GREEN PROSPERITY:

How Clean-Energy Policies Can Fight Poverty and Raise Living Standards in the United States

Robert Pollin
Jeannette Wicks-Lim
& Heidi Garrett-Peltier

Department of Economics and
Political Economy Research Institute
University of Massachusetts, Amherst

Prepared under commission from the
Natural Resources Defense Council
& Green For All

June 2009

POLITICAL ECONOMY RESEARCH INSTITUTE
PERI
University of Massachusetts Amherst

NATURAL RESOURCES DEFENSE COUNCIL
NRDC THE EARTH'S BEST DEFENSE

GREEN FOR ALL

GREEN PROSPERITY

How Clean-Energy Policies Can Fight Poverty and Raise Living Standards in the United States

Robert Pollin

Jeannette Wicks-Lim

& Heidi Garrett-Peltier

Department of Economics and
Political Economy Research Institute (PERI) ,
University of Massachusetts, Amherst

Prepared under commission from the
Natural Resources Defense Council
& Green For All

June 2009

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

ACKNOWLEDGEMENTS

This project has been a top-to-bottom collaboration between ourselves and our colleagues at the Natural Resources Defense Council and Green For All. We are most grateful for this collaboration and support from the NRDC and Green For All at all stages in the preparation of this work. In particular, we wish to acknowledge the contributions of Pete Altman, Laurie Johnson, and Dan Lashof at NRDC and Jason Walsh at Green For All. They, along with several other colleagues at both organizations, including James Barrett, Lane Burt, David Goldstein, and Justin Horner, continually offered us new ways of thinking about important questions, and challenged us to rethink, again and again, many of our own initial ideas. In other words, they held our feet to the fire at all stages of our research and writing. The outcome is a substantially better piece of work than we would have produced otherwise.

We also wish to acknowledge our PERI collaborators James Heintz and Debbie Zeidenberg. James has made basic contributions to the overall approach we take to understanding the broad economic impacts of building a clean-energy economy. His ideas are thoroughly integrated into this study. Debbie has made crucial contributions in terms of layout, editing, and perhaps most challenging, managing the project for PERI. These challenges turned out to have been quite significant, and Debbie maintained her aplomb and sense of humor throughout.

This study is being released concurrently with *The Economic Benefits of Investing in Clean Energy: How the Economic Stimulus Program and New Legislation will Boost U.S. Employment and Economic Growth,* a project commissioned by the Center for American Progress. We authors are grateful to the Center for American Progress for both their substantive and financial contributions in producing that companion paper to this one. We specifically note that the discussion in this paper on overall employment estimates through clean-energy investments benefitted significantly from extensive discussions over the course of a year with colleagues at CAP, including especially Kit Batten, Michael Ettlinger, and Bracken Hendricks. We are grateful to Kit, Michael, and Bracken for helping us to develop these ideas.

—Bob Pollin, Jeannette Wicks-Lim
& Heidi Garrett-Peltier

SUMMARY

The United States today faces a formidable generation-long challenge: to transform the economy from being driven primarily by fossil fuel sources of energy, which are the major cause of global climate change, to becoming an economy that can function effectively through renewable energy sources and by achieving high levels of energy efficiency.

The project of building a clean-energy economy will become a powerful engine of expanding employment opportunities throughout the U.S. economy. According to a study that PERI recently completed with the Center for American Progress (CAP),[1] clean-energy investments at the level of about $150 billion per year—i.e. around one percent of U.S. GDP—can generate about 1.7 million net new jobs throughout the U.S. economy.

This level of annual new clean-energy investments in the U.S. will be strongly encouraged through the combination of direct government spending, along with the subsidies and incentives for private business investors that would result from the American Recovery and Reinvestment Act (the February 2009 Obama stimulus program) and the American Clean Energy and Security Act (ACESA—the Waxman-Markey bill) now being debated in Congress. Within this strongly supportive policy framework, the advance of clean-energy technologies will accelerate and markets supporting these technologies will mature. This will create a self-reinforcing dynamic of rising private-sector clean-energy investment opportunities, which in turn will mean expanding job opportunities.

The building of a clean-energy economy in the United States can also serve another purpose: to create new 'pathways out of poverty' for the 78 million people in this country (roughly 25 percent of the population) who are presently poor or near-poor, and raise living standards more generally for low-income people in the United States. How the project of building a clean-energy economy can benefit low-income people in the U.S. is the focus of this study.

In the discussions that follow, we examine how investments in clean energy—including energy efficiency measures such as residential and commercial building retrofits, public transportation and a smart grid electrical transmission system, along with renewable energy sources such as wind, solar, and biomass power—create major new employment opportunities in comparison with spending equivalent amounts of money within the traditional fossil fuel sectors, i.e. oil, natural gas and coal. We then assess the impact on low-income families of seeing their household energy bills go down as a result of investments in energy efficiency retrofits. We finally also consider how investments in improving public transportation systems can reduce transportation costs for low-income families.

Clean-Energy Investments Create Job Opportunities

In general, our findings show that clean-energy investments create more job opportunities than spending on fossil fuels, across all levels of skill and education. The largest benefits will accrue to workers with relatively low educational credentials.

We further find that a high proportion of the jobs generated by clean-energy investments should offer good opportunities for advancement through training programs, and more generally, that newly employed low-income workers will see new opportunities to lift themselves and their families out of poverty.

Considering a $150 billion annual level of clean-energy investments in the U.S. economy, some of our major specific findings include the following:

EXPANDING EMPLOYMENT OPPORTUNITIES FOR LOWER-INCOME WORKING PEOPLE

- Out of the 1.7 million net increase in job creation, roughly 870,000 of the newly available jobs would be accessible to workers with high school degrees or less.

[1] See Pollin, Heintz, and Garrett-Peltier (2009).

- Roughly 614,000 of the newly expanded number of jobs available for workers with high school degrees or less will offer decent opportunities for promotions and rising wages over time. The job creation within this category is seven times larger than the number of jobs that would be created in this category by spending the same amount of money within the fossil fuel industry.
  - To maximize opportunities for decent job opportunities, clean-energy investment policies need to operate in tandem with high-quality and widely-accessible training programs; minimum wage laws that set a 'living wage' standard throughout the country; and a more favorable environment for union organizing among low-wage workers.
  - The net increase of 1.7 million jobs will generate roughly a one percentage point fall in the unemployment rate. This in turn should raise earnings for low-income workers by about 2 percent.

MORE JOBS ACROSS ALL EDUCATIONAL LEVELS

- 3.2 times more jobs overall than fossil-fuel investments
- 3.6 times more jobs requiring high school degrees or less
- 2.6 times more jobs requiring college degrees or more
- 3.0 times more jobs requiring some college

ENERGY EFFICIENCY RETROFITS LOWER HOME HEATING AND UTILITY BILLS

- Retrofits could reduce living costs by an average of 3-4 percent for low-income households.
- Achieving these benefits will require well-designed policies to expand the market for retrofits.
- The markets to provide retrofitting services must be targeted to benefit low-income renters as well as homeowners.

IMPROVING PUBLIC TRANSIT REDUCES TRANSPORTATION EXPENSES

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

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

INTRODUCTION

The transformation of our fossil-fuel driven economy into a clean-energy economy will be the work of a generation, engaging a huge range of people and activities. But, focusing on essentials, there are three interrelated projects that will define the entire enterprise: dramatically increasing energy efficiency; equally dramatically lowering the cost of supplying energy from such renewable sources as solar, wind and biofuels; and mandating limits on pollution from burning oil, coal, and natural gas.

Success in combining the three projects—energy efficiency, renewable energy and limits on fossil fuel pollution—could produce a decisive environmental and economic victory. It could also advance economic opportunity in the U.S. in several specific ways, by lessening the risks of extreme weather patterns such as Hurricane Katrina, allowing us to breathe clean air and breaking our dependence on oil companies and foreign oil oligarchies. But can a clean-energy investment project also promote broader gains in economic opportunity, by expanding job opportunities and income security, and thereby fighting poverty in the United States?

These are the questions we explore in this study. We examine them both in terms of the overall U.S. economy, and by focusing specifically on conditions in 41 distinct areas throughout the country. Our conclusions are clear.

We find that a clean-energy investment agenda can indeed serve as a tool for expanding economic opportunity broadly throughout the country—to 'create pathways out of poverty,' as the term is frequently used. There are three basic channels through which we observe major connections between the environmental agenda and a program to fight poverty in the United States: by significantly expanding employment opportunities, especially for people with relatively low formal educational credentials; by lowering heating and utility bills through building retrofits; and by increasing access to public transportation.

Job Creation and Poverty Reduction. The most powerful way in which clean-energy investments will expand economic opportunities is through the channel of job creation, especially by increasing the availability of jobs for people with relatively low formal credentials. Considering the country as a whole, expanding overall clean-energy investments by both the public and private sectors by a total of about $150 billion per year—with the private sector accounting for the bulk of new spending—can create about 2.5 million new jobs in the economy, as we have shown in the Center for American Progress study.[2] Even if we assume that a $150 billion expansion in clean-energy investments is basically matched by a reduction in spending in fossil fuel sectors—i.e. oil, natural gas, and coal—the clean-energy investments will still generate a *net increase* in new employment of about 1.7 million jobs. Moreover, about 870,000 of net new jobs created—through the expansion of clean-energy investments and corresponding reduction in fossil fuel spending—will be in jobs with relatively low educational requirements, i.e. a high school degree or less. This means major new job opportunities for people who have faced unemployment or other difficulties establishing themselves in the labor market. The majority of these jobs also include good prospects for training and promotions that can lead to stable, higher-paying positions over time. To the extent that an expansion in employment also leads to a reduction in the unemployment rate, this increases workers' bargaining power. Workers should be able to gain increased wages as a result. Finally, these will not simply be short-term job opportunities, but will continue to be available as long as the clean-energy investment agenda proceeds over time. For example, the construction jobs that will open up through clean-energy investments will not be tied only to one or two specific projects. These positions will rather be sustained as long as construction activity is needed to build a clean-energy economy.

Building Retrofits for Lowering Heating and Utility Bills. Retrofitting the country's existing housing stock could generate major reductions in the consumption of fossil fuels and greenhouse gas emissions. It is reasonable to expect that both individual-family homes and apartment buildings could be weather-

[2] Ibid.

ized such that savings on energy could amount to up to 4 percent of a low-income family's annual income. But to achieve this level of energy efficiency in homes will require careful attention to making retrofits affordable and convenient for low-income homeowners. Programs must also be designed so that the economic benefits of lowered energy costs can be shared equitably between renters and landlords.

Increasing Access to Public Transportation. At present, low-income households spend about 95 percent of their transportation budget on private cars. This is the case even though, on a per mile basis, traveling by private car is more than twice as expensive as public transportation. Auto travel per mile also generates greenhouse gas emissions at roughly twice the level of public transportation. Low-income people do not travel heavily by public transportation for many of the same reasons as those in higher income brackets—i.e. throughout most of the country, public transportation is under-developed and under-supported financially. It can also be expensive for poor people. As we discuss in detail below, well-designed expansions of public transportation systems should be able to increase ridership by low-income people in urban areas such that their public transportation use rises to between 25 and 50 percent of their households' total travel. Shifting toward this level of public transit use is capable of raising the living standards among low-income households by between 1 and 4 percent. The savings could be as much as 10 percent of total living costs if families are able to give up one car.

Falling Fossil Fuel Production and Rising Prices

As noted above, we are assuming that the fossil fuel sectors—oil, natural gas and coal—will contract at approximately the same rate that the clean-energy investment agenda expands. We recognize this is a worst-case scenario, and proceed deliberately from this most negative prospective situation regarding the fossil fuel industry. In fact, some emission reduction projects, such as installing carbon dioxide capture systems at coal-fired power plants and reducing methane leaks from natural gas pipelines, will increase, rather than reduce, employment in the fossil fuel sector. Nonetheless, we can anticipate that the benefits of clean-energy investments will, to some extent, be offset by job losses for workers in the fossil fuel sectors and harmful effects on communities that depend heavily on fossil fuels to generate employment and income.

At present, about 4 million people in the United States owe their jobs to the fossil fuel industries, many of them in low-income families. Certainly a significant share of these people will face difficult adjustments as the fossil fuel industry contracts. It is therefore crucial that we examine the benefits of the clean-energy investment agenda relative to the costs that will be faced by people and communities throughout the country as the United States reduces its dependence on fossil fuels. In the discussion that follows—just as we noted briefly above—we will be clear on the net effects on low-income households of the expansion of a clean-energy investment agenda alongside the concurrent decline of fossil fuel-related economic activities.

It is precisely through recognizing the adjustments that will be faced by individual workers, families, and communities connected to the fossil fuel industries that policymakers can pursue effective interventions to counteract them. The American Clean Energy and Security Act (ACESA) as reported by the Energy and Commerce Committee includes a viable framework for addressing these concerns. ACESA includes a new worker transition program that provides workers who are laid off from energy-intensive industries an allowance that will cover 70 percent of their wages. These payments would continue for three years. Workers facing these circumstances will also receive health, training, and relocation benefits.

The ACESA also includes further initiatives for protecting the well-being of low-income households. A major provision of the ACESA is to establish a mandated cap on carbon emissions. This measure is expected to raise the price of using oil, coal and natural gas. Unless low-income households are protected against the effects of these price increases, the impact of the higher prices will reduce their living standards more than would be the case for higher-income households. This is because energy-related expenditures represent a larger share of overall consumption spending for these households.

However, any such negative impacts can be effectively counteracted by policies directed at shielding low-income households from rising fossil fuel prices. The basic solution is included in the ACESA as reported out of committee. This is to rebate the proceeds that result from the sale of 15 percent of the emissions credits associated with the carbon cap to low-income households through two mechanisms, a refundable 'energy tax credit' and an 'energy refund.' The most important aim would be to at least hold lower-income families harmless against any price increases for energy or energy-intensive goods generated by the cap. In evaluating these specific features of the ACESA, the Center on Budget and Policy Priorities concluded in a letter written to Chairmen Waxman and Markey that: "Our estimate is that setting aside 15 percent of the allowance value for refunds and tax credits for consumers, together with other provisions in the bill . . . *would ensure that the average household in the bottom 20 percent of the population would not experience any reduction in the purchasing power of its budget*" (emphasis added).[3]

For the purposes of our discussion, we assume that this important provision will be included in any carbon cap that is implemented in the U.S.[4] We will therefore proceed with our discussion assuming there are no negative effects from a carbon cap itself on the living standards of low-income households.

Clean Energy Benefits for the Poor

To understand how a clean-energy investment agenda can create 'pathways out of poverty,' we first need to establish what we mean by 'poverty' and for whom, specifically, we are seeking to create new opportunities. As a starting point, we begin with the official definition of poverty established by the U.S. Census Bureau, which is the basis for all funding programs in the United States tied to poverty lines.

Since 1963, the U.S. Census Bureau has set detailed poverty income thresholds for families of different sizes. For example, the poverty threshold in 2008 for a family of two (one adult and one child) was $14,840 and for a family of four with two children was $21,834. The family living at this threshold is expected to subsist on what the Department of Agriculture terms the 'thrifty food plan,' which is the amount of food needed for each family member to receive the basic caloric minimum.

The government's methodology then assumes that poor families spend approximately one-third of their budget on food. Thus, to generate the dollar figures for the poverty threshold, the government simply multiples the dollar value of the 'thrifty food plan' by three.

Over many years, researchers and government officials have questioned the adequacy of this method for establishing poverty thresholds. The most extensive scientific survey of these issues was that sponsored by the National Research Council (hereafter NRC; Citro and Michael 1995). According to the NRC study, establishing overall poverty thresholds on the basis of food costs alone presents many problems. For one thing, there are large variations in housing and medical care costs by region and population groups. In addition, food prices have fallen relative to those for housing. Child care costs have also not been adequately accounted for. This consideration has become increasingly important as rising proportions of women from low-income families—due to the decline in support for traditional welfare programs, among other factors—have entered the labor force.

The NRC study reports on six alternative methodologies to the current official method for measuring absolute poverty for a two adult/two child family.5 The thresholds generated by these alternative methodologies are all higher than the official threshold, ranging between 23.7 and 53.2 percent above the official threshold. The average value of these alternative estimates is 41.7 percent higher than the official threshold.

[3] The full analysis by the Center on Budget and Policy Priorities on this issue is presented in Stone, Parrott, and Rosenbaum (2009). See http://www.cbpp.org/files/5-20-09climate.pdf.

[4] We recognize that a range of challenging technical questions emerges in designing the most efficient and equitable approach to upholding the basic principle that lower-income households be held harmless due to a carbon cap policy. Two excellent discussions, offering somewhat different perspectives, of the issues at stake are Boyce and Riddle (2008) and Parrott, Rosenbaum, and Stone (2009).

[5] The NRC study includes consideration of "relative" as well as "absolute" measures of poverty. Relative poverty, as the term suggests, takes account of problems resulting from pronounced inequality in a society, even if that society's average living standard is relatively high. However, we focus here only on absolute poverty measures. For an insightful overview on these themes as well as current poverty trends throughout the world, see Keith Griffin, "Problems of Poverty and Marginalization" (2000).

An alternative approach to establishing living standard thresholds is reflected in the 'basic family budgets' developed by researchers at the Economic Policy Institute. This basic budget line is significantly higher than the official U.S. poverty line. It is a measure that, according to James Lin and Jared Bernstein (2008), "represents the annual family income required to maintain a safe and comfortable, but modest standard of living." Under this basic family budget, a family will be renting their home, with the rent set at the lower 40th percentile level of the market price in their community. The family's food expenses are based on the U.S. Department of Commerce's 'low cost plan,' which is a basic diet that assumes almost all food is prepared in the home. Similarly modest allocations are also made for health care, child care, and transportation. Expenditures on clothing, entertainment, personal care, reading materials, educational materials, and other miscellaneous items equal, in total, only 24 percent of the family's housing and food budgets. In comparing the EPI 'basic budget line' to the official poverty line, the EPI line ranges between about 200 and 300 percent of the official poverty line.

Considering the results of the NRC study and the EPI line, we think a rough, usable target group for our study—the low-income group for whom we consider whether the clean-energy investment agenda will create expanded economic opportunities—will be all households in the United States living at or below 200 percent of the official government poverty line. According to that low-income standard, as of 2007, there were about 34 million households living beneath this standard, 31 percent of all households in the country. There were also 78 million people living in these households, 26 percent of the total U.S. population.[6] Given these figures, it is clear that any set of policy initiatives that can substantially improve living conditions for so large a proportion of the U.S. population—or even offer this result as a serious possibility—deserves our serious attention.

---

[6] Households include family and non-family households. Figures are based on authors' analysis of the 2008 CPS ASEC data and 2007 American Community Survey.

EXPANDING EMPLOYMENT OPPORTUNITIES THROUGH CLEAN-ENERGY INVESTMENTS

Basic Employment Conditions for Low-Income Households

In Table 1, we show the basic employment situation for workers living in low-income households, i.e. below 200 percent of the official poverty line, versus those living above 200 percent of the official poverty line. A few striking things stand out from these figures.

TABLE 1. EMPLOYMENT CONDITIONS AND JOB CREDENTIALS FOR ADULTS IN LOWER VERSUS HIGHER-INCOME HOUSEHOLDS, 2008

(Adults includes only those between ages 25-54)

	Households below 200% of the poverty line	*Households above 200% of the poverty line*
Median educational attainment level for household adults	12 years (high school graduate)	14 years (two years of college)
Households with at least one unemployed adult	8.5%	4.0%
Households with at least one under-employed adult	4.6%	1.6%
Median hourly wage for employed adults	$10.10	$19.00
Households with any adults in the labor force	71.3%	95.6%
Households with all adults in the labor force	55.1%	82.6%

Source: U.S. Current Population Survey 2008

To begin with, the average level of educational credentials is two full years lower for workers in low-income households. This makes it more difficult for them to compete on the job market. It also emphasizes the point that, for the clean-energy investment agenda to serve well as an anti-poverty agenda, it will be crucial to generate not merely an abundance of new jobs, but, in particular, new job opportunities for people with relatively low educational credentials.

As for the employment situations themselves for adults in low-income households, the first key result is that there is a much higher rate of unemployment for workers in low-income households—8.5 percent of low-income households include at least one unemployed adult member, whereas only 4.0 percent of higher-income households include at least one unemployed adult. We see a similar result in considering adults in low-income households that are 'underemployed.' Among 'underemployed' workers, we include those working part-time who would prefer working full-time. We also include 'discouraged' workers—people who consider themselves still in the labor force, but who have been discouraged from looking for a job over the past two weeks. We see in Table 1 that the number of low-income households with at least one underemployed adult is triple that for higher-income households—i.e. 4.6 percent with low-income households versus only 1.6 percent with higher-income households.

In terms of wages, we see, not surprisingly, that the average wage earned by adults in low-income households, at $10.10 an hour, is about half the median wage for non-poor households of $19.00 an hour. At a wage of $10.10 per hour, a worker would earn roughly $20,000 for a full year of full-time work. This is nearly $24,000 below the amount needed to bring a family of four to 200 percent of the official poverty line.

Lower-income households are also characterized by a much lower percentage of adults participating in the labor force—either having a job or being unemployed but looking for work. As we see, with low-income households, about 70 percent have at least one member in the labor force and about 55 percent with all adults in the labor force. By contrast, fully 96 percent of all higher-income households have at least one adult in the labor force, and 83 percent have all adults as labor market participants.

Why don't lower-income adults participate at higher rates in the labor force, going out, at least, to look for a job even if they do not succeed in obtaining one? According to a range of research, more people do enter the labor force when they see that their chances of gaining employment are rising. For adults in low-income households with substantial unemployment and underemployment rates, they are receiving a strong message that their chances of finding a job are not high. Their low rate of labor force participation reflects this difficult reality. Further research also shows that labor force participation rates rise when pay levels rise. Again, the low average wage of $10.10 serves to discourage low-income adults from entering the labor force.[7]

Overall then, to significantly improve job opportunities for people in low-income households, the most basic factors would be to: 1) raise the number of jobs that are readily available for lower-credentialed workers, and 2) improve the wages for these lower-credentialed workers. Expanding the number of jobs that include opportunities for advancement through training provides one important path for raising wages. Establishing both living wage standards and fair opportunities for workers to join unions will also be crucial for improving wages.

We now consider the extent to which a clean-energy investment agenda can contribute toward these aims.

How a Clean-Energy Investment Program Creates Jobs

Spending money in any area of the U.S. economy will create jobs, since people are needed to produce any good or service that the economy supplies. This is true regardless of whether the spending is done by private businesses, households, or a government entity. However, spending directed toward a clean-energy investment program will have a much larger positive impact on jobs than spending in other areas, including, for example, within the oil industry—including all phases of oil production, refining, transportation, and marketing—or coal industry. Again, this is true regardless of whether the spending—on clean energy or fossil fuel energy—is done by households, private businesses or the government. As such, a clean-energy investment program will be a net source of job creation in the United States relative to spending the same amount of money on fossil fuels.

There are three sources of job creation associated with any expansion of spending—direct, indirect, and induced effects. For purposes of illustration, consider these categories in terms of investments in home retrofitting or building wind turbines:

1. *Direct effects*: the jobs created, for example, by retrofitting homes to make them more energy efficient or building wind turbines;

2. *Indirect effects*: the jobs associated with industries that supply intermediate goods for the building retrofits or wind turbines, such as lumber, steel, and transportation;

3. *Induced effects*: the expansion of employment that results when people who are paid in the construction or steel industries spend the money they have earned on other products in the economy.

Figure 1 shows the total number of jobs—direct, indirect, and induced—that we estimate would be created from spending $1 million in a combination of six clean-energy investment areas—three energy efficiency investment areas, building retrofits, public transportation and freight rail, and smart grid electrical transmission systems; and three renewable energy areas, solar power, wind power, and biomass fuels.[8] As we see, this combination of clean-energy

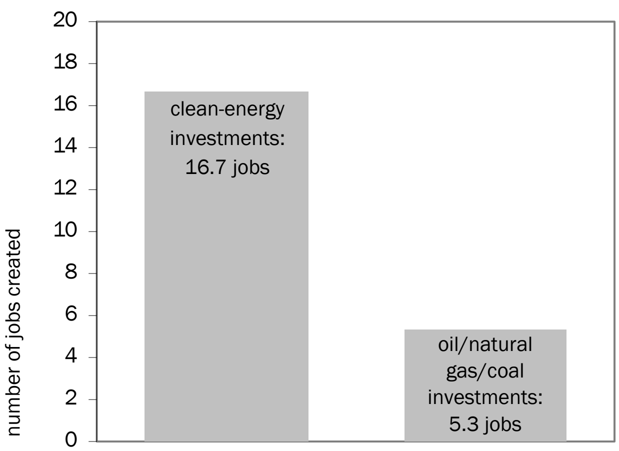
[7] For example, Bartik (2002) finds evidence that when the chances of getting a job improve (i.e., the unemployment rate falls), not only do more people obtain jobs but more people who dropped out of the labor force begin to look for work. In particular, he finds that when the unemployment rate declines by one-percent among single mothers, their labor force participation rate increases by 0.3%. This estimate measures the impact of a fall in unemployment on their labor force participation rate after five years of adjustment, taking into account the fact that a rise in labor force participation may subsequently raise unemployment somewhat if those entering the labor force do not find jobs immediately. With respect to rising incomes and labor force participation, a classic study of the impact of the Earned Income Tax Credit (EITC)—the federal program that subsidizes the earnings of low-income workers—finds that more generous EITC benefits increases the labor force participation among low-income single mothers (Eissa and Liebman 1996). Pollin et al. (2008, Chapter 13) also shows that when Santa Fe, NM established a citywide living wage of $8.50 in 2004-05, which represented a 65 percent raise over the then statewide minimum wage of $5.15, this produced a nearly seven percentage point rise in the labor force participation rate among those with a high school degree or less.

[8] The allocation of total investment funds that we are working with is: 40 percent retrofits; 20 percent mass transit/freight rail; and 10 percent each for smart grid, wind power, solar power and biomass fuels. Adjusting the budgetary allocations would affect the job total estimates, but not by a dramatic extent. These proportions are closely aligned with the clean-energy investment spending priorities of the government ARRA program. The appendix discusses briefly how we derived the job figures. In sum, we worked with the U.S. input-output model to generate direct and indirect employment effects. We then assumed an induced effect as a 40 percent increment above the direct and indirect effects, working from our model that estimates

investments will generate about 16.7 jobs per $1 million in spending.

By contrast, we can use our same estimating model to generate figures for the total job creation by spending $1 million within the fossil fuel industries, i.e., oil, natural gas and coal. As Figure 1 also shows, the total job creation in this case is 5.3 jobs per $1 million in spending on fossil fuels.[9] In short, spending a given amount of money on a clean-energy investment agenda generates more than three times the number of jobs within the U.S. as does spending the same amount of money within the fossil fuel sectors.

FIGURE 1. JOB CREATION THROUGH $1 MILLION IN SPENDING: CLEAN-ENERGY INVESTMENTS VERSUS FOSSIL FUELS



Source: U.S. Commerce Department input-output tables and IMPLAN Note: Employment estimates include direct, indirect and induced jobs. Details of calculations presented in the technical appendix.

Why does the clean-energy investment program create more jobs than spending within the fossil fuels industry? Three factors are at work:

Relative labor intensity. Relative to spending within the fossil fuel industries, the clean-energy program utilizes far more of its overall investment budget on hiring people, and relatively less on acquiring machines, supplies, land (either on- or offshore), and energy itself.

induced effects relative to the expansion of direct and indirect job creation. For a fuller discussion of these issues, see Pollin, Heintz, and Garrett-Peltier (2009).

[9] This figure is based on the output shares represented by oil/natural gas and coal in the overall fossil fuel industry as of 2007. Those shares are 95 percent oil/natural gas and 5 percent coal.

Domestic content. The clean-energy investment program relies much more on products made within the U.S. economy and less on imports than spending within the fossil fuel sectors. About 97 percent of total spending on public transportation and building retrofits will remain within the U.S. economy, while, for the oil and gas industries, about 83 percent is domestic and 17 percent purchases imports.

Pay levels. Clean-energy investments produce far more jobs at all pay levels—higher as well as lower-paying jobs than the fossil fuel industry. Clean-energy investments also produce more jobs per dollar of expenditure, since the average pay for these jobs is less than the average for fossil-fuel industry jobs. Workers thus benefit through the expansion of job opportunities at all levels within the U.S. labor market.

Range of Jobs Generated by Clean-Energy Investments

To obtain a fuller sense of the range of job opportunities generated by clean-energy investments, we present in Table 2 a listing of a representative sample of jobs that are likely to expand significantly through the clean-energy investment agenda. Given our focus on how the clean-energy agenda can create job opportunities for low-income people, it is important to consider the profile of jobs created according to the range of educational credential levels required to move into any given job type. As such, we have sorted our set of representative occupations according to three educational credential categories—'college degree jobs,' requiring at least a BA degree; 'some college jobs,' requiring some college but not a BA; and 'high school or less jobs,' requiring a high school degree or less. We also include as a final subcategory the 'high school or less' jobs that offer decent opportunities for advancement and higher wages over time. As we will discuss in some detail below, these are jobs primarily in construction, manufacturing and transportation, where, among other factors, opportunities for job training are more widely available.

Considering this listing of occupations as a whole, some of the jobs associated with the clean-energy investment agenda will be in specialized areas, such

COUNTING NEW JOB OPPORTUNITIES BY EDUCATIONAL LEVELS

We differentiate jobs using categories of 'education credentials' as opposed to the more traditional skill-level categories for two reasons. First, we want to focus attention on the entry requirements of jobs in order to distinguish which jobs are more likely to provide employment opportunities for low-income workers. For many jobs, such as those in construction, education credentials more accurately reflect their entry requirements for employment, even though such jobs can require significant training to become fully qualified. Such training, however, is frequently obtained on-the-job or through an employer- or employer/union-sponsored apprenticeship program. For this reason many of our high school or less' jobs are classified by researchers Harry Holzer and Robert Lerman (2007) as 'middle-skilled' jobs: such jobs do not require college experience, but do require significant training. In addition, we believe the terms we are using more accurately reflects the actual distinctions between job categories. Many jobs are referred to as 'low-skilled' only because they do not require high education credentials or formal training even while such jobs frequently require operating at a high skill level to deliver a satisfactory product or service. Jobs in needle trades, child care and elderly care provide a few cases in point.

as installing solar panels and researching new building material technologies. Moreover many of these jobs fall within the 'college degree' job category. But others will be available to people with fewer educational credentials. More generally, the majority of jobs will be in the same areas of employment that people already work in today, in every region and state of the country, and in all three of our educational credential categories. Constructing wind farms, for example, creates jobs for sheet metal workers, machinists and truck drivers, among many others. Some of these workers will have received some college education, while other occupations will require less formal education. Increasing the energy efficiency of buildings through retrofitting requires roofers, insulators and architects—again, jobs that entail different levels of formal educational requirements. Expanding mass transit systems employs civil engineers, electricians, and dispatchers. In addition, all of these clean-energy investment strategies engage the normal range of service and support activities—including accountants, lawyers, office clerks, human resource managers, cashiers and retail sales people. Here again, these are occupations that span across the range of formal educational requirements.

TABLE 2. OCCUPATIONS WITH LARGE GROWTH POTENTIAL THROUGH CLEAN-ENERGY INVESTMENTS

College degree jobs
Operations managers
Human resource managers
Sales managers
Lawyers
Accountants
Architects
Civil engineers
Electrical engineers
Mechanical engineers
Computer programmers
Some college jobs
Construction managers
Farmers and ranchers
First-line supervisors of office workers
First-line supervisors of production workers
Engineering technicians
Computer support specialists
Accounting clerks
Payroll clerks
Secretaries
Paralegals
High school or less jobs
Agricultural workers
Janitors
Machinery assemblers
Grounds maintenance workers
Material movers
Cashiers
Customer service representatives
Retail salespersons
Shipping clerks
Stock clerks
High school or less jobs with decent earnings potential
Carpenters
Construction laborers
Electricians
Insulation workers
Roofers
Machinists
Sheet metal workers
Bus drivers
Industrial truck drivers
Truck and bus dispatchers

Source: U.S. Current Population Survey 2008
Note: These occupations are selected from the top 100 occupations with the largest growth potential within each educational category.

Clean-Energy Investments Expand Job Opportunities across All Job Categories

In Table 3, we now consider the breakdown of jobs created by both clean-energy investments and the fossil fuel industry according to our three educational credential categories. To begin with, we can see in Table 3 that the net job creation is substantially higher with clean-energy investments than fossil fuels across all three credential categories.

Compared to investments in fossil-fuel energy, clean-energy investments create 2.6 times more college degree jobs; 3.0 times more 'some-college' jobs; and 3.6 times more 'high school or less' jobs. This is true, even while the *proportions* of jobs created in the different categories differ. For example, about 23 percent of the total clean-energy investment jobs are 'college degree jobs,' while, with fossil fuel spending, 28 percent of the jobs generally require a college degree. Likewise, the proportion of 'some-college' jobs in fossil-fuels is 30.2 percent, higher than with clean-energy investments. The most substantial difference is with 'high school or less' jobs.

Differences in Employment Opportunities across Low-Credentialed Sectors

In considering employment conditions for people with high school degrees or less, it is important to recognize that there are large variations across different sectors of the economy in opportunities both to obtain jobs and to receive rising wages and better conditions over time.

To begin with, we need to give special consideration to conditions in the construction industry. Roughly 30 percent of all the job creation generated by the clean-energy investment agenda will be in the construction industry, whereas construction accounts for only about 6 percent of total US employment. There are important advantages to expanding the construction sector as a major feature of the clean-energy investment agenda. In the short term, construction has been hit severely by the housing bubble collapse, with nearly 1.6 million jobs having been lost since September 2006.[10]

TABLE 3. BREAKDOWN OF JOB CREATION BY FORMAL EDUCATIONAL CREDENTIAL LEVELS

	1) Clean-energy Investments	*2) Fossil Fuels*	*3) Difference in Job Creation (column 1 – 2)*
Total job creation	16.7	5.3	11.4
College degree jobs • *B.A. or above* • *$24.50 average wage*	3.9 (23.3% of clean-energy investment jobs)	1.5 (28.3% of fossil fuel jobs)	2.4
Some college jobs • *some college but not B.A.* • *$14.60 average wage*	4.8 (28.7% of clean-energy investment jobs)	1.6 (30.2% of fossil fuel jobs)	3.2
High school or less jobs • *high school degree or less* • *$12.00 average wage*	8.0 (47.9% of clean-energy investment jobs	2.2 (41.5% of fossil fuel jobs)	5.8
High school or less jobs with decent earnings potential • *$15.00 average wage*	4.8 (28.7% of clean-energy investment jobs)	0.7 (13.2% of fossil fuel jobs)	4.1

Source: 2008 Current Population Survey, IMPLAN

Note: Average wage is the median wage for all workers across all industries within each of the credential categories listed above.

Also, construction jobs cannot be outsourced. Retrofitting a home in Maryland can only be done in Maryland. The public transportation system in Los Angeles can be upgraded only in Los Angeles. On average, construction jobs also pay decently, in part because unions still have a strong presence in the industry. In 2008, union membership among construction workers employed in the private sector was 16.2 percent. This compares to the 8.4 percent among all private sector workers.[11]

Recent studies suggest that construction workers who join unions typically earn 25 percent more than

[10] See http://www.bls.gov/ces/#data.

[11] "Union membership in 2008," Bureau of Labor Statistics News Release, January 28, 2009.

non-union construction workers.[12] This is even higher than the average 15 percent union wage premium for workers across all industries. Aside from the bargaining power that these workers gain through union representation, unions also raise the pay and benefits of construction workers by providing apprenticeship training. This type of training greatly improves the ability of entry-level workers to establish themselves over time in relatively well-paid and stable construction-industry positions. More generally, as we discuss further below the opportunities for entry-level workers in construction are far more favorable than, for example, those facing workers in the restaurant, hotel or personal service occupations such as cleaning services.

On the other hand, employment in construction has long been dominated by white males. The industry has a history of hiring discrimination against women and racial minorities and even now, nearly 60 percent of all construction jobs are held by white non-Hispanic males. Women who try to enter construction trades face sexual harassment and work schedules that are not family-friendly. It is essential that the clean-energy investment agenda include strong measures to break down the employment barriers in these trades. An important first step would be for the Department of Labor to revive its long-dormant Federal Contract Compliance programs. If enforced, these measures would go far toward providing women and minorities a fair share of the construction jobs generated by the clean-energy investment agenda.

Beyond the situation in construction, it is more generally the case that there are significant differences among low-credentialed jobs in terms of their possibilities for advancement. In their 2005 book, *Moving Up or Moving On: Who Advances in the Labor Market?* Andersson, Holzer and Lane provide a systematic examination of what kinds of jobs provide low-income workers with decent earnings growth. By their definition, low-income workers will have made the initial steps toward moving beyond poorly-paid jobs when they are able to raise their initial earnings of about $16,000 per year (in 2008 dollars) to above $20,000 per year after about three years. According to their study, industries in which low-income workers are better able to achieve decent earnings growth include construction first of all, but also durable goods manufacturing, employment services (i.e., temporary employment agencies), health services, public administration, social services, transportation and utilities, and wholesale trade. Workers employed in industries such as apparel and textile manufacturing, hotels, personal services such as dry cleaning, and restaurants and bars have far less opportunity to improve their earnings over time.[13]

In the final row of Table 3, we show data comparing the clean-energy investment agenda with fossil fuel spending in terms of the numbers of high school or less jobs they create that have decent longer-term employment opportunities. These are jobs in the industries identified by Andersson, Holzer, and Lane as offering relatively good opportunities for improved wages over time. As we see in the table, the difference between the clean-energy investment agenda and fossil fuels is particularly sharp in this category. Here we see that clean-energy investments will create 4.8 jobs per $1 million in spending, while fossil fuel investments produce only 0.7 jobs in this category. That is, clean-energy investments generate nearly seven times more jobs here than do fossil-fuel investments. This is in the job category that will certainly be crucial for generating decent new employment opportunities for low-income people through a clean-energy investment agenda.

Expanding Good Job Opportunities through Training

Why do some jobs available to people with relatively low formal educational credentials provide better opportunities for advancement? One key factor appears to be how much training workers need to undergo before becoming fully qualified for their job. In their examination of how low-wage workers escape poverty, Andersson et al. speculate that the reason some firms pay more and provide better raises is because they invest more in training their workforce (2005, p. 117).

[12] See Belman and Voos (2006).

[13] Their findings are also broadly consistent with the research of Cancian and Meyer (2000) who studied the rate at which women improve their wages in different occupations after they stopped receiving government welfare support.

Employers have an incentive to pay their workers decent wages if their workers require moderate to high levels of training. Workers not only become more valuable to the firm because they become more productive once trained, but also because replacing such workers can be costly for the employer. If a trained worker leaves the firm, the employer cannot reap the benefits of the time and resources they invested in their now former employee's skills. Moreover, the firm must then hire and train a new worker. Decent entry-level wages and the promise of higher wages over time can help retain workers. In effect, because it is costly to replace workers with a meaningful amount of training, these workers can bargain for higher wages than workers competing for jobs with minimal training requirements.[14]

The 'high school or less' jobs with decent earnings potential we presented in Table 3, in fact, do require significant levels of on-the-job training relative to jobs in this category offering lesser opportunities for advancement. In Table 4, we illustrate this by comparing the training requirements of two sets of jobs with low formal educational credentials. The first set includes five representative occupations among the 'high school or less' jobs with decent earnings potential. These occupations include carpenters, construction laborers, construction painters, bus drivers, and truck drivers. The second grouping of jobs in Table 4 includes five representative occupations among the industries that Andersson et al. identified as having relatively poor earnings potential (hotels, restaurants, and personal services). These occupations include cooks, waiters/waitresses, cashiers, food preparation workers, and maids/housekeeping cleaners.

We use Bureau of Labor Statistics categories of "the most significant source of education or training needed to become qualified in an occupation" to characterize the training requirements of these two sets of occupations (U.S. Bureau of Labor Statistics 2008). In the upper panel of Table 4, we can see that the five representative occupations require at least moderate-term on-the-job training. These jobs require skills that at minimum "can be acquired during 1 to 12 months of combined on-the-job experience and informal training." For example, most construction laborers acquire their skills on the job by assisting other more experienced workers and then may also get some classroom training. Some construction laborer jobs require more formal training, such as 2 to 4 year apprenticeships, particularly those involved in nonresidential construction. By contrast, four of the five representative occupations with poor earnings potential require one month or less on-the-job training. Only cooks may require more than one month of training, depending on the specific type of establishment they work in, such as fast-food or full-service restaurants.

Overall then, significant levels of on-the-job training are clearly an important resource that will enable workers with low formal educational credentials to be promoted into jobs that will pay good wages. As such, to maximize the potential of the clean-energy investment agenda to create pathways out of poverty, it will be crucial to expand opportunities for ap-

TABLE 4. TRAINING REQUIREMENTS AMONG 'HIGH SCHOOL OR LESS' JOBS

Representative occupations with decent earnings potential

Occupation	*Most significant source of education or training*
Carpenters	Long-term on-the-job training
Construction laborers	Moderate-term on-the-job training
Construction painters	Moderate-term on-the-job training
Bus drivers	Moderate-term on-the-job training
Industrial truck drivers	Moderate-term on-the-job training

Representative occupations with poor earnings potential

Occupation	*Most significant source of education or training*
Cooks	Short-, moderate, and long-term on-the-job training
Waiters/waitresses	Short-term on-the-job training
Cashiers	Short-term on-the-job training
Food preparation workers	Short-term on-the-job training
Maids/house cleaners	Short-term on-the-job training

Source: BLS, 2008; CPS 2008

[14] For a review of the theories and evidence of the relationship between training and earnings see Frazis and Spletzer 2005.

propriate job training as a key complement to the overall growth in employment itself.

Here it is important to note that, as of our publication date, the ACESA bill as reported out of committee, does not include measures to assist unemployed and underemployed workers with entry into the clean-energy economy. This is a major gap in the proposed legislation. It stands in sharp contrast to the generous benefits, discussed above, that would become available to workers who face layoffs in the fossil fuel industries.

Living Wage Laws and Unions

As we have seen in Table 3, of the roughly 17 jobs per $1 million in spending that would be generated through the clean-energy investment agenda, about five fall into the category of requiring high school degrees or less, while still offering decent earnings potential. As we have just discussed, these are the jobs where training opportunities can play a crucial role in raising pay levels. But that still leaves about three jobs per $1 million in spending out of the 17 total that, based on current conditions, would not offer decent pay opportunities for people with high school degrees or less. As we have listed in Table 2, these would be for people working in agriculture, retail, and cleaning services, among others.

However, these jobs as well need to be supported by policies to ensure that they will offer at least minimally decent pay and working conditions. On its own, the clean-energy investment agenda will generate an expansion of employment opportunities in these job categories. But it cannot in itself improve conditions for such jobs. However, two complementary sets of policies can serve this purpose. They are: 1) Minimum wage laws that require a 'living wage' standard throughout the country as the legal pay-level minimum; and 2) A more favorable environment for union organizing among low-wage workers, that would, in turn, improve the bargaining power for workers hired into low-paying occupations.

This is not the place to examine these issues in depth. However, in other recent and forthcoming work, we have addressed a range of the relevant issues at hand, including how to establish living wage standards around the country; how to most effectively combine minimum wage laws and government subsidy programs (especially the Earned Income Tax Credit) to solidify a minimally decent income level for low-income workers and their families; and how unions can play a critical role in improving both wages and the overall quality of work conditions among low-paying occupations (see, for example, Pollin 2007, Pollin et al. 2008, Wicks-Lim forthcoming 2009, and Wicks-Lim and Pollin forthcoming 2009).

Employment Effects of $150 Billion Clean-Energy investment Program

To consider how the clean-energy investment agenda can generate impacts on an economy-wide scale, we have to consider the investments not simply in terms of $1 million in spending, but at a level appropriate both to the size of the economy and to the problems at hand. We therefore propose to examine a clean-energy investment expansion operating at about $150 billion in spending per year—i.e. $150 billion more in clean-energy investments and, correspondingly, $150 billion less than is now being spent on fossil fuels. This $150 billion does not necessarily come from government spending. Indeed, we anticipate that the most of the new spending on clean-energy investments will be provided by private sector investors, though many of these will be subsidized by a range of government incentive programs.[15]

Why $150 billion? Our study with Center for American Progress examines in depth the level of annual new clean-energy investments that could be generated through the combination of subsidies, incentives and regulations provided by the ACESA and the Obama stimulus program—the American Recovery and Reconstruction Act (ARRA). This level of investment would include both the direct public sector

[15] This certainly is the aim of the clean-energy components of the Obama stimulus program, the American Recovery and Reinvestment Act (ARRA) of 2009. That measure includes $100 billion in federal spending for environmental investments. But only about 25 percent of the total amount is to be spent on directly through public-sector programs alone. The rest supports a range of grants, tax incentives, and loan guarantees aiming to subsidize private investors who will undertake clean-energy investments. See Pollin, Heintz, and Garrett-Peltier (2009) for an extensive discussion of this aspect of the ARRA program. See also Pollin (2009) for a discussion of the broader issue of combining public and private investments to advance the clean-energy agenda.

spending incorporated in the ARRA, but even more importantly, the private sector investments encouraged by both the ARRA and the ACESA. A shift toward clean-energy investments at this level would amount to about 1.1 percent of GDP and about 8 percent of total private investment in the economy as of 2007, the level before the severe economic downturn of 2008.[16]

More important for our specific purposes, as we will see, a $150 billion shift in spending from fossil fuels to clean energy within the 2008 U.S. economy will generate a reduction in unemployment of around one percent. This seems like a desirable benchmark, to the extent that the clean-energy investment agenda is concerned with job creation and poverty reduction in addition to its underlying environmental benefits.[17]

In the upper panel of Table 5, we present the overall figures on employment creation through $150 billion in investment spending in clean energy and fossil fuels. The basic result is that the clean-energy investment agenda will generate about 2.5 million jobs. If one assumes the worst-case scenario to be true—that $150 billion spent on clean energy means $150 billion not spent on fossil-fuel energy—then shifting $150 billion out of fossil fuels will, in turn, lead to about 790,000 in job losses.[18] The net effect of the $150 billion clean-energy investment agenda will therefore be to increase overall employment by about 1.7 million.

TABLE 5. IMPACT OF $150 BILLION CLEAN-ENERGY INVESTMENTS ON U.S. LABOR MARKET

A) Overall employment expansion through $150 billion shift from fossil fuels to clean energy

1) Job creation through $150 billion spending on clean energy	2.5 million jobs
2) Job creation through $150 billion spending on fossil fuels	788,557 jobs
3) Net job creation through shift to clean energy (row 1 – 2)	1.7 million jobs

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

B) Impact of clean-energy job expansion on 2008 U.S. labor market

1) Overall labor force	154.3 million
2) Total employed before clean-energy investments	145.4 million
3) Total unemployed before clean-energy investments	8.9 million
4) Unemployment rate before clean-energy investments (row 3 / row 1)	5.8% (8.9 million/154.3 million)
5) Impact on total employment of shift from fossil fuels to clean energy	Employment rises by 1.72 million jobs: 1.2% increase to 147.1 million
6) Impact on unemployment rate of shift from fossil fuels to clean energy (row 3 – row 5) / row 1)	Unemployment falls from 5.8% to 4.7% (7.18 million/154.3 million)

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

In the lower panel of Table 5, we consider what the impact would have been on the 2008 U.S. labor market if there had been a net increase in employment of 1.7 million jobs. As we see, with 145.4 million employed and 8.9 million unemployed in 2008, this produced an average unemployment rate of 5.8 percent. A net increase of 1.7 million new jobs would therefore lower the unemployment rate to 4.7 percent.

This one percentage point reduction in the country's

[16] See Pollin, Heintz, and Garrett-Peltier (2009).

[17] Of course, we cannot know in advance at what point this level of annual investments in clean energy will be reached within the U.S. economy. The figure is probably higher than what is likely to occur within the next year or two, especially given the severe recession and disastrous conditions of our financial institutions. But this level of annual investments is certainly attainable over the next several years, especially if we allow that public policies such as the ACESA continue to support these initiatives beyond the initial spending support provided by the ARRA. See Pollin, Heintz, and Garrett-Peltier (2009) for further discussion on this point.

[18]The job losses would occur across the variety of industries associated with the production and distribution of gas, oil, and coal in this worst-case scenario. These include activities such as oil and gas extraction, coal mining, oil refining, pipeline transport, coal and petroleum product manufacturing, natural gas distribution, and other support activities (see the technical appendix for details). A small number of regions of the country have a high concentration of particular fossil fuel-related activities, including crude oil production in Texas, oil refining in Louisiana, and coal mining in Appalachia and Wyoming. However, other fossil-fuel-related activities—including transporting fuels, converting fuels to electricity, and retail delivery of fuel for cars and home heating—take place in every region of the country. Because these activities are geographically widespread, so too would be the job losses resulting from the declining reliance on fossil fuels as an energy source. At the same time, we do need to emphasize that this is a worst-case scenario. Under a more likely scenario, the increase in clean-energy investments will proceed at a more rapid rate than the decline in spending on fossil fuels.

unemployment rate should generate a rise in wages, across the board, and in particular for low-income workers. This is because the fall in unemployment will increase workers' bargaining power, with businesses willing to pay more to attract the workers they need. According to the body of research surveyed by Bartik (2001), a one percentage point fall in the unemployment rate—from, say, 6 percent to 5 percent, as could be accomplished by a $150 billion shift from fossil fuel spending to clean-energy investments—will in turn lead to a rise in average earnings of about two percent.[19] Bartik notes that this positive wage effect is likely to be somewhat stronger at the lower end of the labor market. This is probably because, other than the falling unemployment rate itself, those at the low end of the labor market are not likely to have other tools to help them raise their bargaining power.[20]

Differential Employment Effects of $150 Billion Clean-Energy investments

In Table 6, we now consider the differential employment effects of $150 billion in spending on fossil fuels as against a $150 billion clean-energy investment program. As we see, overall, a shift from fossil fuels to clean-energy investments will yield a net increase in U.S. employment of 1.7 million jobs—i.e. an increase in 2.5 million jobs through clean-energy investments and a corresponding decline of about 790,000 jobs in fossil fuels. Of the total jobs created through the clean-energy investment agenda, we again see, as with the $1 million program, that about 23 percent are 'college degree' jobs, 29 percent are 'some college' jobs, and 48 percent are 'high school or less' jobs. And again, with fossil fuels, while a higher *proportion* of the jobs created entail higher educational credentials, *the total number of jobs* generated through fossil fuel spending is substantially smaller than clean-energy investments across all job categories.

TABLE 6. BREAKDOWN OF JOB CREATION THROUGH $150 BILLION ENERGY INVESTMENTS BY EDUCATIONAL CREDENTIAL LEVELS

	1) Clean-energy Investments	*2) Fossil fuels*	*3) Difference in job creation (column 1 – 2)*
Total job creation	2,505,732	788,557	1,717,175
College degree jobs • *B.A. or above* • *$24.50 average wage*	591,981 (23.3% of clean-energy investment jobs)	229,185 (28.3% of fossil fuel jobs)	362,796
Some college jobs • *some college but not B.A.* • *$14.60 average wage*	715,665 (28.7% of clean-energy investment jobs)	232,067 (30.2% of fossil fuel jobs)	483,598
High school or less jobs • *high school degree or less* • *$12.00 average wage*	1,198,086 (47.9% of clean-energy investment jobs)	327,306 (41.5% of fossil fuel jobs)	870,781
High school or less jobs with decent earnings potential • *$15.00 average wage*	714,762 (28.7% of clean-energy investment jobs)	100,483 (13.2% of fossil fuel jobs)	614,279

Source: 2008 Current Population Survey, IMPLAN

Note: Average wage is the median wage for all workers across all industries within each of the credential categories listed above.

Of particular interest within the $150 billion clean-energy investment program is the net expansion of 'high school or less' jobs, since these are jobs that low-income people have the best chances to obtain. The data in Table 6 reaffirm what we have already seen in terms of the job effects of $1 million in spending on alternative energy uses. But here, in the context of the $150 billion rise in clean-energy investments, we see that there will be an expansion of 870,000 'high school

[19] A range of estimates exist on the impact of unemployment on earnings. For example, Bartik's 2001 survey of five studies (Bartik 1991, 1994, 2000; Blank and Card 1993; Card 1995) provides a range of a 1.5 to 3.5 percent increase in average real earnings when the unemployment rate falls by 1 percent. Additionally, Bartik's 2001 study estimates that the average household experiences a 1.9 percent increase in real earnings when the unemployment rate falls by one percent. Finally, Hines, Hoynes, and Krueger (2001) estimate that the average family earnings increases by 1.3 percent for one-percent fall in the unemployment rate. A simple average of the seven estimates produced by these various studies suggests that the impact of a 1 percent decline in the unemployment rate produces approximately a 2 percent rise in earnings.

[20] Of course, if an employment expansion leads to a disproportionate rise in the labor force participation rate, the subsequent disproportionate rise in the labor supply is likely to counteract positive bargaining effects for low-income workers. The key factor is that, however much the labor force participation rate rises, the unemployment rate must still fall by one percentage point in order for workers to see wage increases resulting through this channel.

or less' jobs, even after allowing for job losses in the fossil fuel sectors. Moreover, with clean-energy investments, there is a net expansion of about 614,000 'high school or less' jobs that also offer decent possibilities for rising wages over time, in many cases, as a result of workers receiving additional training.

Additional Long-Term Considerations

Is there a difference in the duration of new clean-energy jobs, compared to fossil-fuel jobs? As we have seen, clean-energy investments will generate a disproportionately large expansion of new jobs in the construction industry. It will almost always be the case that working on a single construction project will entail a shorter time commitment than being employed at a given coal mine or oil well. At the same time, the high demand for construction workers to build the clean-energy economy—not on any single construction project but on many projects throughout every community—will continue over the full generation needed to complete this epoch-defining project. In addition, as we have seen, the demand for workers connected directly or indirectly to clean-energy investments will be spread throughout economy, in every job category, not simply in construction. This source of demand for workers will also continue through the full period required to build a clean-energy economy.[21]

There is a related long-term employment effect that operates to enhance long-run job creation. That is, when consumers are able to conserve on energy through investments in various energy efficiency areas, this leaves consumers with more money in their pockets to spend on everything else besides fossil fuel energy. Now consider the full array of goods and services that comprise an average basket of consumer goods. It happens that to produce this consumer basket requires activities—like clean-energy investments themselves—that entail higher labor intensity and domestic content as well as somewhat lower wages than we see with fossil fuels. As such, this factor will tend to strengthen the positive long-term job effects of shifting out of fossil fuels.[22]

Impact of Clean-Energy Investment Agenda on Representative Workers

To provide a more concrete perspective of what it would mean for low-income households to have an adult in the household go from unemployment to having a job, we consider two representative cases drawn from the actual situations we observe with the U.S. government's household and labor market data.

For the first case, we consider the situation for a typical unemployed male construction laborer in his thirties, living alone. About 27 percent of the 33.4 million low-income households are single-person households, with men comprising about 54 percent of these households and women 46 percent. In the second case, we consider a four-person household, with two adults and two children. This kind of household accounts for about nine percent of all low-income households. In this household, we begin with one adult member working. We assume that this person is also a man employed as a construction laborer. Initially, the woman in the family is engaged in child-rearing and managing the household, but does not have a paying job. But due to an expansion of employment opportunities tied to the clean-energy investment agenda, the woman takes a job as a bus driver. In Tables 7 and 8, we consider the impact on each household situation through one adult in the household becoming newly employed.

Case 1:
Unemployed construction laborer lands a job

In this first case, an unemployed construction worker with a high school degree or less, is initially living on a range of small income sources. Typically, these will include support from family and friends, savings, and

[21] For example, as described in Pollin, Heintz, and Garrett-Peltier (2009), to retrofit the entire U.S. building stock, including all residential and non-residential structures, would require something in the range of $800 billion in new investment spending. If we were to consider this as a 20-year project, that would mean $40 billion per year in spending. This level of spending on retrofits would, in turn, generate about 670,000 jobs per year on its own. Moreover, these jobs would be distributed fairly evenly throughout all communities in the country, since, of course, all communities have buildings that would benefit significantly through energy retrofits.

[22] This source of net job creation through increasing energy efficiency has been explored in depth by Skip Laitner of the American Council for an Energy Efficient Economy. See, for example, Laitner and McKinney (2008).

government support such as food stamps. According to government statistical surveys, men in this situation would typically live on about $8,870 per year. This level of income places them well into the range of the severely poor, even according to the official government poverty thresholds.

TABLE 7. CASE 1: CONSTRUCTION WORKER IS UNEMPLOYED, THEN EMPLOYED, THEN PROMOTED

Situation for worker living alone

	Income as long-term unemployed worker	*Income gain from initial job as construction laborer*	*Income gain from promotion to carpenter*
1. Average hourly wage	$0	$12.50	$16.00
2. Annual hours worked	0	2080 (40 hours/ week x 52 weeks)	2080
4. Annual earnings	$0	$26,000 ($12.50 x 2080 hours)	$33,280 ($16.00 x 2080 hours)
5. Total income	$8,000	$26,000	$33,280
6. Federal income tax	$0	-$2,153	-$3,428
7. Social security tax	$0	-$1,989 ($26,000 x 7.65%)	-$2,546
8. Earned income tax credit	$0	$0	$0
9. Child tax credits	$0	$0	$0
10. Food stamps	$870	$0	$0
Disposable Income (sum of rows 5 - 10)	$8,870	$21,858 (+$12,988; a 146% increase)	$27,306 (+$18,436; a 208% increase)

Source: 2008 Current Population Survey

Notes: The new job is a representative construction-laborer job with the average wages and hours of a worker with a high school degree or less. The $8,000 in reported income among jobless single individuals could be coming from social security, supplemental security income, interest income, financial assistance from people outside the household, and financial aid for education.

We then allow that this person becomes employed full-time as a construction laborer, earning the average wage of $12.50 an hour for this job among those with a high school degree or less. As a result of obtaining this job, the construction worker's earnings rise to $26,000 per year. We also assume that this worker is no longer able to draw on his personal sources of support providing him with the $8,000 he was living on while he was unemployed. Because he now is earning income, he also has to now pay both income and social security taxes. He also loses his food stamp eligibility. But as a single man living with no children, he is not eligible for either Earned Income Tax Credit (EITC) support or, of course any form of child tax credits.

Netting out all of these various factors, the effect for the construction worker of moving from unemployment to having a job means that his disposable income rises from $8,870 to $21,858. This is an income increase of about $13,000.

One of the advantages of working as a construction laborer is that it can lead to other better-paid occupations in the construction industry. For example, by assisting other craft workers, such as carpenters, this construction laborer can gain on-the-job training to become a carpenter himself over time. Alternatively, the work experience he gains as a construction laborer can help get him into a carpenter apprenticeship program. After completing a 3-4 year apprenticeship program he can become a carpenter through this route as well. In the last column of Table 7 we illustrate how the living standard of this worker would change if he moved from his entry-level job as a construction laborer to a position as a carpenter.

Thus, in the last column of Table 7, we allow the construction laborer to advance to a job as a carpenter earning the average carpenter wage of $16.00 an hour. This higher wage increases the worker's earnings from $26,000 to $33,280, an increase of about $7,000. This worker is now earning at a level that well exceeds our poverty standard of twice the official poverty line, or $20,652 for a single person under 65 years old.[23] Netting out the rise in his tax obligations, the higher wage rate of $16.00 now represents an

[23] Both the federal poverty income threshold and EPI's basic budget income thresholds (discussed earlier) are pre-tax measures. That is, these income thresholds account taxes as among a family's living expenses.

increase in disposable income to about $27,000. This level of disposable income represents an improvement of $18,000 per year relative to his situation when he was unemployed. In this case, the clean energy investment agenda has provided a clear pathway out of poverty for this worker.

Case 2: Mom becomes a bus driver

In this case, we assume that the father in this household, like in the previous case, holds a job as a construction laborer. But the mother, who had been focused on childcare and running the household, now accepts a position as a bus driver. This position opens up as a result of the large expansion in public transportation spending associated with clean-energy investments. This woman's wages will be $13.70 per hour, which is the average wage for bus drivers with a high school degree or less. She will be employed for a full 52 weeks, but at 30 hours per week, as opposed to a full-time position. This is about the average number of hours that bus drivers are now employed throughout the U.S.

We see in Table 8 the impact on the family's living standard of the mother becoming a bus driver. When only the father working in paid labor, the family was eligible for both the earned income tax credit of $3,290 and child credits of $2,000. But these government subsidies are counterbalanced by both federal income and social security tax obligations.

Overall, when the father brought home the family's only paycheck, the family's earnings were $26,000. This places them at about $17,700 below our poverty standard of 200 percent of the official poverty line of $43,668 for this sized family. When the mother takes a job as a bus driver, this means that the family's total earnings rise to $47,372. Their income and social security taxes now rise with this additional income source. The family also now loses its EITC eligibility. With both parents working, the family's annual disposable income now rises to more than $43,000. This is a 48 percent increase over their situation when only the father was employed in construction.

At the same time, because the mother is now in the workforce, she now has much less time available for child care. We therefore have to allow that the family's child care expenses will rise considerably. Based on research underlying the EPI's basic budget standard, we allow that child care costs will amount to about 20 percent of the household's earnings when

TABLE 8. CASE 2. MOTHER/HOMEMAKER BECOMES A BUS DRIVER

Change in family income when second adult in 4-person household becomes employed

	Family income with just father as construction laborer	*Family income with both adults working: mother hired as bus driver*
Father:		
1. Hourly wage as construction worker	$12.50	$12.50
2. Total hours of work	Full-time: 2080 hours (40 hours/week x 52 weeks)	Full-time: 2080 hours
3. Annual earnings	$26,000 ($12.50 x 40 x 52)	$26,000
Mother:		
4. Hourly wage as bus driver	—	$13.70
5. Total hours of work	0	¾ time: 1,560 hours (30 hours/week x 52 weeks)
6. Annual earnings	0	$21,372
Household:		
7. Total household income (rows 3 + 6)	$26,000	$47,372 (+82.2%)
8. Federal income tax	-$111	-$2,569
9. Social security tax	-$1,989	-$3,624
10. Earned income tax credit	$3,290	$0
11. Child tax credits	$2,000	$2,000
12. Food stamps	$0	$0
13. Disposable income without child care costs (sum of rows 7 – 12)	$29,190	$43,179 (+47.9%)
14. Child care costs	—	-$9,500
Disposable income with child care costs (row 13 + row 14)	$29,190	$33,679 (+15.4%)

Source: 2008 Current Population Survey

Notes: This household has two adults and two children. The new employment is from a representative bus driver job with the average wages and hours of a worker with a high school degree or less.

both parents are at jobs close to full-time. This means that child care expenses rise to about $9,500 per year. Even so, net of the increase in the family's child care costs, the family's disposable income is now about $34,000. Thus, even if we subtract the new child care costs from the family's disposable income, the family still has about $4,000 more in their budget. This is a 15 percent rise over their situation when only the father was employed.

Thus, with this household as well, the new job opportunities generated by the clean energy investment agenda has created a pathway out of poverty for this family as well. They move from earning about $17,700 below the 200 percent of poverty line standard to $3,700 over the 200 percent line. Even after allowing for their increased tax obligations and child care costs, the new job opportunities generated by the clean energy investment agenda will lead to a substantial improvement in the family's living standard.

HOME RETROFITS FOR LOW-INCOME HOUSEHOLDS

Since 1977, the U.S. Department of Energy has maintained a Weatherization Assistance Program (WAP) for low-income families that provides support for homeowners' residential retrofits. Since its inception, 6.2 million households have received support through this program. This amounts to about 200,000 low-income households a year getting assistance to retrofit their homes. In more recent years, the number of households served per year has dipped significantly below this average rate, to roughly 100,000 households per year.[24]

The program is being expanded substantially through the ARRA, with $5 billion being allocated over two years to support retrofits for households whose income is up to 200 percent of the official poverty line, i.e. to the level we are using within this study as our target group. Under this program, low-income households could receive up to $6,500 to finance their home retrofit. The ARRA also is providing an additional $3.1 billion through the State Energy Program and $3.2 billion through the Energy Efficiency and Conservation Block Grant Program, which are other potential sources of funding, both for retrofitting buildings and to support consumers making additional energy-saving improvements in their homes. Beyond the ARRA, additional measures, such as the ACESA now before Congress, aim to create further incentives to promote energy efficiency in residential structures. In the ACESA, the primary policy tools to promote energy efficiency are: (1) a national building code; (2) funding to states for building efficiency retrofit and low-income energy efficiency programs; (3) a national energy efficient appliances program.[25]

Overall, these government initiatives recognize a crucial point about residential building retrofits—that they offer a major opportunity to deliver environmental benefits as well as a higher living standard for low-income households. We can see this both for low-income households composed of homeowners as well as those who are renters. In all cases, the key will be to develop adequate incentives and institutional support networks to effectively deliver the large benefits that are available.

To begin with, let us consider the possibilities available to homeowners through retrofitting an average privately-owned home in the United States. We develop this average case based on figures provided by the U.S. Department of Energy, as well as through the work of Prof. Paul Fisette, a leading authority in the field. Fisette has found that for an average home in the United States, an investment of about $2,500 in a home retrofit could produce an energy saving of about 30 percent per year. The $2,500 expenditure would cover an energy audit, sealing air leaks with caulking, insulating attics and basement ceilings, and purchasing energy-efficient light bulbs.[26]

As of 2007, the average household income was around $60,000, and the average household spends about five percent of its income on household energy consumption. This means that the five percent of total income going to household energy consumption amounts to $3,000 per year. This means that through a $2,500 investment for a retrofit—about 80 percent of the household's annual energy budget—the average household would save about $900 per year in reduced energy costs. The $900 in savings that this average household would enjoy each year through the energy retrofit means that the $2,500 investment in home retrofitting will fully pay for itself within three years. These figures are brought together in Table 9 below.

[24] See apps1.eere.energy.gov/weatherization/prog_goals.cfm?print for details on the rate of service of the Weatherization Assistance Program.

[25] See http://apps1.eere.energy.gov/weatherization for details on the Weatherization Assistance Program.

[26] See http://www.umass.edu/bmatwt/faculty/PFisetteCV_2006.pdf for Prof. Fisette's publications on this issue. We are grateful to Prof. Fisette for extensive personal discussion in addition to what we found in his publications. In terms of the costs of retrofitting an average home, Fisette explains that average household could raise energy efficiency still more by spending another $2,500—for a total of $5,000—on insulating or replacing windows, purchasing energy-efficient appliances, and purchasing a thermostat reset, which can control the amount of energy needed to maintain hot water in the home's boiler. A still more expensive retrofit, in the range of $8,000 would include putting more insulation into walls, putting new siding on walls, and purchasing a more energy efficient furnace or boiler.

TABLE 9. ANNUAL SAVINGS FROM INVESTMENT IN HOME RETROFIT

Example is for average household, $2,500 retrofit

Annual household income	$60,000
Annual household energy expenditures (5% of total income)	$3,000
Potential annual savings from $2,500 retrofit (30% of current expenditure level)	$900

The proportional costs and savings attainable through these relatively modest investments in retrofits could be achievable as well with both smaller homes owned by low-income households as well as with multi-unit residential buildings for renters. That is, a savings in energy costs of around 30 percent per year would be attainable through an initial investment which is roughly equal to about 80 percent of one year's annual energy bill.

In Table 10, we show the living circumstances for the 33.4 million household that live below 200 percent of the poverty line. As we see, these households are roughly evenly divided between homeowners (16.5 million households) and renters (16.9 million households). We have broken down renters further between those living, respectively, in unsubsidized (12.5 million households) and subsidized (4.4 million households) apartments. These differences will be significant for establishing the appropriate arrangements to enable the residents of these various dwelling types to all benefit from the energy savings resulting from retrofits.

The most straightforward situation is with the 16.5 million low-income households that are homeowners. This household type could save about $630 per year through a low-cost retrofit, costing about $1,800. As we see in the table, savings at this level would represent a nearly four percent reduction in living costs relative to the households' income. In other words, after the retrofit has been paid off, this investment alone would raise the living standard of these households by about four percent. By lowering their demand for energy within the home, low-income households would also reduce their vulnerability to the severe swings in energy prices that we have experienced in recent years. These sharp price fluctuations have produced insecurity among low-income households as to their ability to cover their monthly energy bills, especially in the winter. The benefits for low-income households of raising their level of home energy efficiency are, of course, in addition to the environmental benefits of reducing energy consumption and greenhouse gas emissions.

TABLE 10. ENERGY COST SAVINGS FOR LOW-INCOME HOUSEHOLDS

Type of residence	# of Units	Median household income (2007$)	Average annual energy expenditure	Approximate investment per unit for low-cost retrofit	Approximate potential cost savings	Energy savings as % of household of income
Owner occupied	16.5 million	$16,564	$2,108	$1,800	$630	3.8%
Renter-unsubsidized	12.5 million	$14,740	$1,648	$1,400	$500	3.4%
Renter-subsidized	4.4 million	$10,476	$1,648	$1,400	$500	4.7%

Sources: Median income comes from ASEC 2008; U.S. Department of Housing and Urban Development (2008); U.S. Department of Health and Human Services (2008).

Yet we do still need to consider how the initial up-front investment of $1,800 will be financed. The easiest answer is that the funds could come through the $5 billion in Weatherization Assistance provided by the ARRA. However, at most, these funds could cover around 2.8 million owner-occupied homes with $1,800 in support, i.e. about one-sixth of all low-income households. This would represent a major level of support for energy efficient homes in the U.S., but would still leave close to 14 million low-income households in need of financing through other means.

Self-Financing?

As a more general case, it is clear from our numerical examples that, if low-income households could cover the initial $1,800 up-front investment in the retrofit, they would start seeing energy cost savings immediately, and their full investment would be covered in three years. In subsequent years, the energy savings would go directly into their pocketbooks. In principle therefore, individual homeowners could certainly choose to take on the retrofit project on their own, without a government subsidy, and still come out ahead within about three years.

The drawback of this approach is that it relies on millions of homeowners to take the initiative to get the financing and manage the retrofit project. This could create excessive levels of small-scale administrative efforts, which would slow down the forward progress of any large-scale clean-energy investment initiative. This is a problem especially to the extent that one would want the program to be implemented fairly quickly. It also places heavy demands on low-income households to come up with the initial investment funds, take on financial risks and find extra time to manage such a project.

As a way to make such projects broadly feasible for low-income homeowners beyond the subsidies available from the Weatherization Assistance Program, it will be necessary to introduce intermediaries of some sort to serve as administrators and risk-bearers. These intermediaries could be paid for their services through the utility bills of building owners, or some other pre-established mode of payment. Indeed, a local utility company, or home heating oil supplier could themselves possibly serve as the intermediaries administering the program. Non-profit community organizations or stand-alone businesses could equally serve this role.[27]

The logistics of such an arrangement could be quite straightforward. Let's first consider a case within the context of the Weatherization Assistance Program. To begin with, in exchange for handling all the bureaucratic matters associated with receiving support from the Weatherization Assistance Program as well as arranging all the logistics of the home retrofit, the intermediary would receive, for example, the $630 in energy savings from the first year subsequent to the retrofit. These funds would come directly from the homeowners' heating or utility bills. The homeowners would then see the benefits of reduced energy bills one year later than they would have had they themselves arranged for the retrofit. Meanwhile, the intermediary would have a substantial incentive to provide these cost savings as quickly as possible for all low-income homeowners.

What about the majority of cases, when there is not likely to be support available through the Weatherization Assistance Program? Of course, it would be preferable to be able to extend the WAP to most, if not all, low-income homeowners. Short of that, we should at least allow low-income homeowners who invest in retrofits to receive bank loans for the project at a subsidized rate.

Table 11 illustrates a simple financing scheme for retrofitting an average home for low-income households. Under this plan, the full amount of the $1,800 funding for the project is borrowed. The full loan period is five years, with a simple interest rate at the below-market subsidized rate of three percent.

TABLE 11. FINANCING ARRANGEMENT FOR LOW-INCOME HOMEOWNER RETROFIT

Funds needed for retrofit	$1,800
Loan principal	$1,800
Subsidized interest rate on loans	3 percent subsidized simple interest
Repayment schedule	1st year savings split between homeowner and intermediary; 4 subsequent years, principal and interest
Total annual debt servicing for four years	$500/year ($450 principal; $50 interest)

	Annual savings relative to pre-retrofit	*Annual debt servicing*	*Annual net savings*
Year 1: Retrofit year	$630	0	$630 (split between homeowner and intermediary)
Year 2	$630	$500	$130
Year 3	$630	$500	$130
Year 4	$630	$500	$130
Year 5	$630	$500	$130
All subsequent years	$630	0	$630

[27] These issues are also explored well in Rogers (2007).

In the first year of the loan, we assume the $630 in savings is shared between the homeowner and the intermediary who arranged for the financing and contracting out the project. The homeowner would then make annual payments of $500 in four subsequent years—$450 of principal and $50 in interest.[28] During these four years, the homeowner would still see their energy bill reduced by $130 per year. They would also make no out-of-pocket payments to their lenders. The payments to lenders could rather come directly from the homeowner's utility bill. As we see in the lower panel of Table 12, there is no period over the life of the loan where the annual repayment is greater than the annual energy savings of $630. And of course, after the loan is repaid, the homeowners will then receive the full net energy savings of $630 every year thereafter.[29]

Getting Benefits to Renters

This arrangement could not operate quite as straightforwardly in delivering benefits of retrofits to the 16.9 million low-income households that are renters. But as a general principle, if the government is providing weatherization assistance for rental units as well as owner-occupied dwellings, the condition under which landlords could receive government assistance could be that their tenants would have to receive some significant share of the reduction in energy costs. This could be handled in a straightforward way in cases where the renters themselves cover their own utility bills. In this case, the renters would see the utility bills reduced as a proportion of the overall energy savings achieved through the retrofit. We would also allow the landlords to receive a share of their energy savings. For example, if we assume that the total energy savings is $500 per year for each rental unit, we could allow that the tenant receives $450 in a reduced utility bill and the landlord receives the remaining $50 per unit. In this case, the tenant would still see their annual energy costs reduced by about four percent of their annual income. Again, this means that effectively their living standard would rise by four percent from this measure alone.

It will be more difficult to implement such measures when landlords rather than tenants are responsible for paying utility bills. However, the landlords themselves would see their energy costs fall through the retrofit. In a competitive housing market, this fall in landlords' costs should in turn lead to at least a partial pass-through in terms of lower rents for tenants, since landlords that do lower their rents will be more likely to attract new tenants.

In the case of subsidized housing units, rents are established based on formulas tied to renters' ability to pay. Here, we could simply incorporate the energy savings into the formula, and reduce rent levels commensurately, after allowing for the administration costs of arranging for the retrofits. We saw in Table 11 that the average low-cost retrofit could generate energy savings of about 4.7 percent of the annual income for low-income families living in subsidized housing. It is therefore reasonable to expect that the retrofit could yield an improvement in these families' living standard in the range of four percent, with the remaining cost savings being used to support the general administrative costs of the subsidized housing program.

Overall, through advancing a series of institutional innovations in the market for building retrofits in combination with the existing and continued levels of government support, it is reasonable to expect that a large-scale residential retrofit program could reduce living costs, and corresponding raise living standards, for low-income households by about 3 – 4 percent. And of course, these benefits would be in addition to the environmental gains achieved through operating our residential housing stock much more efficiently than is done at present.

---

[28] At a three percent interest rate, the actual interest annual interest payment would be $54, rather than $50. We have rounded to $50 to keep the illustration as simple as possible.

[29] In the case of a homeowner who wishes to sell their home before having fully repaid their loan, the sale price of the house should, in principle, be higher, to reflect that the house operates at a higher level of energy efficiency. However, the U.S. housing market is not likely to incorporate the benefits from retrofit investments in home prices, if for no other reason than this would be unfamiliar territory for them. It will therefore be important for government initiatives to spread information as widely as possible as to the cost savings that homeowners will receive after a house has been retrofitted.

PUBLIC TRANSPORTATION

Increasing use of public transportation, as against private auto transportation, is an important element in building a clean-energy economy. At present, burning fossil fuels for transportation purposes accounts for about 34 percent of total carbon emissions emitted within the United States, and private transportation accounts for about 61 percent of all transportation emissions.[30] To transport people via public transportation as opposed to private cars produces a net reduction in carbon emissions of about 45 percent per passenger mile. Thus, if we allowed that the share of public transportation travel could rise to about 25 percent as a share of total transportation, this, in turn, would alone generate a two percent reduction in total greenhouse gas emissions.[31]

Investing in public transportation is also a major source of job creation, relative to spending on fossil fuels. Spending $1 million on public transportation will generate about 21 jobs, while, as we have seen, spending the same $1 million on oil and coal will generate about 5.3 jobs—i.e. spending a given amount of money on mass transit generates about 4.4 more jobs than spending on fossil fuels.[32]

Finally, traveling by public transportation is much cheaper than traveling by private car. On average, it costs about 22 cents to travel one mile by public transportation, while a private car costs about 54 cents per mile.[33] That is, on average, public transportation is about 59 percent cheaper than traveling by private car.

The Obama administration's ARRA program clearly recognized the importance of expanding the access to public transportation, allocating $18 billion over two years to a range of transportation projects. This represents 18 percent of the clean-energy and environmental budget within the ARRA. Some of the specific initiatives being supported by the ARRA include purchases of electric buses, light rails, and high-speed trains, to both expand public transportation offerings and raise their energy efficiency. Given our specific concern with job creation, it is important to also note that the $18 billion expenditure—$9 billion per year—will generate about 190,000 jobs per year within the U.S. economy. If the same level of funding were instead allocated to expand activity in the fossil fuel industry, the total job creation would instead be about 50,000 jobs per year. Thus, moving the funds into public transportation as opposed to fossil fuels generates a net employment gain of about 140,000 jobs.

Despite these major advantages of public over private transportation, public transportation accounts for an extremely low share of total travel in the United States. We can see this from the figures presented in the upper panel of Table 12. As the table shows, as of 2007, the average U.S. household spent about 94 percent of its total transportation budget on private automobiles, and only six percent on public transportation. The share of public transportation spending by lower-income households is even lower, with the lowest 20 percent income group spending only 5 percent, and the 21-40 percent income group spending a still lower 4 percent of their respective transportation budgets on public transportation.

---

30 American Public Transportation Authority, www.apta.com/research/info/online/documents/climate_change.pdf.

31 Figures in this paragraph come from the Energy Information Administration, www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html; and the American Public Transportation Authority, www.apta.com/research/info/online/documents/climate_change.pdf. See technical appendix for a description of how we estimated the reduction in emissions due to increasing public transit use to 25 percent of total transportation. Achieving a rate of public transit use this high or higher has been achieved in dense urban areas such as the city of Chicago. In other areas, such rates would likely be achieved only among households close to urban centers. Given that 80 percent of the U.S. population lives in urban areas (see U.S. Census Bureau, 2000 Census of Population and Housing, Population and Housing Unit Counts PHC-3) an estimate of 25 percent of public transit use seems like a reasonable high end goal.

32 Pollin, Heintz, and Garrett-Peltier (2009).

33 Cost of public transportation is from 2008 Public Transportation Fact Book, published by the American Public Transportation Association (June 2008), Table 2: National Totals, Fiscal Year 2006, and adjusted by the Bureau of Labor Statistics Consumer Price Index to reflect public transportation price increases between 2006 and 2007. Cost of private car transportation is from the Bureau of Transportation Statistics, National Transportation Statistics, Table 3-14: Average Cost of Owning and Operating an Automobile. The latest figure is for 2007 http://www.bts.gov/publications/national_transportation_statistics/html/table_03_14.html.

TABLE 12. HOUSEHOLD SPENDING ON PUBLIC AND PRIVATE TRANSPORTATION IN THE UNITED STATES, 2007

A) Public and private transport as share of total transport

		Private transportation		*Public transportation*	
	Total transportation spending	Amount of private transportation spending	Private transportation spending as share of total	Amount of public transportation spending	Public transportation spending as share of total
All U.S. households	$8,758	$8,220	94%	$538	6%
Lowest 20% income group	$3,240	$3,071	95%	$169	5%
21-40% income group	$5,717	$5,475	96%	$242	4%

B) Public and private transport as share of total household spending

	Total household spending	Private transport spending as share of total household spending	Public transport as share of total household spending
All U.S. households	$49,638	16.6%	1.1%
Lowest 20% income group	$20,471	15.0%	0.8%
21-40% income group	$31,150	17.6%	0.8%

Source: Consumer Expenditure Survey, 2007, "Table 1. Quintiles of income before taxes: Average annual expenditures and characteristics," www.bls.gov/cex/2007/Standard/quintile.pdf

The broader importance of these figures becomes clear from the lower panel of Table 12, where we show transportation costs as a share of total family spending. As we see, transportation constitutes a very large share of a household's total budget—nearly 18 percent of the budget for an average household, and between 15 and 18 percent for lower-income households. As such, any initiative that could succeed in shifting households toward using public transportation would generate major benefits both in terms of the environment and job creation. It would also be a way to significantly reduce the costs of living for low-income households.[34]

There has been a notable rise in public transportation ridership over the past two years, with, for example, overall ridership rising by about four percent in 2008 relative to 2007.[35] This increase in public transportation use was initially sparked by the sharp rise in oil prices. But even as oil prices fell beginning in the fall of 2008, public transportation use continued to rise. The main factor here is almost certainly that households are attempting to reduce costs during the recession. Thus, automobile travel fell by 3.6 percent in 2008. It remains an open question whether this shift in favor of public transportation will be sustainable over time, depending primarily on whether the quality of service can improve.

Beyond this experience of the past two years, the broader question is why haven't U.S. residents, especially those at low income levels, relied more on public transportation over time? The answers provided in surveys are not surprising. According to a 2001 study by Giuliano, Hu and Lee, the main factor is that public transportation is much less convenient than driving—i.e. access is bad, off-peak hours service is limited, and transferring is difficult. This makes public transportation particularly difficult for low-income people, who, as part of their regular routine, often need to commute between multiple jobs, as well as transport children to child care and school. Of those that do use public transportation, a significant share say that it is also expensive.

Survey evidence also makes clear that if the public transportation component of the clean-energy investment agenda could address these issues of inconvenience and costs with reasonable success, the payoff could be substantial for low-income households. For example, if the public transportation component of the clean-energy investment agenda could enable the average lower-income household to in-

[34] Why do higher-income households spend a higher share of total household spending on public transportation? This is primarily because higher-income households tend to travel longer distances (e.g., from a suburb to the downtown of a nearby city) whereas lower-income households tend to travel short distances within central cities. Also, commuter rail service attracts higher-income riders even though they own cars because this service can provide a more dependable, less stressful, and faster way to travel than driving (Pucher & Renne, 2003).

[35] Data are from American Public Transportation Association March 9, 2009 quarterly report, www.apta.com/media/releases/documents/090309_ridership.pdf.

crease their use of public transportation to 25 percent of their miles traveled, that alone would save the household $260 to $500 per year, raising their living standard through this one measure alone by 1 to 2 percent. Of course, a more ambitious target would deliver proportionally greater benefits. For example, raising the low-income household's use of public transportation to 50 percent of its total miles traveled would save low-income families nearly $800 per year, raising their living standard by nearly four percent.

How Public Transportation Raises Living Standards

This rise in living standards for lower-income households, in the range of one to four percent, actually averages two distinct situations: large cost savings that occur when households replace one of their vehicles with public transit, and limited cost savings when households use public transportation but do not reduce the number of cars they own.

Consider the situation that applies to the roughly 75 percent of low-income households that own at least one vehicle. An improved public transit system could allow some of these households to reduce the number of cars that they own.[36] Households that replace a car with public transit would see their annual transportation expenses fall by roughly $2,000, about 10 percent of their total household expenditures.[37] This dramatic reduction in the household's transportation expenses occurs because fully 70 percent of the cost of owning a car are 'fixed'—they result because you own a car, regardless of how much you drive the car. These fixed costs include the sales price itself, including financing, insurance, registration fees, and taxes. Only 30 percent of costs depend on how much one drives—i.e. variable costs, including fuel and maintenance. Moreover, the costs per mile on public transit are roughly equal to the variable costs per mile of driving. As such, just replacing the number of miles travelled by car with public transit, while still owning the same number of cars, does not yield any cost savings.

What about the 25 percent of low-income households that owns no vehicles? For these households, an improved public transit system will deliver savings, but these will be lower than for the households that could reduce their level of car ownership. These savings for households who own no cars come from reducing their use of other more expensive modes of transportation, such as taxis, that they rely on when they do not either own a car or have convenient public transit service. Other available modes of transportation such as walking or biking, while less expensive than public transit, can only be used to access areas within a limited distance. By contrast, as we discuss further below, better public transit can improve the living standards of low-income people by increasing their mobility, including their access to jobs.

Finally, there are broader benefits for all households in a low-income neighborhood in which public transit service is improved. Public transit access is generally viewed as a neighborhood amenity, and consequently, tends to raise the property values of nearby residences. In addition, public transit stations tend to attract retail activity to the neighborhoods in which they are located.[38] These higher levels of retail activity can further reduce the transportation expenses of households in that neighborhood, since more retail stores can be reached by walking or biking.

Overall, dramatic improvements in public transit can raise the living standards among some low-income families as much as 10 percent when they reduce the number of cars they own. Such costs savings will most likely be possible for households near the urban centers in their area.

Targeting Investments in Public Transit

Such a shift in transportation patterns for lower-income households would require major investments in our public transportation infrastructure. The ARRA is certainly a major step in the right direction, but a continued large-scale commitment will be needed beyond the two years budgeted through the ARRA.

[36] In fact, in large cities known for their effective public transit systems such as New York, Washington D.C., Boston, San Francisco, and Chicago, the percentage of residents who own no cars is much higher than the national average and roughly equal to the percent of residents that rely on public transportation for commuting (2005-2007 American Community Survey, U.S. Census Bureau). This pattern suggests that when public transportation is accessible and convenient, significant numbers of households choose to own fewer vehicles.

[37] See technical appendix for details on the cost savings calculations.

[38] See Debrezion, Pels, & Rietveld (2007) and Bowes & Ihlanfeldt (2001).

We do have useful experiences on which to draw from the federal government's current program that is aimed at improving public transportation services available to low-income people and reducing the fares of such services. This is the Job Access and Reverse Commute Program (JARC), which was established in 1998, "to address the unique transportation challenges faced by welfare recipients and low-income persons seeking to obtain and maintain employment," according to the U.S. Federal Transit Administration. When the country's welfare policies were overhauled in 1997, JARC was created specifically to assist welfare recipients to connect with job opportunities by making transportation to jobs much more accessible. The U.S. Government Accountability Office reported in 1998 that three-fourths of welfare recipients were living in central cities or rural areas, while two-thirds of new entry-level jobs were located in suburbs (GAO, *Public Transportation, 2006,* www.gao.gov/new.items/d06910t.pdf, p. 6). Since its inception, the program has evolved to offer transportation services more broadly among low-income people, though the focus has been maintained on facilitating access to employment opportunities. For fiscal year 2009, federal JARC funding is $165 million. These funds are then matched on an equal basis by state and local support within the communities in which JARC services are provided.

For 2006, the JARC program provided about 23 million one-way trips overall. At a total cost of about $280 million, this meant that the average cost per ride under JARC was about $12. By contrast, the cost per ride for non-JARC transportation services averaged about $10 in 2006. The program is therefore relatively expensive to administer in terms of this cost measure alone. At the same time, the benefits of the program have also been substantial. According to a 2008 survey of JARC users, 27 percent reported that they were able to newly enter the labor force due to the services provided by JARC. Forty-one percent of JARC users were workers who already had jobs, but were able to earn more as a result of the services provided by JARC. About 12 percent of JARC users reported being able to access new destinations for employment that previously had been inaccessible (Thakuriah et al. 2008, p. 22). Given these results, it is fair to conclude that the JARC program does, at the least, offer important lessons as to how to develop public transportation systems in ways that benefit low-income households. These gains for low-income households, moreover, are in addition to the important environmental benefits that accrue from raising the share of public transportation use throughout the U.S.

It is beyond the scope of this study to examine in depth the most cost effective means for making public transportation broadly accessible and affordable for low-income people. However, in addition to considering the relatively small-scale JARC program, we can also gain valuable perspectives by considering the regions of the country where public transportation is already utilized extensively, by low-income people as well as the population more generally. Thus, in Table 13, we have listed five major cities—New York, Washington DC, Boston, San Francisco, and Chicago—where at least 25 percent of residents rely primarily on public transportation for commuting. As Table 13 also shows, in Los Angeles, only 11 percent of residents rely on public transportation for commuting. Thus, as a general approach, we can learn from the positive cases of New York, Washington, Boston, San Francisco, and Chicago, as well as from the negative example of Los Angeles in developing effective public transportation systems—i.e. systems that can succeed in delivering both environmental benefits and improved living standards for low-income people.

TABLE 13. PUBLIC TRANSPORTATION USE FOR WORK COMMUTES 2005-07

Percentage of workers who use public transit to commute to work

New York	54.6%	San Francisco	32.2%
Washington, DC	37.8%	Chicago	25.9%
Boston	32.5%	Los Angeles	11.0%

Source: 2005-2007 American Community Survey, U.S. Census Bureau, factfinder.census.gov/servlet/ACSSAFFFacts?_submenuId=factsheet_0&_sse=on

Overall then, the transportation component of the clean-energy investment agenda can contribute as a significant pathway out of poverty. But to do so, it will be imperative to build on the knowledge available as to how to make public transportation a truly viable option for low-income people.

CONCLUSION

Probably the single most fundamental policy challenge for the next generation is to build a clean-energy economy and defeat the threat of global climate change. The overarching strategies for achieving this aim are clear: to make massive investments every year in energy efficiency and renewable energy, and to establish limits on the pollution from the production and consumption of oil, coal and natural gas, to reflect the environmental damages inflicted through burning fossil fuels.

As we are becoming increasingly focused on this environmental agenda, we also need to recognize that this project—as with all economic policy initiatives—will generate effects beyond those that define its central mission. The question we have pursued in this paper is the extent to which clean-energy investments may serve to raise living standards for low-income people in this country, i.e. create new 'pathways out of poverty' for the 78 million people in this country who are presently poor or near-poor. This is about 25 percent of the entire U.S. population.

Our study has focused on three basic channels through which a clean-energy investment agenda can indeed significantly improve living conditions for low-income households: by significantly expanding employment opportunities, especially for people with relatively low formal educational credentials; by lowering heating and utility bills through building retrofits; and by increasing access to public transportation. Table 14 summarizes our main findings in the three areas of employment effects, building retrofits, and public transportation.

In exploring these connections, a few central facts have emerged. The first and most important is that spending a given amount of money on building a clean-energy economy will create roughly three times more jobs within the United States than spending the same amount of money within our existing fossil fuel infrastructure. As shown in our study with CAP, in the context of an annual $150 billion dollar-for-dollar investment shift out of fossil fuels and into clean energy, this difference nets out to about 1.7 million jobs. Most of these jobs will pay at least decently or offer good prospects for job training, raises and promotions. We can ensure that all the jobs provide at least minimally decent opportunities through combining the clean-energy agenda and job training programs with living wage standards and fair access to union representation.

The net increase of 1.7 million jobs throughout the U.S. economy, including nearly half that are accessible to workers with relatively low formal educational credentials, can itself drive down the unemployment rate by about one percentage point, from, say, six to five percent. This in turn improves workers' bargaining power, including their power to fight for better training programs, union representation, and living wage standards. In this context, the transformation to a clean-energy economy can serve as a major long-term engine for expanding decent job opportunities in the U.S. This, in turn, is the single most effective tool for moving people out of poverty and into productive working lives.

TABLE 14. SUMMARY OF BENEFITS FROM CLEAN-ENERGY INVESTMENT PROGRAM FOR LOW-INCOME HOUSEHOLDS

1) Moving from unemployment to employment	• 1.7 million new jobs overall • 870,000 jobs for workers with low education credentials • Newly employed low-income workers can lift themselves and family out of poverty
2) Falling unemployment produces rising wages	• Average low-income worker could see a rise in earnings of about 2% as unemployment rate falls 1%
3) Building retrofits lower home heating and utility bills	• Retrofits could reduce living costs up to 4 percent, depending on the climate and quality of current housing stock. • Requires well-designed policies to create market for retrofits for homeowners and renters so benefits of retrofits are shared by renters
4) Improved public transportation	• Accessibility of public transportation could improve considerably through targeted investments • Increasing public transportation use in urban centers to around 25% to 50% of total could reduce living costs by about 1-4% • Households able to replace a car through increased public transit use could save roughly 10% of total living costs

If managed correctly, a clean-energy investment agenda can also lower overall energy costs for consumers, especially benefitting lower-income households, even as we necessarily impose limits on the burning of fossil fuels. The channels here are through retrofitting home residences to raise energy efficiency as well as substantially improving access to public transportation.

Considering the full array of policy channels we have presented in this study, the main conclusion we reach is that the transition to a clean-energy economy has the capacity to merge the aims of environmental protection, broadening economic opportunity and poverty reduction through powerful and mutually reinforcing connections. The clean-energy investment agenda, in other words, holds the promise of delivering a wide range of fundamental economic and environmental gains across all segments of the U.S. population.

TECHNICAL APPENDIX

Characteristics of Low-Income Households

EMPLOYMENT STATUS

The data presented in Table 1 in the main report on the employment conditions of low-income households are estimated from the 2008 Annual Social and Economic survey (ASEC) and the 2008 March basic monthly survey of the Bureau of Labor Statistics Current Population Survey (CPS).

The CPS is a monthly household survey conducted for the Bureau of Labor Statistics by the U.S. Census Bureau. The basic monthly survey of the CPS collects information from about 50,000 households every month on a wide range of topics including current employment status, wages and work schedules. The ASEC survey, conducted only in March as a supplement to the March basic monthly survey, provides additional data on family structure, all income sources, public subsidies, and poverty status for the prior calendar year (e.g., the data in the 2008 ASEC refer to income from 2007). The ASEC survey also provides information on respondents' employment conditions during the prior year.

For the purposes of understanding the average employment conditions of low- and higher- income households, we assign households' low- and higher- income status by using a CPS-provided poverty ratio that is equal to the household's total annual income in 2007 divided by their appropriate official poverty income threshold for 2007. We assume that a household's poverty ratio in 2007 is a good proxy for their poverty ratio in 2008. The employment situation of the members of these households is defined by their current employment status in 2008, using the standard BLS categories.

The households in our sample include both primary family households—households containing a householder and at least one other related person, as well as single person households. Other types of families include related subfamilies, unrelated subfamilies, and secondary individuals. We treat related subfamilies as part of the primary family instead of as a separate unit. The remaining two categories are excluded from the sample. We exclude these last two categories, unrelated subfamilies and secondary individuals because these types of families and individuals can include household guests or lodgers who should be accounted for in their primary residence.

We restrict our sample to households with at least one prime working age adult (25 years to 54 years old) in order to focus our analysis on individuals that depend primarily on paid employment for their livelihoods. We exclude workers below 25 years old because they have a high likelihood of being dependent on parental support, if in varying degrees. We exclude workers older than 54 years old because a significant number of these workers likely depend on some form of retirement income.

We estimate wage rates from the ASEC data on workers' earnings over the last calendar year, their total number of weeks worked, and their usual weekly hours. From these data, a wage rate can be calculated by: annual earnings/(total weeks worked x usual weekly hours).

CHARACTERISTICS OF REPRESENTATIVE CASES

We used the same approach as above to define household types. We then used the 2008 ASEC data to estimate the characteristics of each representative household presented in Tables 7 and 8 in the main text. We assume that these households' incomes come mainly from their wages and salaries.

We used the 2008 1040 Individual Income Tax Form and Instruction Booklet to derive the figures for federal income tax liability and tax credits (www.irs.gov).

We estimate a FICA tax equal to 7.65 percent. This includes a social security tax of 6.2 percent and a Medicare tax of 1.45 percent (U.S. BLS, 2006).

Our estimate of the cost of childcare for Case 2 is based on EPI's 2008 basic family budget figures for a four-person, two-child family (www.epi.org/content/ budget_calculator). We take the average of the proportion of childcare costs to total expenses for this family type (about 25 percent) and then adjust this to reflect that the primary caretaker in our representative family works 3/4 time (30 hours weekly), rather than full time. Therefore, we estimate that childcare costs will equal roughly 20 percent of the household's total income (25 percent x 75 percent = 19 percent).

Employment Estimates

EMPLOYMENT MULTIPLIERS

Data and Methodology. The employment estimates in this report are derived from an input-output model. The input-output model allows us to observe relationships between different industries in the production of goods and services. We can also observe relationships between consumers of goods and services, including households and governments, and the various producing industries. For our purposes specifically, the input-output modeling approach enables us to estimate the effects on employment resulting from an increase in final demand for the products of a given industry. For example, we can estimate the number of jobs directly created in the construction industry for each $1 million of spending on construction. We can also estimate the jobs that are indirectly created in other industries through the $1 million in spending on construction—industries such as lumber and hardware. Overall, the input-out-put model allows us to estimate the economy-wide employment results from a given level of spending.

For this report, we used the IMPLAN 2.0 software and IMPLAN 2007 data set constructed by the Minnesota IMPLAN Group, Inc. This data provides 440-industry level detail and is based on the Bureau of Economic Analysis of the U.S. Department of Commerce (BEA) input-output tables. IMPLAN provides this data at zip-code and congressional district levels, therefore we were able to model the national economy as well as metropolitan areas and congressional districts.

Modifications to the Data. We made three significant modifications to the existing data. The IMPLAN data set, like the BEA data, do not recognize certain energy industries such as wind, solar, or building weatherization. We therefore constructed a number of energy industries from this existing data. The details of this are below. Secondly, there was a an error in the IMPLAN data which would have affected any of the estimates that contained the construction industry. Two of the construction sectors – residential repair and non-residential repair construction – had employment multipliers that varied drastically from the other construction sectors and from these same sectors in previous years. It was therefore necessary to adjust the employment multipliers and we did so by replacing the employment/output ratio in both of these sectors with the average of all other construction sectors. This yielded employment multipliers that were consistent with those obtained using 2005 and 2006 data.

Finally, at the national level, all 440 industries have a significant amount of employment and output. At the district level, however, some industries have negligible employment, and the employment/output ratios and resulting employment multipliers are often unrealistically high or low. To correct for this bias, when employment in an industry was less than 100 people in the district, we replaced the district's employment/output ratio with the national employment/output ratio. This mainly affected the direct employment estimates (though in some cases not at all, since employment in some industries was zero). All other district information was preserved, therefore inter-industry relationships remained unchanged, and indirect and induced employment changed only proportionally to the change in direct employment.

Induced Effects. The input-output model allows us to estimate both the direct job creation and the indirect job creation that result from an increase in demand to one industry or a group of industries. It is much more difficult to estimate the size of the induced employment effects—or what is also commonly termed "multiplier effects"—than to estimate direct and indirect employment effects of a program such as the $150 billion program we propose. Of course, we know that when hundreds of thousands more people become employed directly and indirectly through a clean-energy program, those people will spend most of the money they have newly earned on other products in the economy. Moreover, we have a good sense of what percentage of the additional income people receive will be spent by them—between about 97 percent and 99 percent.[39]

But how much this extra spending will mean in terms of overall job creation depends on the existing conditions in the economy, including how many people are unemployed, what the inflation rate is, what is happening with oil prices, the size of the government's fiscal deficit, the size of the economy's trade deficit, and whether the increase in government spending is targeted to either encourage or discourage private-sector investment. A 2002 article by economists at the International Monetary Fund surveyed the professional literature estimating the size of the induced effects in the United States, among other economies, in a range of circumstances and time periods.[40] They report wide variations in these estimates. This includes some estimates of a negative induced effect—an overall expansion of less than $150 billion resulting from an initial $150 billion program—to a doubling of the initial expansion—$300 billion in overall expansion emerging out of an initial $150 billion stimulus.

The clean-energy program we propose is designed specifically to generate a large induced expansion of jobs. This is because the economy at present is operating with high unemployment, with plenty of slack resources to be utilized; spending will be focused on domestic industries rather than imports; and it aims specifically to encourage private-sector investment rather than relying on government spending. Given these factors, one might expect that the induced effect would be closer to the higher end estimates of the IMF study—that the total number of jobs would be double the level of direct and indirect job creation. Nevertheless, to be cautious, it is appropriate to underestimate rather than overestimate the induced employment effect, even if the program is designed, and conditions are favorable, for a relatively large induced effect. We therefore assume that the induced employment effects of this clean-energy program will add forty percent to the overall level of job creation generated by the direct and indirect effects nationwide. This is in line with the lower-end estimate of such effects for the U.S. economy reported in the IMF survey study.

While the forty percent induced effect has a straightforward application at the national level, it becomes more complicated at the district level (or metropolitan area) due to regional trading patterns. A district which imports a high percentage of its goods from outside the district will have lower induced job creation than a district that imports a smaller percentage of its goods and buys more "domestically-produced" goods and services. Thus, to account for these

39 Based on BEA data for personal disposable income and outlays (personal consumption, interest payments, and transfer payments to governments and the rest of the world) for 2006-2008.

40 Hemming, Kell, and Mahfouz (2002).

differences, we adjusted the 0.4 induced effect by two distinct measures of regional trade.

First, the household spending patterns within IMPLAN contain a domestic trade sector. Thus, the employment multiplier generated by $1 million in household consumption accounts for inter-regional trade. We calculated the output and employment that would result from this level of expenditure, net of trade, and then scaled the employment effects to 40% of the direct plus indirect job creation. As a second approach, we used the ratio of exports/imports for each region and multiplied that by 0.4*(direct + indirect job creation). So a region with more exports than imports will have induced job creation that is higher than 40%, and a region with net imports will have lower than 40% induced effects. The results of these two methods were fairly similar, and rather than selecting one method over another, we averaged the two results to determine induced job creation by district (or metropolitan area).

Imputed Indirect Employment. At the national level there are only three levels of job creation: direct, indirect, and induced. But at the district level (or metropolitan area), some of the indirect effects that result from trade are not captured in the input-output model. For example, if a construction project in location X uses lumber produced in location Y, then this indirect job creation (for lumber) occurs in region Y and of course should not be counted in total job creation in region X. However, if the lumber produced in region Y comes from forests in region X, then there is a second-round indirect effect that is not being captured, and which should be accounted for in the total job creation in region X.

We therefore define a category of job creation called “imputed indirect.” We measure this by comparing the total job creation per district (or metropolitan area) to the total job creation nationally. While district-level (or metropolitan-area-level) direct effects can be either lower or higher than the national direct effects, the district-level indirect effects are lower in all cases. But of course, nationally all the indirect effects in each district should sum up to the national indirect effects. To account for some of this gap, we inflate each district’s indirect jobs by the proportion of total district jobs to total national jobs. This yields, for each district, a number of imputed indirect jobs.

Definition of Energy Industries. The BEA input-output tables organize industries according to the North American Industrial Classification System (NAICS). This system, unfortunately, does not identify energy industries as such. While certain industries such as oil and gas extraction or coal mining are identified in the tables, others such as wind and solar are not. Furthermore, the oil and gas industry does not consist solely of extraction but also of research, manufacturing and distribution. Therefore for both identified and unidentified energy industries we must make certain assumptions in using the input-output tables to study output and employment.

For each energy strategy, we identified the industries most relevant to the strategy and assigned weights for the share of that industry within the energy strategy. These weights were chosen based on various industry journals and energy reports, as well as our best judgment when information was unavailable. So, for example, we defined the coal industry as 44% coal extraction, 8% support activities for coal mining, and 48% coal products manufacturing. In this way, we were able to use weighted averages of the figures in the output and employment tables to generate estimates of output and employment in the coal industry, given a certain level of demand for that industry’s product. In order to ensure that our employment estimates for each energy strategy were not driven primarily by the weights we assigned, we ran the model with various alternative weighting schemes and found that the results were in fact quite robust and varied only slightly even when weights changed quite drastically. The final weights that we selected for each energy strategy are listed at the end of this section.

In order to be able to compare employment estimates between various energy strategies, we needed a common metric to use as a basis for comparison. We chose to compare job estimates in relation to a given amount of spending, rather than a given amount of energy production. So, for instance, we compare the employment estimates in solar energy versus coal by showing how the same level of spending in each category results in a certain number of jobs. The alternative, which is to show how many jobs are supported by a given level of energy production, would produce inflated estimates in industries with high energy costs. If we had used a given level of BTUs as the basis for comparison, then the number of jobs needed to produce a given level of BTUs in solar would be very high compared to the number of jobs needed to produce that level of energy production through coal. This would have simply been due to the fact that the cost per BTU for solar power is still much higher than the cost per BTU of coal. Therefore, we chose to compare the number of jobs created by a given level of spending, which is not sensitive to the current prices of these various energy sources and technologies.

ENERGY INDUSTRIES – SECTORS AND WEIGHTS

Biomass

25% grain farming
25% logging
25% other new construction
12.5% refining
12.5% scientific research and development

Building Weatherization

50% non-residential repair construction
50% residential repair construction

Coal
44% coal mining
08% support activities for coal mining
48% coal product manufacturing

Oil and Gas
23% oil and gas extraction
07% drilling oil and gas wells
04% support activities for oil and gas extraction
10% natural gas distribution
45% petroleum refineries
08% petroleum product manufacturing
03% pipeline transport

Smart Grid
25% construction
25% machinery
25% electronic equipment
12.5% electrical power goods
12.5% storage batteries

Solar
30% construction
17.5% hardware manufacturing
17.5% electrical equipment
17.5% electronic components
17.5% scientific and technical services

Transit/Rail
45% other construction
10% rail transportation
45% ground passenger transportation

Wind
26% construction
12% plastic products
12% fabricated metal
37% machinery
03% mechanical power transmission equipment
03% electronic components
07% scientific and technical services

Clean-Energy Program
40% building weatherization
20% transit/rail
10% smart grid
10% wind
10% solar
10% biomass

Fossil Fuels
XX% oil and gas
YY% coal
Where XX and YY are determined according to the 2007 output level of these industries in each district

Characteristics of Jobs Generated by Clean-Energy Investments and Fossil Fuel Investments

In this report, we are concerned not only with the overall level of job creation, but specifically with the types of occupations and the credentials needed by workers in these occupations.

Our basic strategy for identifying the types of jobs that would be added to the economy due to an investment in the clean-energy or fossil fuel sectors (as defined above) involves two steps. The first step is to calculate each industry's share of total employment created through either an investment in clean energy or fossil fuels. We calculated the percentage of new employment generated in each of the 440 sectors in our input-output model. These industry shares take into account the direct, indirect, and induced effects as discussed above. The second step is to combine this information on the industry composition of new employment created by investing in each energy sector—clean energy or fossil fuels—with data on workers currently employed in the industries. We use the characteristics of these workers to determine the types of occupations (and the credential requirements of these occupations) that will add jobs with an investment in each energy sector. Our data on current workers comes from the 2008 Current Population Survey (CPS) described above.

Specifically, we used the industry shares to weight the worker data in the CPS so that the industry composition of the workers in the CPS sample matches the industry composition of the new jobs that will be added by investing in the energy sector we are analyzing. We do this by using the industry shares to adjust the CPS-provided sampling weights. The CPS-provided sampling weights weight the survey sample so that it is nationally representative. We use the industry shares to adjust these sampling weights so that the sample of workers in the CPS is representative of the industrial mix of jobs that IMPLAN estimates will be produced by new investments in clean energy or fossil fuels.

In order to create the weights we first aggregated the 440 industry shares to the 3-digit level NAICS industries (for a total of 69 industries). This allowed us to merge the industry share data to the CPS worker data using the most detailed industry variable provided in the CPS. So, for example, at the 440 sector level there are 7 construction sectors, while at the 3-digit NAICS level there is 1 construction industry. In Table A1 we present the industry shares for the clean-energy and fossil fuel sectors.

TABLE A1. INDUSTRY EMPLOYMENT SHARES BY ENERGY SECTOR

Industry	*Industry share of clean-energy sector*	*Industry share of fossil fuels sector*
farms	3.88%	1.10%
forestry, fishing, and related activities	1.03%	0.10%
mining		
oil and gas extraction	0.28%	15.77%
mining, except oil and gas	0.27%	1.55%
support activities for mining	0.01%	0.25%
utilities	0.26%	2.27%
construction	25.69%	7.68%
manufacturing: durable goods		
wood products	0.81%	0.21%
nonmetallic mineral products	0.61%	0.23%
primary metals	0.47%	0.38%
fabricated metal products	2.17%	1.65%
machinery	1.66%	0.63%
computer and electronic products	1.59%	0.18%
electrical equipment, appliances, and components	0.85%	0.20%
motor vehicles, bodies and trailers, and parts	0.28%	0.31%
other transportation equipment	0.04%	0.03%
furniture and related products	0.23%	0.09%
miscellaneous manufacturing	0.15%	0.19%
manufacturing: nondurable goods		
food and beverage and tobacco products	0.48%	0.50%
textile mills and textile product mills	0.09%	0.08%
apparel and leather and allied products	0.07%	0.08%
paper products	0.18%	0.24%
printing and related support activities	0.20%	0.28%
petroleum and coal products	0.14%	2.19%
chemical products	0.37%	1.17%
plastics and rubber products	0.81%	0.51%
wholesale trade	2.65%	3.55%

Industry	*Industry share of clean-energy sector*	*Industry share of fossil fuels sector*
retail trade		
motor vehicle and parts dealers	0.79%	0.63%
food and beverage stores	1.05%	0.85%
general merchandise stores	1.07%	0.87%
other retail	3.72%	3.00%
transportation and warehousing		
air transportation	0.14%	0.17%
rail transportation	0.42%	0.23%
water transportation	0.02%	0.04%
truck transportation	1.20%	1.40%
transit and ground passenger transportation	8.80%	0.25%
pipeline transportation	0.02%	0.96%
other transportation and support activities	0.62%	0.83%
warehousing and storage	0.33%	0.33%
information		
publishing industries (includes software)	0.29%	0.37%
motion picture and sound recording industries	0.15%	0.18%
broadcasting and telecommunications	0.67%	0.86%
information and data processing services	0.12%	0.15%
finance and insurance		
federal reserve banks, credit intermediation, and related activities	1.32%	1.96%
insurance carriers and related activities	1.02%	1.15%
funds, trusts, securities, commodity contracts, and other investments	1.87%	2.50%
real estate and rental and leasing, and other financial vehicles		
real estate	2.70%	3.48%
rental and leasing services and lessors of intangible assets	0.50%	1.02%

TABLE A1. INDUSTRY EMPLOYMENT SHARES BY ENERGY SECTOR, CONTINUED

Industry	*Industry share of clean-energy sector*	*Industry share of fossil fuels sector*
professional, scientific, and technical services		
legal services	0.90%	1.49%
computer systems design and related services	0.11%	0.16%
miscellaneous professional, scientific, and technical services	6.00%	7.64%
management of companies and enterprises	1.04%	3.22%
administrative and waste management services		
administrative and support services	4.82%	7.27%
waste management and remediation services	0.18%	0.22%
educational services	0.75%	0.76%
health care and social assistance		
ambulatory health care services	1.85%	1.85%
hospitals	1.28%	1.28%
nursing and residential care facilities	0.94%	0.94%
social assistance	0.96%	0.96%
arts, entertainment, and recreation		
performing arts, spectator sports, museums, and related activities	0.58%	0.69%
amusements, gambling, and recreation industries	0.54%	0.59%
accommodation and food services		
accommodation	0.51%	0.63%
aood services and drinking places	3.23%	3.80%
other services, except government	4.26%	4.83%
government		
federal	0.09%	0.12%
state and local	0.40%	0.61%

Source: IMPLAN. See Appendix text for details

We adjust the CPS-provided sampling weights by multiplying each individual worker's sampling weight with the following:

$$S \times \frac{\text{IMPLAN's estimate of the share of new jobs in a worker's industry I}}{\sum \text{(CPS sampling weights of all workers in industry I)}}$$

where *S* is a scalar equal to the number of jobs produced overall by the particular level and type of investment being considered. For example, in our analysis of the job characteristics of the employment generated by a national $150 billion investment in the clean-energy sector, *S* is equal to 2,505,732.

We use these adjusted sampling weights to estimate the proportion of workers in each energy sector that has 1) a high school degree, and no college experience, 2) some college, but no B.A. degree, and 3) a BA degree or more. We then assume that the same proportion of jobs in each energy sector requires each level of education credentials. These figures are presented in the main text in Tables 3 and 6.

The average (median) wage data presented in Tables 3 and 6 in the main text are based on the 2008 CPS outgoing rotation files (ORG) of the basic monthly survey. These data files have detailed information about hourly rates for hourly-paid workers, and weekly earnings and weekly hours for non-hourly paid workers. We divide weekly earnings by weekly hours to estimate hourly rates for non-hourly paid workers. For some non-hourly paid workers, we do not have data on their usual weekly hours (some report usual hours vary). For these workers, we impute their usual weekly hours by assigning their *actual* hours worked as their usual hours worked *if* their actual hours worked is consistent with what they report is their usual work schedule – part-time or full-time. For example, if a worker reports that his hours usually vary, but he reports that he worked 15 hours last week and that he usually works part-time, we impute that worker's usual hours to be 15 hours per week. However, if this worker reports that he usually works full-time, we assigned his usual hours as missing. Roughly five percent of the hours, and thus hourly wages, in our data set are imputed in this fashion.

Impact on Living Standards from Transportation Savings

COST SAVINGS AVERAGED OVER ALL LOW-INCOME HOUSEHOLDS

In this section, we explain how we estimate the impact on the living standards of low-income households of using public transportation to meet 25 percent of their transportation needs.

We do not have direct data on the number of miles travelled by public and private transit in low-income households which we could then use to estimate cost-savings from travelling more by public transit. In order to estimate the miles travelled by each mode of transportation, we use the following equation that relates the data presented in Table 12 and the number of miles that the household travels annually. We can then use this equation to estimate the number of miles traveled by each mode of transportation. The equation is as follows:

EQUATION 1

$$\frac{\text{(\% private transit expenses) x total transit budget}}{\text{cost per private transit mile}} + \frac{\text{(\% public transit expenses. x total transit budget)}}{\text{cost per public transit mile}} = \text{total miles traveled}$$

Table 12 provides data on the percent of private transit expenses, public transit expenses, and total household spending on transportation. In the main text of the report, we provide estimates of the cost per private transit mile ($0.54 per mile) and the cost per public transit mile ($0.22 per mile). Inserting these figures into equation 1, we derive the total miles traveled by the average low-income household: 6,471 miles. I.e.,

$$\frac{\text{(94.6\% x 3,240)}}{\text{\$0.54/mile}} + \frac{\text{(5.4\% x \$3,240)}}{\text{\$0.22/mile}} = \text{6,471 miles}$$

where 5,696 miles are traveled by private transit (87.7% of total) and 795 miles are traveled by public transit (12.3% of total).

To shift to a mix of 75 percent of household miles traveled by private transit and 25 percent traveled by public transit, we simply shift travel miles by transit type to fit the 75/25 mix, re-arrange equation 1, and calculate the new total budget:

[(75% x 6,471 miles) x $0.54/mile] +
[(25% x 6,471 miles) x $0.22/mile] = $2,977

Based on these calculations, we estimate that the average low-income household's overall transportation budget will fall from $3,240 to $2,977, a decrease of $263. The $263 savings is equal to 1.3 percent of the average low-income household's total spending ($263/$20,471 = 1.3 percent). An analogous calculation for households in the 21-40% income group of Table 12 produces a savings of about $560, or 1.8 percent of these households' total spending. The impact of shifting to a mix of 50 percent of miles traveled by private transit and 50 percent of miles traveled by public transit, we simply shift travel miles by transit type, and re-calculate the household's total transportation budget again.

[(50% x 6,471 miles) x $0.54/mile] +
[(50% x 6,471 miles) x $0.22/mile] = $2,459

This is equal to an overall change in transportation expenses of $781 ($3,240-$2,459=$781), or a savings equal to 3.8 percent of total household spending ($781/$20,471 = 3.8 percent).

COST SAVINGS AVERAGED BY NUMBER OF CARS OWNED AMONG LOW-INCOME HOUSEHOLDS

As discussed in the main text of the report, costs savings vary dramatically depending on whether a household decides to replace a car with public transit or not.

We explain here how we estimate the cost savings for a low-income household that decides to go from one to no car and for a low-income household that decides to go from two cars to one car. According to the 2001 National Household Transportation Survey, among low-income households (defined as households with incomes of less than $20,000 in 2001) 27 percent owned no cars, 48 percent owned one car, 18 percent owned two cars, and 8 percent owned more than two cars.

Low-Income Households with One Car. We know from the figures above that the average low-income household spends about $3,065 on private transit and $175 on public transit, for a total of $3,240. We also know that the typical low-income household owns one car. Therefore, we assume that $3,065 represents the costs of owning and using one car. If this household got rid of their one car, this would reduce their private transit expenses to zero and all of the 6,471 miles would now be travelled by public transit. Therefore, their new transportation costs would be equal to $1,424 (6,471 x $0.22 per mile). This households transportation budget is $1,816 lower, or a savings equal to 8.9 percent of total household spending ($1,816/$20,471 = 8.9 percent).

Low-Income Households with Two Cars. If $3,065 represents the costs of owning and using one car, then we know that 70 percent of this cost is fixed ($2,145) and 30 percent of this cost is variable ($920). Therefore, if this household owns two cars, then their fixed costs would be about $4,290 and assuming that all of the 6,471 miles of travel are by private transit, their total transportation budget would be about $5,390 ($4,290 + (6,471 miles x $0.17 per mile) = $5,390). If this household got rid of one car, then their fixed costs would fall by half, or $2,145. That is, their total fixed costs would now be $2,145. We assume that half of the 6,471 miles they travel would now be completed by public transit and half by private transit. The costs associated with these travel miles add $550 to cover private transit miles and $712 to cover public transit miles. In total, this household's new transportation budget is $3,471 ($2,145 + $550 + $712 = $3,471). Overall, the household's transportation budget is about $1,970 lower, or a savings equal to 9.6 percent of total household spending ($1,970/$20,471 = 9.6 percent).

Impact on Emissions from Increasing Public Transit Use

We estimate the overall reduction in emissions by raising public transit use to 25 percent of overall transportation by combining the following data:

- From our calculations above, we estimate that low-income households use private transportation roughly 90 percent of the time and public transit about 10 percent of the time.
- Private transportation generates roughly 61 percent of the total emissions generated by transportation.[41]
- Transportation generates roughly 34 percent of total emissions.[42]
- Public transportation use produces 45 percent less emissions than private transit, taking account the impact of reduced traffic congestion.[43]

Working from these figures we estimate that the share of total emissions generated by private transportation is equal to 20.7 percent (61 percent x 34 percent). If public transit represent 10 percent of all transportation use but produces 55 percent of the emissions of private transit, we can calculate the share of total emissions produced by public transit implied by these figures to be 1.3 percent ([(20.7 percent/90 percent) x 10 percent] x 55 percent = 1.3 percent).

We then assume that the private/public transit mix shifts to 75/25. Then the percentage of total emissions produced by private transit would fall by 3.4 percent to 17.3 percent [(75 percent /90 percent) x 20.7 percent = 17.3 percent]. The share of total emissions produced by public transit would rise to about 3.2 percent [(25 percent /10 percent) x 1.3 percent = 3.2 percent]. The new total share of emissions produced by public and private transit combined would be 20.5 percent, or about 1.6 percent less than before public transit use rose to 25 percent.

[41] This figure is from the American Public Transportation Authority, see Table 2, "Table 2. U.S. Greenhouse Gas Emissions from Mobile Sources, by Vehicle Type (Tg CO2 Eq.)," see http://www.apta.com/research/info/online/documents/climate_change.pdf .

[42] According to EIA statistics, transportation accounted for approximately 33.6% of carbon emissions in the U.S. in 2007, based on Table 6, "U.S. Energy-Related Carbon Dioxide Emissions by End-Use Sector," see http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html .

[43] This figure is from the American Public Transportation Authority, see http://www.apta.com/research/info/online/documents/climate_change.pdf .

Energy Costs by Household Type

The Low Income Home Energy Assistance Program (LIHEAP) produces an annual *Home Energy Notebook* report (U.S. Department of Health and Human Services, 2008) that provides some basic data on the energy costs of low-income families.

The Home Energy Notebook provides average annual expenditures on all residential energy which includes heating as well as other energy uses by region and by low-income status. They define low-income status as those households that meet the LIHEAP eligibility requirements: "the greater of 150 percent of the poverty income guidelines and 60 percent of the State median income." This group roughly overlaps with our definition of low income (200 percent or less of the official poverty line).

For these low-income families their average annual residential energy expenditures was $1,690 in Fiscal Year 2006. Adjusted by the CPI for home energy for urban consumers, this is equal to $1,916 in 2008 (inflation equal to 13.4 percent for these items).

To adjust for the fact that renters typically face lower energy costs than owners, we use the average energy costs for renters and owners from the 2007 American Housing Survey 2007 to adjust energy costs by tenancy. Based on the 2007 American Housing Survey figures, we estimate that energy costs for low-income renters is equal to 86 percent of the $1,916 in energy costs of all low-income housing units. For low-income owners, the figure is 110 percent of $1,916.[44] Therefore, we estimate annual home energy expenditures to be $1,648 (86 percent of $1,916) for low-income renters and $2,108 (110 percent of $1,916) for low-income owners.

Regional Profiles

In addition to the national estimates that we discuss in this report, we also produced a select number of regional estimates of how low-income households may be impacted by an investment shift into clean energy. These estimates are available as individual regional fact sheets at www.peri.umass.edu. In this section, we explain how we regionalized our national estimates.

EMPLOYMENT IMPACT BY REGION

We begin by discussing the approach we have taken for allocating both the expansion in clean-energy investments in each region and the corresponding decline in fossil fuel spending. It will be on the basis of estimating the amount of

[44] We derive these ratios by comparing the 2007 AHS estimates of the monthly total costs across all low-income household units of oil, gas, and electricity among renters ($217) and owners ($277) and comparing this to the figure for all low-income units ($251).

money by which clean-energy investments increase and fossil fuel spending decreases in each area that we can then derive the net employment effects of the transition to a clean-energy economy.

We have derived the $150 billion level of economy-wide clean-energy investment spending based on two criteria: 1) our assessment of the combined impact on the U.S. economy of the American Recovery and Reinvestment Act and the set of incentives and regulations included in the American Clean Energy and Security Act, now being debated in Congress; and 2) developments that are likely to occur in the private clean-energy investment market, driven primarily by advances in clean-energy technologies and the maturation of the institutions and linkages serving this market. Of course, these two broad sets of factors—the impact of government policies and advances in technologies and market practices—are also closely interrelated.[45]

To proceed with a regional breakdown of this $150 billion in total clean-energy investment spending throughout the U.S. economy, we first need to establish criteria for estimating how the funds are likely to be distributed. Correspondingly, based on the worst-case scenario assumption that we describe in the main text (page 16) that the total $150 billion in clean-energy investments will be matched dollar-for-dollar by declines in fossil fuel spending, we also need establish criteria for distributing the decline in fossil fuel spending across the regions that will total to $150 billion. In fact, we conclude that the same approach is appropriate for both distributing the gains in clean-energy investments and declines in fossil fuel spending. That is, as we explain in detail, we generate both the clean-energy investment increases and the fossil fuel spending declines as equally weighted averages of the level of GDP and the level of population in each region.

Clean-Energy Investment Increases. One way to allocate the flow of clean-energy investment funds would be to make a determination as to which regions have advantages in various investment areas, such as solar or wind power, urban density for mass transit investments, or with agriculture to produce targeted advances in next-generation biofuels. But whatever funding assumptions we would establish from these criteria would inevitably be highly sensitive to our assumptions. That is, we do not have an empirically rigorous way to balance the importance of these geographic or climatic advantages for any given region relative to the economic resources available in other regions.

With this in mind, we considered two approaches to assigning investment levels for each region based on two easily observable and measurable traits for each area—i.e. local GDP and population levels.

Distributing the total $150 billion in clean-energy investments on the basis of each region's share of total GDP means assigning proportions of spending based on existing patterns of financial investments and levels of development. This provides an accurate measure of how clean-energy investments would flow if they followed current levels of economic development across the regions. Distributing the funds based on each area's population assumes a more egalitarian approach, with each person in the country effectively receiving an equal dollar claim on the overall pool of investment funds.

We then try to balance these two considerations, recognizing that building retrofits, for example, will in part follow a pattern based on population density, but that new capital investment will also naturally flow toward areas of pre-existing capital investment in industry, infrastructure, and building stock.

In our view, both a GDP-share and a population-based allocation of funds represent reasonable criteria for estimating what regional-level clean-energy investments should be. This is because, regardless of an area's topography or climate, major opportunities for clean-energy investments exist now and will grow with time. Accordingly, our approach is to calculate what the allocation of new investment funds would be under both the GDP- and population-based approaches, and use the midpoint of these two calculations as our figure for each region's allocation of the total $150 billion in new clean-energy investments.

Fossil Fuel Spending Declines. Similar issues arise in deciding an approach for estimating the distribution of declines in fossil fuel spending across the regions. One approach would be to distribute the cuts in proportion to the existing levels of fossil fuel spending in each area. According to this standard, areas in major oil-producing states such as Texas, Louisiana and Oklahoma and coal-producing regions such as Appalachia and Montana would experience larger overall spending reductions than other areas in which the fossil fuel industry plays a less significant role. Under this scenario, the costs of the transition from a fossil fuel- to a clean-energy based economy would therefore fall disproportionately on areas that have large-scale fossil fuel industries. But if we used this criterion for allocating the distribution of fossil fuel spending declines, we would be contradicting a principle incorporated into the draft ACESA, which is to compensate people and communities tied to the fossil fuel industry as one feature of the transition to a clean-energy economy.

Thus, to remain consistent with the policy approach incorporated into the ACESA, we follow the same principle that we used for allocating the spending increases in each region. That is, in our approach, the declines in fossil fuel spending in each region are distributed across regions as an equally

[45] Our treatment of the interrelationship between these two policy initiatives and private investment activity is developed more fully in our companion study with Center for American Progress (Pollin, Heintz, and Garrett-Peltier 2009).

weighted average of each local area's population and GDP. How could this weighting scheme be made compatible with the fact that the areas do have very different levels of fossil fuel expenditures? Following the principle of equitable impacts across all regions, the simplest way is to assume that areas with larger than average fossil fuel industries will also be given disproportionate levels of compensation through the ACESA compensation programs. We would also assume that areas with relatively large fossil fuel industries will also receive a disproportionate level of government support for investments in clean energy, in particular clean-energy projects that are necessarily tied to specific locations, such as building retrofits, public transportation, and smart grid.

ESTIMATING REGIONAL CHARACTERISTICS OF JOBS GENERATED BY CLEAN-ENERGY INVESTMENTS AND FOSSIL FUEL INVESTMENTS

For our regional profiles, we needed to make a few minor modifications to the methodology described above for estimating the characteristics of jobs generated by clean-energy investments and fossil fuel investments.

First, we pooled five years of CPS data (2004 to 2008) in order to obtain samples of sufficient size for analysis. Some local areas, however, could not be identified separately within the CPS data. In those cases, we used the next smallest geographic unit that includes the local area.

For example, we estimate the average wage and the distribution of jobs across credential categories for Congressional District 4 of Arkansas from all workers in Arkansas, rather than within the District because the CPS does not separately identify workers residing within the District. The District's workforce makes up a substantial share of Arkansas' total workforce, just under one-quarter according to the U.S. Census Bureau, so we believe that the worker characteristics of workers in Arkansas should reasonably approximate the worker characteristics of workers in the District.

Second, the Bureau of Labor Statistics does not provide labor force statistics (unemployment and employment levels and rates) for all of the regions we analyze. In particular, the BLS does not provide congressional district-level estimates. The U.S. Census Bureau, based on survey data from the American Community Survey, does provide three-year-average district-level estimates, the latest covers 2005 to 2007. In order to estimate current labor force numbers, we combine data from the BLS and Census Bureau in the following way.

For each district, we calculate the ratio of the Census Bureau's district-level labor force estimates to its state-level labor force estimates. We then apply these ratios to the 2008 state-level BLS labor force estimates to approximate the 2008 district estimates. Take, for example, Arkansas Congressional District 4. We present the figures we used to estimate its labor force figures in Table A.2. We present the Census Bureau three-year average estimates for the District in row 1, and for the whole state of Arkansas in row 2. Row 3 shows how the District figures compare to the state figures. We can see that the District's labor force and unemployment levels make up roughly one-quarter of the state's levels. Row 4 provides the current data on the state of Arkansas provided by the BLS. Finally, the fifth row presents our adjusted figures for the District. These figures are equal to the BLS figures in row 4 multiplied by the ratios in row 3.

TABLE A2. ESTIMATING LABOR FORCE FIGURES FOR ARKANSAS CONGRESSIONAL DISTRICT 4

	# in labor force	# unemployed
1. Arkansas Congressional District 4, ACS 2005-2007 estimate	299,623	27,026
2. Arkansas, ACS 2005-2007 estimate	1,332,678	95,327
3. Ratio (row 1/row 2)	0.225	0.28
4. Arkansas, 2008 BLS estimate	1,370,259	69,717
5. Arkansas Congressional District 4, estimate based on Arkansas 2008 BLS estimate adjusted by ratio (row 3 x row 4)	308,072	19,765
6. Unemployment rate for Congressional District 4, using row 5 adjusted figures (col. 2/col. 1)	6.4% (=19,765/ 308,072)	

Sources: American Community Survey 2005-2007, U.S. Census Bureau; Bureau of Labor Statistics, 2009

To generating the state figures for jobs by educational credential level, we use two sets of estimates. The first set of estimates is the national figures presented in the main report. The second set is directly estimated from state-level data. We combine these two sets of estimates to balance the strengths and weaknesses of each.[46]

Both sets of estimates are based on a subset of the workers we want to observe, e.g., a sample of workers from each state rather than all the workers in each state. A sample of obser-

[46] Note that earlier estimates for only 21 states, released in June 2009, have been revised. The earlier estimates were not adjusted by the national figures because this adjustment could only be made with a full set of estimates for all 50 states and the District of Columbia. Estimates of all 50 states and the District of Columbia—adjusted to reflect the methodology described here—were produced and released in July 2009.

vations always has the potential to produce different estimates from what would be observed if we had information on all workers. Specifically, the characteristics of the workers in the sample will tend to be over-represented and the characteristics of workers not in the sample will tend to be under-represented. This is because the workers in the sample are assumed to represent all the workers we want to observe. These differences are referred to as sampling errors.

The national estimates of the number of net jobs by educational credential level will tend to have smaller sampling errors than the state estimates. This is because the CPS 2008 national sample provides many more observations on workers in each of the 69 CPS-defined detailed industries that comprise the clean-energy and fossil fuels sectors (as described above) compared to the state samples. The national figures, however, cannot reflect state-specific labor market characteristics—that is, what kind of workers and jobs would be produced in each state given the types of industry expansions expected to occur with an increase in clean-energy investments.

To provide these state-specific details we estimate the number of net jobs by educational credential level by state. In order to ensure that the range of detailed industries we use to define the clean-energy sector and fossil fuels sector are represented in our samples, we pool five years of CPS data (2004-2008), and in some cases, we use regional samples (i.e., pool states within a region). Even after pooling data, however, a state's sample may still have few observations within one of the CPS detailed industries. In such cases, the data will less accurately reflect the types of workers in that industry. Specifically, in the clean-energy sector, "high school degree of less" workers will tend to be over-represented at the state level because they are more prevalent in the clean-energy sector generally (see table 6 of the main report)—and thus more likely to be included in a given state sample of data. Similarly, college-degree workers will be under-represented at the state level because they are less prevalent. This type of state-level bias in the data is weaker in the fossil fuels sector since workers in this sector are more evenly spread across the educational credential categories.

The state estimates still provide valuable information on state-specific labor market characteristics. This is because all the state-level estimates will be somewhat inflated. As a result, the state estimates should still accurately identify which states have higher numbers of "high school degree or less" jobs relative to other states. Therefore, we can use the national figures to set the number of jobs by educational credential level across states—this will correct for the bias generated by state-level data, and then use the state figures to distribute these jobs within educational credential level across the states—to incorporate state-specific labor market characteristics.

IMPACT ON LIVING STANDARDS FROM TRANSPORTATION SAVINGS

We divide the over 300 Metropolitan Statistical Areas (or MSAs, as defined by the U.S. Census) into roughly three categories. The top 100 MSAs, we call high-density metropolitan areas. These MSAs range between 380 people per square mile to 13,000 people per square mile. Note that because MSAs span over more than one town or city, they can contain both rural and urban areas. The next 100 MSAs, we call medium-density metropolitan areas. These MSAs range between 200 people per square mile to 380 people per square mile. The remaining MSAs we refer to as low-density metropolitan areas. We then characterize the regional areas we analyze according to the MSA they contain. If a region does not contain an MSA, it would be considered rural.

We assume that public transit in medium to high density metropolitan areas, particularly around urban centers, can be improved enough to allow significant numbers of low-income households to replace a car with public transit. For those households, they would achieve savings equivalent in magnitude to that estimated for the nation (see discussion above).

We also assume that public transit in low-density metropolitan or rural areas cannot be improved sufficiently to allow significant numbers of low-income households to replace a car with public transit. We assume that only some households may achieve significant savings from public transit improvements. However, living standards may still rise due to increased access to employers and other resources outside their neighborhoods.

For high-density areas where a high fraction of the population (i.e., more than 10 percent) already uses public transit (e.g., the New York metropolitan area), we estimate the cost savings by assuming a 50 percent price reduction in public transit fares and a mix of 25 percent of miles traveled by public transit and 75 percent of miles traveled by private transit. In other words we estimate how much a households overall transportation budget would decrease if they could receive 50 percent fare discounts, and assuming that they currently use public transportation 25 percent of the time.

We estimated above that without discounted public transit rates, the average overall transportation with the 75/25 mix would be equal to \$2,977. When we reduce the public transit cost by 50 percent, from \$0.22 per mile to \$0.11 per mile, the overall transportation budget would be:

$$[(75\% \times 6{,}471 \text{ miles}) \times \$0.54/\text{mile}] +$$
$$[(25\% \times 6{,}471 \text{ miles}) \times \$0.11/\text{mile}] = \$2{,}799$$

That is, the overall transportation budget would decrease from \$2,977 to \$2,799, or \$178. This savings is equal to an average of about 0.9 percent of overall household spending.

OTHER DATA SOURCES

1. Measures of overall economic activity:

For congressional districts, the overall level of activity is estimated directly by the IMPLAN 2.0 software and IMPLAN 2007 data set constructed by the Minnesota IMPLAN Group, Inc. IMPLAN provides a measure of the total value added at the district level and includes the basic components of a district-level GDP:

- Employee compensation (wages, salaries, benefits)
- Proprietor income (payments received by self-employed individuals and private businesses).
- Other property income (payments from interest, rents, royalties, dividends, profits)
- Indirect business taxes (excise and sales taxes paid by individuals to businesses)

IMPLAN derives their data from the BEA's National Income and Product Accounts, and adjusts it to their sectorization pattern.

For metropolitan areas, the BEA provides direct estimates annually. The latest figures are for 2006: www.bea.gov/newsreleases/regional/gdp_metro/2008/pdf/gdp_metro0908.pdf (Accessed May 8, 2009).

We adjust these IMPLAN 2007 figures and the BEA 2006 figures using the regional BLS CPI-U.

2. Percentage of renters and quality of housing stock:

"Selected Housing Characteristics: 2005-2007," from the American Community Survey U.S. Census Bureau: fact-finder.census.gov/servlet/ACSSAFFFacts?_submenuId=factsheet_0&_sse=on (Accessed May 8, 2009).

3. Public transportation use:

"Selected Economic Characteristics: 2005-2007," from the American Community Survey U.S. Census Bureau. Online: fact-finder.census.gov/servlet/ACSSAFFFacts?_submenuId=factsheet_0&_sse=on (Accessed May 8, 2009).

4. Details on the local energy industry activity:

"State Energy Profiles," U.S. Department of Energy, Energy Information Administration, December 14, 2006. Online: tonto.eia.doe.gov/state (Last update: April 23, 2009; Accessed May 8, 2009).

5. Details on the local climate conditions:

"Monthly State, Regional, and National Heating Degree Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation," U.S. Department of Commerce National Oceanic and Atmospheric Administration National Environmental Satellite, Data, and Information Service, May 2009. Online: www.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200707-200812.pdf (Accessed June 2, 2009).

REFERENCES

Andersson, Frederik, Harry Holzer and Julia Lane. (2005). *Moving Up or Moving On: Who Advances in the Low-Wage Labor Market.* New York: Russell Sage Foundation.

Bartik, Timothy. 2002. "Spillover effects of welfare reforms in state labor markets." *Journal of Regional Science,* Vol. 42(4), pp. 667-701.

—. 2001. *Jobs for the Poor: Can Labor Demand Policies Help?* New York: Russell Sage Foundation.

—. 2000. *The changing effects of the economy on poverty and the income distribution.* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

—. 1994. "The effects of metropolitan job growth on the size distribution of family income," *Journal of Regional Science,* Vol 34(4), pp. 483-501,

—. 1991. *Who benefits from state and local economic development policies?* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Belman, Dale and Paula B. Voos. 2006. "Union wages and union decline: Evidence from the construction industry," *Industrial and Labor Relations Review,* Vol. 60 (1), pp. 67-87.

Blank, Rebecca M. and David Card. 1993. "Poverty, income distribution, and growth: Are they still connected?" Brookings Papers on Economic Activity (2), pp. 285-339.

Boyce, James and Matt Riddle. 2008. "Keeping the Government Whole: The Impact of a Cap-and-Dividend Policy for Curbing Global Warming on Government Revenue and Expenditure," PERI Working Paper No. 188 (November).

Bowes, David R. and Keith R. Ihlanfeldt. 2001. "Identifying the Impact of Rail Transit Stations on Resdiential Property Values," *Journal of Urban Economics,* 50 (July), pp. 1-25.

Cancian, Maria and Daniel Meyer. 2000. "Work after welfare: Women's work effort, occupation, and economic well-being," *Social Work Research,* Vol. 24 (2), pp. 69-86.

Card, David. 1995. "The wage curve: A review," *Journal of Economic Literature* (33), pp. 785-99.

Citro, Constance F., and Robert T. Michael, eds. 1995. *Measuring Poverty: A New Approach.* Washington, D.C.: National Academy Press.

Debrezion, Ghebreegziabiher, Eric Pels, and Piet Rietveld. 2007. "The Impact of Railway Stations on Residential and Commercial Property Value: A Meta-Analysis," *Journal of Real Estate Finance and Economics,* 35(2), pp. 161-180.

Eissa, Nada and Jeffery B. Liebman. 1996. Labor Supply Response to the Earned Income Tax Credit. *The Quarterly Journal of Economics,* Vol. 111, (2), 605-637.

Frazis, Harley J. and James R. Spletzer. 2005. "Worker training: what we've learned from the NLSY79," *Monthly Labor Review* (February), pp. 48-58.

Giuliano, Genevieve, Hsi-Hwa Hu, and Kyoung Lee. 2001. *The role of public transit in the mobility of low income households.* Los Angeles, CA: National Center for Metropolitan Transportation Research.

Government Accountability Office (GAO). 2006. Public transportation preliminary information on FTA's implementation of SAFETEA-LU changes. Washington DC: U.S. GAO.

Griffin, Keith. 2000. "Problems of poverty and marginalization." Manuscript, Department of Economics, University of California-Riverside.

Hemming, Richard, Michael Kell, and Selma Mahfouz. 2002. *The Effectiveness of Fiscal Policy in Stimulating Economic Activity: A Review of the Literature.* Washington, D.C.: International Monetary Fund.

Hines, James R., Hilary Hoynes, and Alan B. Krueger. 2001. "Another look at whether a rising tide lifts all boats," National Bureau of Economic Research, Working Paper No. 8412 (August).

Holzer, Harry J. and Robert I. Lerman. 2007. America's Forgotten Middle-Skill Jobs. Washington DC: The Workforce Alliance.

Laitner, John A. "Skip" and Vanessa McKinney. 2008. "Positive Returns: State Energy Efficiency Analyses Can Inform U.S. Energy Policy Assessments," ACEEE Report E084. Washington, DC: American Council for an Energy-Efficient Economy.

Lin, James and Jared Bernstein. 2008. "What we need to get by." Washington D.C.: Economic Policy Institute.

Neff, John. 2008. *Public transportation fact book.* Washington, DC: American Public Transportation Association.

Parrott, Diane, Dottie Rosenbaum and Chad Stone. 2009. "How to use existing tax and benefit systems to offset consumers' higher energy cots under an emissions cap." Washington DC: Center on Budget and Policy Priorities.

Pollin, Robert. 2007. "Making the Federal Minimum Wage a Living Wage," *New Labor Forum* 16(2), pp. 103-107.

—. 2009. "Financing the Green Economy as an Answer to Casino Capitalism," *New Labor Forum* 18(1), pp. 108-111.

Pollin, Robert, Mark D. Brenner, Jeannette Wicks-Lim, and Stephanie Luce. 2008. *A Measure of Fairness: the Economics of Living Wages and Minimum Wages in the United States.* New York: Cornell University Press.

Pollin, Robert, James Heintz, and Heidi Garrett-Peltier. 2009. "The Economic Benefits of Investing in Clean Energy: How the economic stimulus program and new legislation will boost U.S. economic growth and employment" Washington, DC: Center for American Progress.

Pucher, John and John L. Renne. 2004. "Urban-rural differences in mobility and mode choice: Evidence from the 2001 NHTS." Manuscript. Bloustein School of Planning and public policy, Rutgers University.

Rogers, Joel. 2007. "Seizing the opportunity (for climate, jobs, and equity) in building energy efficiency." Manuscript. Madison, WI: Center on Wisconsin Strategy and the Center for State Innovation.

Thakuriah, Piyushimita, P.S. Sriraj, Siim Sööt, and Joseph Persky. 2008. "Economic benefits of employment transportation services." Chicago, IL: Urban Transportation Center, University of Chicago.

U.S. Bureau of Labor Statistics. 2009. News Release: Union Membership in 2008. Online: www.bls.gov/news.release/union2.nr0.htm January 28, 2009 (Accessed May 8, 2009).

—. 2008. Occupational Projects and Training Data, 2008-2009 edition. Washington DC: U.S. Department of Labor.

—. 2006. "Employer Costs for Employee Compensation—March 2006." June 21, 2006. www.bls.gov/news.release/pdf/ecec.pdf (July 26, 2006).

U.S. Census Bureau. 2008. United States and Puerto Rico — Metropolitan Area GCT-PH1. Population, Housing Units, Area, and Density: 2000 Data Set: Census 2000 Summary File 1 (SF 1) 100-Percent Data. Online: factfinder.census.gov/servlet/GCTTable?_bm=y&-ds_name=DEC_2000_SF1_U&-CONTEXT=gct&-mt_name=DEC_2000_SF1_U_GCTPH1_US25&-redoLog=false&-_caller=geoselect&-geo_id=&-format=US-10|US-10S&-_lang=en July 15, 2008 (Accessed May 8, 2009).

—. 2004. Census of Population and Housing, Population and Housing Unit Counts PHC-3 Online: www.census.gov/census2000/pubs/phc-3.html April 09, 2004 (Accessed May 8, 2009).

U.S. Department of Health and Human Services, Administration for Children and Families, Office of Community Services, Division of Energy Assistance. 2008. LIHEAP Home energy notebook for fiscal year 2006. Washington DC: U.S. Department of Health and Human Services.

U.S. Department of Housing and Urban Development (HUD), Office of Policy Development and Research. 2008. Housing and Demographic Analysis Division Characteristics of HUD-Assisted Renters and Their Units in 2003. Washington D.C.: U.S. Department of Housing and Urban Development.

Wicks-Lim, Jeannette. Forthcoming 2009. "Prospects for Creating Decent Jobs: the Role of Collective Bargaining." Amherst, MA: Political Economy Research Institute.

Wicks-Lim, Jeannette and Robert Pollin. Forthcoming 2009. "State Minimum Wage Laws and Earned Income Tax Credits." Amherst, MA: Political Economy Research Institute.

About the Authors

Robert Pollin is Co-Director of PERI and Professor of Economics at the University of Massachusetts, Amherst. His recent books include *A Measure of Fairness: The Economics of Living Wages and Minimum Wage in the United States* (co-authored), *An Employment-Targeted Economic Program for South Africa* (co-authored) and *Contours of Descent: U.S. Economic Fractures and the Landscape of Global Austerity*.

Jeannette Wicks-Lim is an Assistant Research Professor at PERI. Wicks-Lim specializes in labor economics with an emphasis on the low-wage labor market. Recent publications include articles in *Dollars and Sense,* and co-authorship of the book *A Measure of Fairness: The Economics of Living Wages and Minimum Wages in the United States* and "Job Opportunities for the Green Economy."

Heidi Garrett-Peltier is a Research Fellow at PERI. She is a co-author of "Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy" as well as a number of other recent and forthcoming studies which examine the transition to a clean-energy economy and the role of the public sector.