primary anthropogenic greenhouse gas (GHG) in the atmosphere.[425] As will be shown below, however, reality is much more complex. Several unintended consequences are associated with the use of biofuels.[426] Belated recognition of these has led to the current emphasis on cellulosic ethanol, which biofuel supporters believe can reduce, if not avoid, some of these consequences.[427]

Assuming that the biomass is grown as part or all of a crop, as opposed to being scavenged off the landscape, it takes extra energy to grow the biomass. This energy is provided in the form of fertilizers and pesticides needed to increase crop yields, and fuels used to operate the machinery needed to cultivate, seed, and harvest the crop. If the energy is not needed in

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[419] Capehart, *supra* note 417, at CRS-5; Food, Conservation, and Energy Act of 2008, Pub. L. 110-234. Ethanol Tariff Extension (through 1/1/2011), 122 Stat. 923, at 1516. For actual tariff imposed, see http://www.eia.doe.gov/oiaf/aeo/otheranalysis/aeo_2008analysispapers/ffttc.html.

[420] Capehart, *supra* note 417, at CRS-1, CRS-2; Pub. L. 110-140, Dec. 19, 2007, 121 Stat. 1492.

[421] Brent D. Yacobucci, Cong. Research Serv., REPORT NO. RS22870, WAIVER AUTHORITY UNDER THE RENEWABLE FUEL STANDARD (RFS), at CRS-2 (2008), *available at* http://www.nationalaglawcenter.org/assets/crs/RS22870.pdf.; 42 U.S.C. 7545(o)(2)(B)(i) (2007); 42 U.S.C. 7545(o)(2)(B)(i)(I) (2009).

[422] Yacobucci, *supra* note 421, at CRS-2; 42 U.S.C. 7545(o)(2)(B) (2009).

[423] *See, e.g.*, Yacobucci, *supra* note 421, at CRS-3.

[424] *EPA Rejects Landmark Attempt to Cut Ethanol Mandate*, CLIMATE WIRE, Aug. 8,2008, http://www.eenews.net/climatewire/2008/08/08/archive/3?terms=rfs+perry+waiver.

[425] *E.g.*, Want to Know It? Answers to Life's Questions, Advantages of Biofuels, http://wanttoknowit.com/advantages-of-biofuels/ (last visited Feb. 22, 2009); The Administrator may use the traditional administrative rulemaking process to modify Congressionally-mandated greenhouse gas reduction percentages, but not below 40 percent for advanced biofuel & biomass diesel; 10 percent for renewable fuel; and 50 percent for cellulosic biofuel. 42 U.S.C. 7545(o)(4) (2009).

[426] Indur M. Goklany, *Unintended Consequences*, Int'l Herald Trib., Apr. 24, 2007, at 9, *available at* http://www.iht.com/articles/2007/04/23/opinion/edgolany.php.

[427] Dale Buss, *Bush Comments Lend Another Boost to Cellulosic Ethanol*, EDMUNDS AUTO OBSERVER, 29 Feb. 2008, http://www.autoobserver.com/2008/02/bush-comments-lend-another-boost-to-cellulosic-ethanol.html.

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concentrated - and preferably liquid - form, it is probably more efficient overall to burn the biomass as wood without further processing. Otherwise extra energy will be required to convert the biomass into more concentrated liquid forms (e.g., methanol, ethanol, or biodiesel). Consequently the net energy obtained from such biofuels is significantly less than the gross energy produced when it is finally consumed.

The uncertainties related to the net energy balance associated with the life cycle of biofuel production and use has led to a cottage industry in estimating whether the production of particular liquid biofuels produces any net energy benefit.[428] The answers vary with assumptions regarding, among other things, the specific crops used to grow the biomass, crop yields, cultivation practices, the amount of energy consumed at the farm and in ethanol processing, whether the byproducts and residues can be used to supplement food or feed, and the amount of greenhouse gas or energy credit that should be given for that. Currently, however, the accepted wisdom is that substituting at least some biofuels for gasoline does indeed produce net energy savings.[429]

Even if biofuels produce net usable energy, it does not follow that their use would necessarily reduce greenhouse gas emissions. First, nitrogenous fertilizers which are used as inputs to grow energy crops, are a primary source of nitrous oxides, a greenhouse gas (GHG) that is pound-for-pound 300 times more effective as a greenhouse gas than carbon dioxide. [430] Second, cultivation of any crop generally involves disturbing the soil. Globally, there is more carbon stored in the soil than in the atmosphere. Disturbing the soil leads to decomposition or oxidation of the stored carbon, which results in carbon dioxide emissions to the atmosphere.[431] Accordingly, clearing any vegetated land (such as forests and grasslands) to raise energy crops initially adds to the atmospheric concentration of GHGs, which some have labeled as a "carbon debt" that would have to be "repaid" by the net reductions in carbon dioxide emissions resulting from the subsequent use of any biofuels produced from that land.[432] Fargione et al. estimate that it would take 93 years to repay the carbon debt if central U.S. grassland is converted to cropland for corn (for ethanol), and 48 years if land enrolled in the Conservation Reserve Program (CRP) for 15 years was converted for corn ethanol.[433] However, if biofuels were made from waste biomass or from biomass grown using perennials on CRP lands, then the carbon debt, if any, could be repaid in as little as a year.[434]

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[428] *E.g.*, David Pimentel & Tad W. Patzek, *Ethanol Production Using Corn, Switchgrass, and Wood; Biodiesel Production Using Soybean and Sunflower*, 14 NAT. RESOURCES RES. 65, 65-76 (2005); Tad W. Patzek, *Thermodynamics of the Corn-Ethanol Biofuel Cycle* (2006), *available at* http://petroleum.berkeley.edu/papers/patzek/CRPS416-Patzek-Web.pdf (updated version of Tad W. Patzek, *Thermodynamics of the Corn-Ethanol Biofuel Cycle*, 23 CRITICAL REVS. IN PLANT SCI. 519, 519-67 (2004)); Justus Wesseler, *Opportunities (Costs) Matter: A Comment on Pimentel and Patzek Ethanol Production Using Corn, Switchgrass, and Wood; Biodiesel Production Using Soybean and Sunflower*, 35 ENERGY POL'Y 1414, 1414-16 (2007); Michael Wang, Argonne Nat'l Lab., *Key Differences Between Pimentel/Patzek Study and Other Studies* (2005), *available at* http://eerc.ra.utk.edu/etcfc/docs/pr/MichaelWangResponse~7-19-05.doc.

[429] *See, e.g.*, Searchinger et al., *supra* note 81, at 1238.

[430] Intergovernmental Panel on Climate Change, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 35 (2007), *available at* http://www.ipcc.ch/ipccreports/ar4-wg1.htm.

[431] *See, e.g.*, Jörn P.W. Scharlemann & William F. Laurance, *How Green Are Biofuels*, 319 SCIENCE 43, 43-44 (2008) [hereinafter Scharlemann & Laurance, *Biofuels*]; Searchinger et al., *supra* note 81, at 1238.

[432] Joseph Fargione et al., *Land Clearing and the Biofuel Carbon Debt*, 319 SCIENCE 1235, 1235-38 (2008); Searchinger et al., *supra* note 81.

[433] Fargione et al., *supra* note 432.

[434] *Id.* at 1236, fig.1D.

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Searchinger et al. used a worldwide agricultural model to estimate emissions from the conversion of habitat to cropland as farmers worldwide respond to higher prices for food commodities set in motion with the artificially created demand for biofuels.[435] This increased demand would result in greater conversion of forest and grassland to new cropland to replace the grain (or cropland) diverted to biofuels. Specifically, they found that:

> corn-based ethanol, instead of producing a 20% savings, nearly doubles greenhouse emissions over 30 years and increases greenhouse gases for 167 years. Biofuels from switchgrass, if grown on U.S. corn lands, increase emissions by 50%. This result raises concerns about large biofuel mandates and highlights the value of using waste products.

Neither the Searchinger or Fargione papers are definitive, and both have come under criticism.[436] Alternative assumptions regarding the type of tilling system or other agronomic practices, for instance, may change the results dramatically.[437] The key point is that there is an active scientific controversy about the net impact of biofuels, a controversy that is barely acknowledged in the green jobs literature. The green jobs reports simply assert that "next-generation biofuels" deserve massive public support.[438] Ignoring an ongoing debate over whether the policies in question actually produce a net benefit is a serious problem.

An even larger environmental problem for biofuels than whether they actually reduce greenhouse gases is that the biomass used for feedstock is generally harvested as part of a crop. If grown as a crop, it is plagued by all the environmental problems associated with agriculture, namely, it contributes to soil erosion, pesticide residues, and nutrient run-off from the fertilizers, all of which worsens water quality. Even more important, biofuel crops divert land and freshwater from other uses.[439] In fact, conversion of land and freshwater to agriculture is the single largest threat to the conservation of terrestrial and freshwater species and biodiversity in the United States and worldwide,[440] and growing energy crops to produce biofuels only adds to these pressures.

Scharlemann and Laurance reported in *Science* on a Swiss study by Zah et al.[441] that compared, for 29 kinds of fossil fuels and biofuels, the net greenhouse gas emissions and "total" environmental impacts based on life cycle analysis.[442] The total environmental impacts are estimated by aggregating estimates of natural resource depletion, and damage to human health and ecosystems into a single indicator. While the results no doubt are sensitive to the specific impacts included in the study, the methodologies used to estimate these impacts, the aggregation

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[435] Searchinger et al, *supra* note 81.

[436] Bruce Dale, Biofuels, *Indirect Land Use Change and Life Cycle Analysis: Do We Now Know Enough to Know That We Don't Know?* (July 25, 2008) (presentation to Low Carbon Fuels Webinar), *available at* http://www.ncbioconsortium.org/vertical/Sites/%7B2CDC9F83-EF8C-48DE-BCA4-C099640B955B%7D/uploads/%7BA292DD0E-EF23-4121-B96C-973EDC3CDC2B%7D.PDF.

[437] *Id.*

[438] CAP, *supra* note 10, at 2, 5, 8, 25.

[439] *See, e.g.*, Searchinger et al., *supra* note 81; Carey W. King & Michael E. Webber, *Water Intensity of Transportation*, 42 ENVTL. SCI. & TECH. 7866, 7866-72 (2008).

[440] MEA, *supra* note 82, at 117; Goklany, *supra* note 82, at 941.

[441] Rainer Zah, *LCA of Biofuels in Switzerland: Environmental Impacts and Improvement Potential?* (Aug. 28, 2007) (presentation to LCM 07 Zürich), *available at* http://www.lcm2007.org/presentation/Tu_2.07-Zah.pdf.

[442] Scharlemann & Laurance, *Biofuels*, *supra* note 431, at 43-44; Jörn P.W. Scharlemann & William F. Laurance, *How Green Are Biofuels?* SCI. SUPPORTING ONLINE MATERIAL (2008), http://www.sciencemag.org/cgi/data/319/5859/43/DC1/1 [hereinafter Scharlemann & Laurance, ONLINE].

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methodology, the weights employed in reducing the different types of impacts to a common metric, the fact that the study was based on 2004-vintage technologies, and a host of other assumptions, the results indicate that when broader environmental factors are considered, many biofuels may create substantially greater environmental problems than the fossil fuels they would replace. Furthermore, these environmental problems may not be offset by reductions in greenhouse gas emissions (see Figure 10).

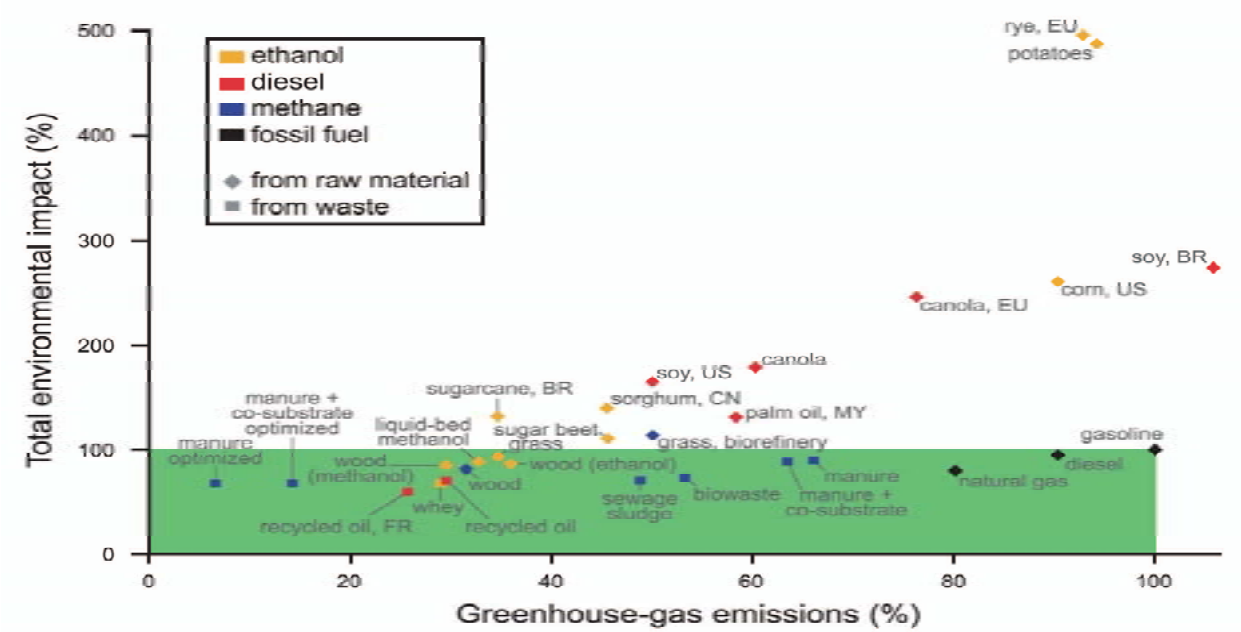

Figure 9 - Greenhouse-gas emissions versus overall environmental impacts of various fossil- and bio-fuels, scaled relative to gasoline. [443]

Counterintuitively, soy- and corn-based biofuels grown in the U.S. have substantially higher environmental impacts than natural gas, diesel, and gasoline despite reductions in GHG emissions. This brings into question one of the central premises for subsidizing or mandating biofuels.

These are not just theoretical concerns. In 2007, 25 percent of the U.S. corn crop ended up as ethanol (see Figure 11). This has increased the pressure to take land out of the Conservation Reserve Program (CRP) and cultivate it once again.[444] In South Dakota alone**,**

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[443] Scharlemann & Laurance, *Biofuels*, *supra* note 431(based on Zah, *supra* note 441). Note: The origin of biofuels produced outside Switzerland is indicated by country codes: Brazil (BR), China (CN), European Union (EU), France (FR), Malaysia (MY), and United States (US). Fuels in the shaded area are considered advantageous in both their overall environmental impacts and greenhouse-gas emissions.

[444] Dan Morgan, *Subsidies Spur Crops on Fragile Habitat*, WASH. POST, Dec. 7, 2008; David Streitfield, *As Prices Rise, Farmers Spurn Conservation Program*, N.Y. TIMES, Apr. 9, 2008.

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about 425 square miles of grassland were turned into farmland between 2002 and 2007 partly because of the demand for corn to be used in ethanol stimulated by subsidies and mandates against a backdrop of higher oil prices due to the petroleum demand from China, India, and other economies that were then firing on all cylinders.[445] In fact, cropland devoted to corn and soybean, which is used for biodiesel, has increased sharply in the U.S. over the past few years, as indicated by Figure 12.

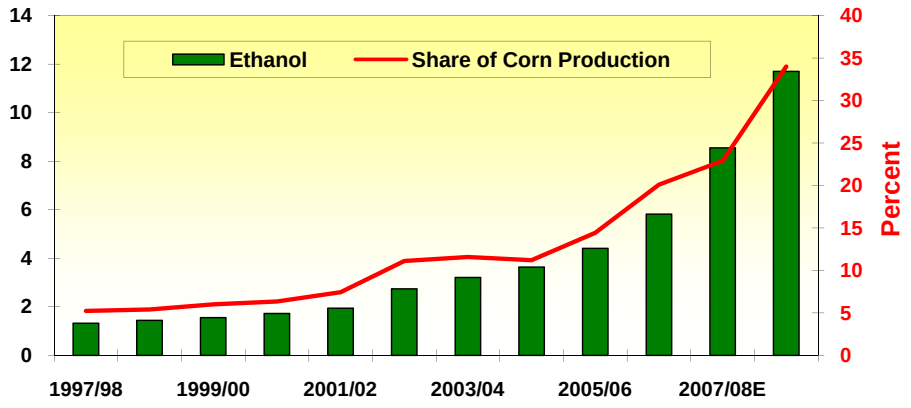

Figure 10 - Growth in US ethanol production (in billions of gallons), and the share of corn production going to ethanol. [446]

[445] Morgan, *supra* note 444; Streitfeld, *supra* note 444.

[446] Hunter H. Moorehead, The Farm Bill and Beyond, 2008 MAEA Annual Meeting, (Oct. 31, 2008).

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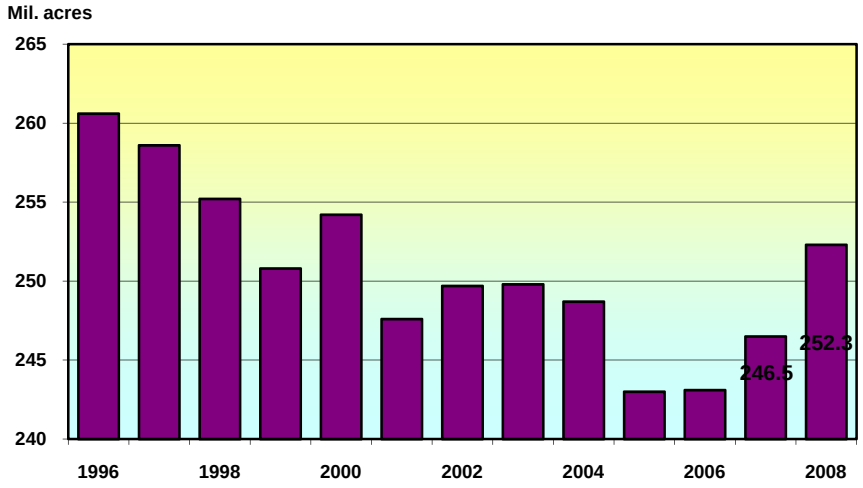

Figure 11 - US cropland, 1996-2008. Includes wheat, feed grains, soybeans, upland cotton, and rice.[447]

Not surprisingly, the total amount of U.S. cropland devoted to grains has increased over the last few years, with crops now being planted on land that would otherwise not have been cultivated with the help of biofuel subsidies and mandates (see Figure 12, which also confirms Searchinger et al.'s basic approach).

In addition to questions about the net environmental benefits of biofuels, scientists also have serious issues relating to the impacts of biofuels on the world's poor. For a literature that so regularly expresses concern for exactly these populations, it is surprising that this problem receives so little attention.[448] The analyses represented in Figure 12, as well as the analyses of Fargione et al.[449] and Searchinger et al.,[450] do not consider these impacts of biofuel subsidies and mandates on global food production, and any resulting consequences for global hunger and malnutrition. Consideration of these factors further reduces the attractiveness of biofuels, and associated subsidies and mandates.

For example, the increased demand for corn for ethanol has additional "multiplier" effect on other food and feed commodities by increasing the price of all corn-based products, including feed for animals, and many foods consumed by human beings. Ethanol-related demand for corn has been linked to increases in the price of eggs, milk, meat, cereal, candy bars and any product containing corn-based sugars or starches, to name just a few.[451]

The food price increases are clearly linked to corn-based ethanol. Although commodity prices have declined more than 50 percent since the middle of 2008, the UN Food and

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[447] Source: Hunter H. Moorehead, *The Farm Bill and Beyond*, 2008 MAEA Annual Meeting. (October 31, 2008). Note: 2008 planted area based on September 12, 2008, *Crop Production* report.

[448] The UNEP report is the only one to address this issue, noting that the FAO is concerned about the percent of cropland that could be turned from feeding people to producing fuel, but the report comes down in favor of more biofuels so long as done in a labor-intensive manner with respect for water supplies and such. UNEP, *supra* note 5, at 117-26.

[449] Fargione et al., *supra* note 432.

[450] Searchinger et al, *supra* note 81.

[451] *E.g.*, Siobhan Hughes, Ian Talley & Anjali Cordeiro, *Corn Ethanol Loses More Support*, WALL ST. J., May 3, 2008, at A4.

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Agricultural Organization's Food Price Index was 28 percent higher in October 2008 than two years previously.[452] These price increases, fueled in part by the diversion of cropland to produce energy rather than food (and feed) fueled by energy subsidies and mandates in the United States and the EU, reduced the availability of food for millions in the developing world.[453]

As a result, the FAO estimates that 963 million people worldwide were suffering from chronic hunger in 2008, an increase of 115 million compared to the 2003-2005 period.[454] This marks a reversal of one of mankind's signal achievements of the 20th century — the reduction of hunger in developing countries. The proportion of the developing world's population suffering from chronic hunger, which had declined from around 30-35 percent in 1969-1971[455] to 16 percent in 2003-2005, has now increased to about 18 percent.[456] As the FAO's *State of Food and Agriculture* report notes, biofuel production would have a significant negative impact on hunger globally but provide relatively modest energy gains.[457]

Many have argued that the problems associated with using crops and cropland for producing biofuels can be avoided by using cellulose as feedstock.[458] However, tilting the field to help cellulosic ethanol, whether directly through subsidies or indirectly through mandates, will inevitably make it more attractive for farmers to divert land and water to grow fuel rather than food.[459] As a result, some portion of the resources that would otherwise be used for food production would go toward fuel production. This is exactly what is indicated by Searchinger et

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[452] Food & Agric. Org., HIGH-LEVEL CONFERENCE ON WORLD FOOD SECURITY: THE CHALLENGES OF CLIMATE CHANGE AND BIOENERGY (2008), *available at* http://www.fao.org/fileadmin/user_upload/foodclimate/HLCdocs/HLC08-Rep-E.pdf [hereinafter FAO, HIGH-LEVEL CONFERENCE].

[453] Food & Agric. Org., STATE OF FOOD INSECURITY IN THE WORLD 2008: HIGH FOOD PRICES AND FOOD SECURITY – THREATS AND OPPORTUNITIES 11 (2008), *available at* ftp://ftp.fao.org/docrep/fao/011/i0291e/i0291e00.pdf [hereinafter FAO, INSECURITY] (The FAO estimates that in 2007-2008, 4.7 percent of global cereal production will be used for biofuel production).

[454] *Id.* at 2; FAO, HIGH-LEVEL CONFERENCE, *supra* note 452.

[455] In 2008, the FAO modified its recommendations for the minimum daily energy requirement (MDER) for an individual in order for the individual to survive and fulfill basic functions. The MDER varies with the country, age group, and levels of daily activities a person may indulge in. This change, along with new population estimates and other methodological changes, resulted in a net reduction in earlier estimates for the total number of chronically undernourished in developing countries of less than 8 percent for 1990-1992. FAO, INSECURITY, *supra* note 453, at 45-47. Estimates for 1969-1971, previously estimated at 37 percent, were, however, not revisited. Goklany, *supra* note 241. Based on the changes in numbers using the latest methodologies and assumptions, 30-35 percent would, therefore, seem to be a reasonable approximation for 1969-1971.

[456] FAO, INSECURITY, *supra* note 453.

[457] *Id.*

[458] Former President Bush stated that, "The solution to the issue of corn-fed ethanol is cellulosic ethanol," Amanda Paulson, *U.S. Eyes Shift Away From Corn Ethanol*, CHRISTIAN SCI. MONITOR, May 1, 2008, at 3, *available at* http://www.csmonitor.com/2008/0501/p03s03-usec.html. That is, there are "good" biofuels and "bad" biofuels. This argument was most cogently summarized by a *New York Times* editorial:

> It is time to end an outdated tax break for corn ethanol and to call a timeout in the fivefold increase in ethanol production mandated in the 2007 energy bill. . . .
>
> This does not mean that Congress should give up on biofuels as an important part of the effort to reduce the country's dependency on imported oil and reduce greenhouse gas emissions. What it does mean is that some biofuels are (or are likely to be) better than others, and that Congress should realign its tax and subsidy programs to encourage the good ones. Unlike corn ethanol, those biofuels will not compete for the world's food supply and will deliver significant reductions in greenhouse gases. . . .
>
> Congress's guiding principle should be to tie federal help to environmental performance. The goal is not just to stop the headlong rush to corn ethanol but to use the system to bring to commercial scale promising second-generation biofuels - cellulosic ethanol derived from crop wastes, wood wastes, perennial grasses. These could provide environmental benefits and reduce dependence on oil without displacing food production.

Editorial, *Rethinking Ethanol*, N.Y. TIMES, May 11, 2008, at 11.

[459] Posting of Indur Goklany to Cato-at-Liberty, *Wishful Thinking on Cellulosic Ethanol*, http://www.cato-at-liberty.org/2008/05/01/wishful-thinking-on-cellulosic-ethanol/ (May 1, 2008 08:39 EST).

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al.'s research.[460] Specifically their results indicate that "biofuels from switchgrass, if grown on U.S. corn lands, increase emissions by 50%." If switchgrass is grown on CRP land, its GHG impacts would be worse.[461]

It is also claimed that using crop wastes would increase the effective yield of biofuel production, and therefore mitigate some negative environmental impacts of crop-based biofuels. However, this argument overlooks the fact that so-called crop "wastes" are often utilized to conserve both soil and moisture (that is, water) on many farms, and they are frequently cycled back to the soil, in order to replenish its nutrient content. That is, crop waste is frequently a misnomer.

From this brief survey of the biofuels debate we can draw two important conclusions. First, biofuels are not necessarily environmentally preferable to fossil fuels, particularly in their present forms. Requiring billions of dollars of investment in biofuels infrastructure and production before we know enough to choose the right technologies will require government planners to have a greater degree of insight into future technological developments than is humanly possible. Policies that require large, early bets on specific technologies are less desirable than ones that spur innovation (e.g. prize competitions). Second, the record of ethanol's development thus far is not encouraging as it reveals an extraordinary degree of rent seeking from the start.[462]

C. Electricity Generation

The green jobs literature contains numerous calls for massive shifts in power generation. As we described earlier, the literature is selectively optimistic about favored power generation technologies (e.g. wind, solar, biomass) and selectively pessimistic about disfavored ones (e.g. coal and nuclear). As with biofuels, the literature barely acknowledges the serious problems facing its preferred technologies. In this section we briefly survey the literature on three power generation technologies: wind, solar, and nuclear, and show how the green jobs literature fails to adequately address the technical issues involved with each.

1. Wind power

Partly because of subsidies, the contribution of wind to *renewable electricity* generation is expected to increase from 7 percent in 2006 to 16 percent in 2020 and 20 percent in 2030.[463] However, despite being heavily subsidized, its total contribution to "energy security" is slight, and unlikely to rise to a significant level over the foreseeable future. Wind contributes less than 0.6 percent of total U.S. energy production, based on federal statistics from January through

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[460] Searchinger et al, *supra* note 81.

[461] *Id.* at 1238, 1240.

[462] *See, e.g.*, Jonathan H. Adler, *Rent Seeking Behind the Green Curtain*, 19 Regulation No. 4, at 26 (1996) (describing rent-seeking in 1990s ethanol programs); Jonathan H. Adler, *Clean Politics, Dirty Profits: Rent-Seeking Behind the Green Curtain*, in POLITICAL ENVIRONMENTALISM: GOING BEHIND THE GREEN CURTAIN 1, 2 (Terry L. Anderson ed., 2000) (same); Jonathan H. Adler, *Clean Fuels, Dirty Air* in ENVIRONMENTAL POLITICS: PUBLIC COSTS, PRIVATE REWARDS (Michael S. Greve & Fred L. Smith, Jr. eds., 1992) at 19 (clean fuels program as ethanol subsidy).

[463] Energy Info. Admin., *supra* note 374, at tbl.17. This report, which is issued each year, provides the Departmernt of Energy's best estimate of future supply and demand for the energy sector, based on its judgments about economic growth, labor supply, technological change, and so forth. It "generally assumes that current laws and regulations affecting the energy sector remain unchanged" throughout the projection period (2030 for this document). *See id.* at 2. In this respect, it differs from the Department of Energy study cited previously, DOE, 20% WIND, *supra* note 112, which was an anlysis of the consequences of meeting a target for wind energy to increase to 20 percent its contribution to total electricity generation.

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September 2008.[464] According to the DOE's latest projections, it will account for less than 0.9 percent of total *energy* consumption in 2020 and 1.1 percent in 2030.[465] Wind plays an increasing role in electricity generation, but electricity is only a fraction of *energy* production in the United States which is why wind is such a tiny share of total energy produced.

Wind's contribution to energy security is diminished by its ability to deliver electricity only intermittently. Wind turbines cannot produce when wind speed is either too low or too high, or if the turbine blades or other critical components are iced up. In fact, the Electric Reliability Council of Texas (ERCOT) assumes, based on historical experience, that only 8.7 percent of wind power's installed capacity would be available during summer peak hours, one of the times when electricity is most needed.[466] Because of this lack of reliability and the fact that wind energy cannot be stored to alleviate the reliability/availability problems, electricity generated by wind must be backed up by more reliable electric generation sources, which effectively increases the cost of wind energy substantially.[467] So while wind is free, even if one ignores construction, installation and transmission costs (see below), wind turbines by themselves cannot satisfy consumers' need for reliability and continuous, round-the-clock availability.

Yet another problem associated with wind energy is that the most favorable locations for wind power are often not accessible by the existing electrical grid,[468] a problem recognized by President Obama:

> One of, I think, the most important infrastructure projects that we need is a whole new electricity grid. Because if we're going to be serious about renewable energy, I want to be able to get wind power from North Dakota to population centers, like Chicago. And we're going to have to have a smart grid if we want to use plug-in hybrids then we want to be able to have ordinary consumers sell back the electricity that's generated from those car batteries, back into the grid. That can create 5 million new jobs, just in new energy.[469]

Additional electrical transmission lines are also key to entrepreneur T. Boone Pickens'

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[464] Energy Info. Admin, U.S. Dep't of Energy, REPORT NO. DOE/EIA-0035(2008/12), MONTHLY ENERGY REVIEW: DECEMBER 2008 (2008), *available at* http://tonto.eia.doe.gov/FTPROOT/multifuel/mer/00350812.pdf.

[465] Energy Info. Admin., *supra* note 374, at tbls.1 & 17.

[466] ERCOT, Report on the Capacity, Demand, and Reserves in the ERCOT Region (May 2008). *See also* Drew Thornley, TEX. PUB. POLICY FOUND., TEXAS WIND ENERGY: PAST, PRESENT, AND FUTURE 3 (2008), *available at* http://www.texaspolicy.com/pdf/2008-09-RR10-WindEnergy-dt-new.pdf. A study of small (10 kW or less) wind projects funded by the Massachusetts Technology Collaborative (MTC), which admininisters the state's Renewable Energy Trust and has has been funding small wind systems through the Small Renewables Initiative since 2005 indicates that on average such facilities are generating only 6.6percent of the energy that they could have had they been operating at full capacity for all the time during the year. Mass. Tech. Collaborative, Small Wind Progress Briefing Summary (June, 12 2008), *available at* http://www.masstech.org/RenewableEnergy/sm_renew/Progress%20Briefing%20Summary%20061208.pdf.

[467] This is more than a problem of people shivering in the cold or sweltering in the summer when the power goes off. Hospitals must have constant, reliable power. People who use electric-powered oxygen machines or ventilators require reliable power. "Britain's wind farms have stopped working during the cold snap due to lack of wind, it has emerged, as scientists claimed half the world's energy could soon be from renewables. The Met Office said there has been an unusually long period of high pressure across the UK for the last couple of weeks, causing the cold snap and very little wind". Louise Gray, *Wind Energy Supply Dips During Cold Snap*, TELEGRAPH, Jan 10, 2009, at , *available at* http://www.telegraph.co.uk/earth/energy/windpower/4208940/Wind-energy-supply-dips-during-cold-snap.html.

[468] Matthew Wald, *The Energy Challenge: Wind Energy Bumps Into Power Grid's Limits*, N.Y. TIMES, Aug. 29, 2008, at A1, *available at* http://www.nytimes.com/2008/08/27/business/27grid.html?_r=1&pagewanted=print.

[469] Rachel Maddow Show, *Barack Obama Talks to Rachel Maddow 5 Days Before Election* (MSNBC television broadcast Oct. 30, 2008), *available at* http://www.msnbc.msn.com/id/27464980/.

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dream of turning Texas into "the Saudi Arabia of wind."[470] According to the Department of Energy, it would require an additional 12,000 miles of high-voltage transmission lines costing $60 billion (undiscounted) to increase the contribution of wind to national electricity production to 20 percent by 2030.[471]

Wind power thus faces two key problems in increasing its share of electricity generation. First, it is unavailable at some times of peak power demand and so requires costly backup capacity. Second, current infrastructure is inadequate to support a rapid expansion of wind energy generation. Further, as we noted earlier, existing efforts to increase wind generation capacity have run into major hurdles with regulatory laws and NIMBY efforts.[472] Despite these widely known problems, which are never discussed in depth in the green jobs literature, green jobs policy proposals propose enormous increases in wind capacity without detailing a strategy for how these problems will be solved.[473] Green jobs proponents thus exhibit extensive technological optimism with respect to wind's prospects.

2. Solar power

Solar power is a second favored technology in the green jobs literature. As with wind energy, substantial – and largely unacknowledged – hurdles to a significant expansion exist in solar electric generation. First, despite decades of effort and high subsidies,[474] the current contribution of solar to meeting the nation's energy needs is only 0.05 percent.[475] Most of this (95 percent) is from solar thermal and hot water production rather than electricity generation. The remainder is from solar PV.[476] By 2030, the contribution of solar to energy consumption is projected by the EIA to rise to just 0.13 percent, with only half of that from solar PV.[477]

Although solar PV is projected to grow faster than other forms of solar energy, current technical analyses suggest that the costs of current solar PV installations so far exceed their benefits. Indeed, no reasonable valuation of the benefits of greenhouse gas reductions would result in positive estimates for the total net benefits from solar PV.[478] A comprehensive analysis of this issue by Borenstein accounts for the fact that in California and in most U.S. locations, solar electric power is produced disproportionately during summer peak demand hours, that is, at times when the value of electricity is high. Second, Borenstein considers that energy losses from electricity transmission and distribution from PV sources is low because it is primarily generated on-site. Despite taking into consideration these factors that favor solar technology, Borenstein

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[470] *Pickens Set on Turning Texas into Saudi Arabia of Wind*, ENVTL. LEADER, July 23, 2008, http://www.environmentalleader.com/2008/07/23/pickens-set-on-turning-texas-into-saudi-arabia-of-wind/; see also *Pickens Plan: The Plan*, http://www.pickensplan.com/theplan/ (last visited Feb. 22, 2009) (discussing the "Pickens Plan").

[471] DOE, 20% WIND, *supra* note 112, at 95, 98.

[472] *See supra* note 142.

[473] *See supra* notes 113-119 and accompanying text.

[474] *See supra* tbl.1.

[475] ENERGY INFO. ADMIN., *supra* note 374, at tbls.2 & 17.

[476] *Id.* at tbl.17.

[477] *Id.* at tbls.1 & 17.

[478] Severin Borenstein, *The Market Value and Cost of Solar Photovoltaic Electricity Production* (Ctr. for the Study of Energy Mkts., Working Paper, Paper No. WP 176, 2008) [hereinafter Borenstein]; Severin Borenstein, Response to Critiques of "The Market Value and Cost of Solar Photovoltaic Electricity Production," http://faculty.haas.berkeley.edu/borenste/SolarResponse.pdf (last visited Jan. 1, 2009) [hereinafter Borenstein, Response].

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finds that:

> the net present cost of installing solar PV technology today far exceeds the net present benefit under a wide range of assumptions about levels of real interest rates and real increases in the cost of electricity. Lower interest rates and faster increases in the cost of electricity obviously benefit solar PV, but even under the extreme assumption of a 1% real interest rate and 5% annual increase in the real cost of electricity, the cost of solar PV is about 80% greater than the value of the electricity that it will produce. It is worth noting that even without further technological progress in energy generation from wind, geothermal, biomass, and central station solar thermal, with a 5% annual increase in the real cost of electricity, all of these technologies would be economic (without subsidies or recognition of environmental externalities from fossil fuels) well before the 25-year life of the solar panels was over. Under more moderate assumptions about the real interest rate and the escalation in the cost of electricity, the net present cost of a solar PV installation built today is three to four times greater than the net present benefits of the electricity it will produce. [479]

Borenstein estimates for a range of scenarios that the market costs of solar PV exceed market benefits by $148/MWh to $492/MWh, in 2007 dollars.[480] This cost-benefit gap is, he notes, "much greater than plausible estimates of the value of greenhouse gas reduction."[481] In a meta-analysis of over 200 estimates, economist Richard Tol concludes that there is a 1 percent probability that the social cost of carbon exceeds $78 per tonne of carbon in 1995 dollars, based on a 3 percent pure discount rate of time preference.[482] And in a response to critiques of his analysis, Borentein concludes that:

> the current cost of solar PV, as it is being installed in California and the rest of the U.S. today, is extremely high not just compared to fossil fuel generation, but also compared to generation from wind, central station solar thermal, geothermal and other renewable resources.[483]

Finally, Borenstein makes other points with respect to solar PV, but which are applicable across the board to many alternative energy technologies:

> if solar PV costs are coming down very rapidly for reasons exogenous to the solar PV subsidy policy, then it is more likely to make sense to delay investment. If solar PV costs are declining by 20% per year, for instance, the same amount of investment (in present value terms) made 5 years from now will yield much more renewable energy than today. Given that the damage from GhGs is cumulative over time, it makes almost no difference whether the gasses are released in 2007 or 2012.[484]

Just as with our other examples, the green jobs literature's treatment of the technical challenges facing solar power suffer from selective technological optimism.

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[479] Borenstein, *supra* note 478.

[480] *Id.*

[481] *Id.* at 26.

[482] Richard S.J. Tol, *The Social Cost of Carbon: Trends, Outliers and Catastrophes*, ECON.: OPEN-ACCESS OPEN-ASSESSMENT E-JOURNAL, Aug. 12, 2008, at 9-10, http://www.economics-ejournal.org/economics/journalarticles/2008-25/view.

[483] Borenstein, Response, *supra* note 478, at 1.

[484] Borenstein, *supra* note 478, at 24.

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Even more problematically, the literature forecasts substantial increases in solar power generation without a serious discussion of the hurdles.

3. Nuclear power

In contrast to how the favored technologies are treated, the green jobs literature almost completely dismisses nuclear power generation. We are not advocating increasing or decreasing nuclear power generation here. We are noting the inconsistency of green jobs advocates between how unproven technologies with serious technical problems, such as wind and solar PV are treated, and how existing technology with widespread commercial use that actually produces a significant share of U.S. electric power, are treated in the literature. This difference reveals important embedded assumptions.

The U.S. currently gets just under 20 percent of its electricity from nuclear reactors.[485] This power is essentially carbon free to generate, just like solar and wind, and does not require blanketing huge areas of land with wind turbines or solar panels.[486] In Europe, 15 nations produce an even greater share of their electricity from nuclear power. Japan and South Korea also get a larger share of electricity from nuclear power than does the United States.[487] The widespread use of nuclear power across nations -- something likely to increase as European nations formerly skeptical of the environmental impact of nuclear power turn to it to reduce greenhouse gas emissions and to reduce their reliance on shaky Russian natural gas supplies[488] -- is a striking contrast to the tiny shares of electricity generated by wind and solar.

One reason for the failure of the green jobs literature to assign a role to nuclear power appears to be its political unpopularity among green jobs proponents' constituents. In the United States, nuclear power became unpopular after the Three Mile Island incident in 1979, during which a small amount of radiation was released.[489] That, combined with falling energy prices in the 1980s, reduced interest in and political support for nuclear power.[490] Politically, nuclear power is controversial and the U.S. environmental groups oppose it as a survey of their websites indicates:[491]

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[485] Nuclear is responsible for a little over eight percent of U.S. energy. *See* Energy Info. Admin, U.S. Dep't. of Energy, RENEWABLE ENERGY CONSUMPTION AND ELECTRICITY PRELIMINARY STATISTICS 2007, at tbl.1 (2008), *available at* http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/table1.pdf. It produces about 20 percent of electricity. *See* Energy Info. Admin, U.S. Dep't of Energy, TOTAL ELECTRIC POWER INDUSTRY SUMMARY STATISTICS, http://www.eia.doe.gov/cneaf/electricity/epm/tablees1a.html (last visited Feb. 22, 2009).

[486] Jesse H. Ausubel, *Renewable and Nuclear Heresies*, 1 INT'L J. NUCLEAR GOVERNANCE, ECON. & ECOLOGY 229, 229-43 (2007), *available at* http://www.inderscience.com/storage/f419103782512116.pdf.

[487] *See supra* note 70.

[488] John Deutch & Ernest J. Moniz et al., THE FUTURE OF NUCLEAR POWER: AN INTERDISCIPLINARY MIT STUDY 71 (2003), *available at* http://web.mit.edu/nuclearpower/pdf/nuclearpower-full.pdf; Anna Momigliano, *Russian Gas Cut-off Energizes Nuclear Comeback*, CHRISTIAN SCI. MONITOR, Jan. 16, 2009, at 6, *available at* http://www.csmonitor.com/2009/0116/p06s01-wogn.html; *Gas row shakes Europe's trust in Russian energy*, KYIV POST, January 21, 2009, at http://www.kyivpost.com/business/33934

[489] U.S. Nuclear Regulatory Comm'n, *Fact Sheet on the Three Mile Island Accident*, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.pdf (last visited Feb. 22, 2009). The disaster at the Chernobyl reactor in the USSR in 1986 was another matter. An improperly run Soviet reactor caused a large radiation leak and loss of life. *See* World Nuclear Ass'n, Chernobyl Accident, http://www.world-nuclear.org/info/chernobyl/inf07.html (last visited Feb. 22, 2009).

[490] *See, e.g.*, EIA ANNUAL, *supra* note 183, at 312.

[491] In each case the main website was used. The term "nuclear power" was entered in the site search box and the quotes come from the first page that appeared. All were accessed on Nov. 25, 2008.

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- Sierra Club: "The Sierra Club opposes the licensing, construction and operation of new nuclear reactors…."[492]
- Greenpeace USA: "Dangerous. High-Risk. Meltdown. Catastrophe… See why these words accurately describe nuclear energy and join us as we push for no new nukes."[493]
- National Audubon Society and National Wildlife Federation: "Clean, renewable energy like solar and wind power currently produces about 2 percent of our electricity nationwide. In contrast, nearly 90 percent of our electricity still comes from polluting sources of energy like coal and nuclear power."[494]
- World Wildlife Fund (WWF): "But among currently deployed commercial technologies, scaling up nuclear power is not an effective course to avert carbon emissions."[495]
- Environmental Defense Fund: "Serious questions of safety, security, waste and proliferation surround the issue of nuclear power. Until these questions are resolved satisfactorily, Environmental Defense cannot support an expansion of nuclear generating capacity."[496]

This skepticism is incorporated into the green jobs literature. For example, as noted previously, the UNEP report states that "nuclear power is not considered an environmentally acceptable alternative to fossil fuels, given unresolved safety, health, and environmental issues with regard to the operations of power plants and the dangerous, long-lived waste products that result."[497]

The overt opposition to nuclear power, or ignoring of it, raises questions about the real concern of advocates of "green power" with effective strategies to reduce carbon. Nuclear power represents proven technology that is moving ahead rapidly in the rest of the world. Plants in operation today in the United States were licensed in the 1960s and early 1970s, and so represent technology about 40 years old, but 23 new plants were under consideration in 2007 and 2008.[498] In an extreme case of the selective technological pessimism in the literature, opponents of nuclear power, despite the lack of problems in the United States even with the old technology, still talk as if 40-year-old technology was the norm today, as the website quotes above indicate.

While the experts at assorted environmental groups claim to know that nuclear power should be off the table and that limited options, such as wind and solar, are desirable, the same is not true among experts outside these groups. The National Research Council issued a report in 2008, recommending that to help deal with carbon emissions, a concerted effort should be

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[492] Sierra Club Conservation Policies – Nuclear Power, http://www.sierraclub.org/policy/conservation/nuc-power.asp (last visited Nov. 25, 2008). This is a 1974 resolution from the board of director—subject to many qualifications; but no significant change in position since 1974.

[493] Greenpeace USA, *Nuclear*, http://www.greenpeace.org/usa/campaigns/nuclear (last visited Nov. 25, 2008).

[494] Nat'l Audubon Soc'y & Nat'l Wildlife Fed'n, GLOBAL WARMING: IMPACTS, SOLUTIONS, ACTIONS 10 (2008), *available at* http://www.audubon.org/local/pdf/Global_Warming_Users_Guide_short.pdf. No other comment is made about nuclear power in the report.

[495] WWF, *Climate Solutions: WWF's Vision for 2050*, at 28, http://www.worldwildlife.org/climate/Publications/WWFBinaryitem4911.pdf (last visited Nov. 25, 2008). The report calls for a "phase-out of nuclear power," *id.* at 1, "due to its costs, radiotoxic emissions, safety, and proliferation impacts," *id.* at 8.

[496] Environmental Defense Fund, *Questions and Answers on Nuclear Power*, http://www.edf.org/article.cfm?contentid=4470 (last visited Nov. 25, 2008).

[497] UNEP, *supra* note 5, at 89. The report also notes, at that point, that nuclear power is not employment intensive, so would not be a source of many jobs.

[498] Nuclear Energy Inst., *New Nuclear Plant Licensing*, http://www.nei.org/keyissues/newnuclearplants/newnuclearplantlicensing/ (last visited Feb. 22, 2009).

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underway to enhance research in nuclear energy and to streamline the process to get the approvals for new plants, as they take years to construct.[499]

In 2003, a group of experts at MIT issued a major report on addressing greenhouse gases and urged that nuclear power generation should be taken seriously as an option.[500] The MIT Study concluded that, for the foreseeable future, only four major "realistic options" existed for reducing carbon dioxide emissions in electricity production, including nuclear. Crucially, the authors state that it is not possible to know, looking decades ahead, which strategy is best; rather, "*it is likely that we shall need all of these options and accordingly it would be a mistake at this time to exclude any of these four options from an overall carbon emissions management strategy*."[501] The MIT Study discusses, in depth, the key issues of cost, safety, proliferation, and waste. None of the issues involved are simple.

What the study illustrates is that technology consistently advances and that there are strategies to deal with real problems inherent in any complex process. The best technologists cannot predict what technology will dominate years from now, as they know technology changes. A policy that eliminates major possible options, assuming that the technology we know today is what will exist in decades to come, will have us locked into costly, economically destructive policies.

This is not to say that there are not serious technological issues that must be addressed if nuclear power use is to be expanded. The crucial point is that the failure of the green jobs and green power advocates to deal in a straightforward manner with alternatives such as nuclear power indicates a bias. The prospects for technological change should be treated consistently across technologies.

V. Conclusion

The costs of the green jobs programs proposed by the interest groups that authored these reports and others with less fully developed proposals are staggering. Already the federal government has committed $62 billion in direct spending and $20 billion in tax incentives to green jobs programs in the recently passed stimulus bill.[502] Even the proponents are reluctant to give a firm price tag. For example, the UNEP report concludes that:

> [n]o one knows how much a full-fledged green transition will cost, but needed investment will likely be in the hundreds of billions, and possibly trillions, of dollars. It is still not clear at this point where such high volumes of investment capital will come from, or how it can be generated in a relatively short period of time.[503]

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[499] Nat'l Research Council, REVIEW OF DOE'S NUCLEAR ENERGY RESEARCH AND DEVELOPMENT PROGRAM (2008), *available at* http://www.ne.doe.gov/pdfFiles/rpt_NationalAcademiesReviewDOEsNE_RDProgram_2008.pdf. The report notes that the federal nuclear energy research budget "had collapsed to $2.2 million" in FY 1998. *Id.* at 9. It has risen rapidly since, allowing further advances in nuclear research.

[500] Deutch & Moniz et al., *supra* note 488.

[501] *Id*., at 1 (emphasis in original).

[502] *See* Kate Sheppard, *A Green Tinged Stimulus Bill*, GRIST (Feb. 12, 2009) available at http://gristmill.grist.org/story/2009/2/12/83439/6486.

[503] UNEP, *supra* note 5, at 306.

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The scale of social change that could be imposed is equally immense. To take just one example, the worldwide production of cement in 2007 was 2.77 billion metric tons.[504] Cement is ubiquitous in modern society. Anyone reading this article in a developed country can likely see cement from where he or she sits. Yet we are told that "[t]he cement industry will only become sustainable if the building industry finds completely new ways to create and use cement or eventually figures out how to replace it altogether."[505] And, as we have described in detail above, green jobs advocates propose equally dramatic shifts in energy production technologies, building practices, and food production. These calls for dramatic changes in every aspect of modern life are wrapped in a new package in the green jobs literature, promising not only a revolution in our relationship with the environment but to employ millions in high paying, satisfying jobs. Despite their new packaging, these calls for creating a new society through central planning are as old as human history. The failure of the twentieth century's utopian experiments suggests caution in undertaking such widespread transformations of society.

Unfortunately, the analysis provided in the green jobs literature is deeply flawed, resting on a series of myths about the economy, the environment, and technology. We have explored the problems in the green jobs analysis in depth; we now conclude by summarizing the mythologies of green jobs in seven myths about green jobs:

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

[504] U.S. Geological Survey, CEMENT STATISTICS (2008), available at http://minerals.usgs.gov/ds/2005/140/cement.pdf.

[505] UNEP, *supra* note 5, at 203.

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competitive market, factors of production, including labor, earn a return based on productivity. By focusing on low labor productivity 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 no 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.

To attempt to transform modern society on the scale proposed by even the most modest bits of the green jobs literature, such as the Conference of Mayors report, 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. 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.

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