# Greening the Global Economy

Robert Pollin

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**For Judy Fogg, Jerry Epstein, and Jim Boyce**

*wonderful PERI co-workers; tremendous friends*

## Contents

# 6 Expanding Job Opportunities through Clean Energy Investments

The massive investments in energy efficiency and clean renewable energy necessary to stabilize the climate will also drive job expansion, in all regions of the world, for countries at all levels of development. Yet there is a widely held view that protecting the environment and expanding job opportunities are necessarily in conflict, creating severe and unavoidable trade-offs. How can there be such huge differences in perspective over a question that is subject to verification through the consideration of evidence?

Aside from posturing by fossil fuel industry spokespeople or pure ideologues, two serious issues contribute to the confusion. The first is that all modern economies, regardless of their current level of development, need an abundance of affordable energy in order to grow at healthy rates, and thereby expand job opportunities. Limiting the supply or raising the price of oil, coal, and natural gas would, by definition, make fossil fuel energy more scarce and costly. Employment opportunities would then have to fall, according to this logic.

But as we have seen in Chapter 5, the full energy mix resulting from twenty years of investments will include roughly 30 percent from clean renewables after efficiency standards have

dramatically increased. The evidence we have reviewed in Chapters 3 and 4 show that there is no reason to expect that energy prices would have to rise under this scenario, given that investments in energy efficiency will generate savings on energy costs and that most clean renewable energy prices will be at rough parity or lower than those from fossil fuels and nuclear power.

The second issue is that building a clean energy economy, and bringing down global emissions to 20 billion tons (2.3 tons per capita), will be bad for *fossil fuel industry* jobs specifically. In the United States, for example, this position has been advanced aggressively regarding the Keystone pipeline project: building and maintaining the Keystone pipeline from the Canadian border through the Midwest to Louisiana would create jobs, while preventing the project means that these jobs will never exist.

This second argument is true, as far as it goes. There is absolutely no way to reduce global fossil fuel production by 40 percent within twenty years, or by 80 percent within thirty-five years, without also cutting employment in the fossil fuel industry by roughly proportional amounts. That can only mean far fewer jobs for coal miners, oil rig operators, and natural gas delivery truck drivers.

But what this perspective leaves out is that, overall, building a clean energy economy will be a positive source of *net job creation* in all regions of the globe, even after we take account of the job losses generated by fossil fuel industry retrenchments. This conclusion is supported by work my co-authors and I have done on job creation through spending within both the clean energy and fossil fuel sectors within various countries. We have studied this question for a diverse set of



nine major economies: Brazil, China, India, Indonesia, Germany, South Africa, South Korea, Spain and the United States. (We are continuing this work for other countries as well.) We have found that building a clean energy economy will be a positive source of job creation in all of these countries, despite substantial differences in labor markets and energy infrastructures.

Tables 6.1 (p. 79) and 6.2 (p. 81) present the main findings of our work. Table 6.1 shows the number of jobs that will be generated in each country through spending $1 million on either building a new clean energy economy or maintaining the country's existing fossil-fuel based energy infrastructure. Table 6.2 gives the same estimates for spending 1.5 percent of current-level GDP. That is, the data in Table 6.2 simply takes the figures from Table 6.1 and scales the level of spending to 1.5 percent of each country's GDP as opposed to spending a flat $1 million on clean energy in each country.

### Where the Data Come From

Our estimates draw directly from national surveys of public and private economic enterprises within each country. These data are organized systematically within national "input-output" statistical tables for each country's economy. Here is one specific example of our methodology. If a business invests an additional $1 million on energy efficiency retrofits of an existing building, we are able to measure, using the input-output tables, how much of the $1 million the business will spend on paying wages and benefits to workers and on needed supplies (such as windows, insulation, and lumber), how much will be left over to keep as profits, and how many new workers will be hired by the

window, insulation, and lumber companies as a result. We also examine this same set of questions for investment projects in renewable energy as well as spending on operations within the fossil-fuel energy sectors.[1]

### Dividing Countries between Fossil Fuel Producers and Importers

I have divided our full set of nine countries into two groups in Tables 6.1 and 6.2. The first group includes countries that are, at present, large-scale producers of either oil, coal or natural gas, or some combination of all three. The second group includes countries that are heavily dependent on imports for their fossil fuel supplies. This distinction is crucial for assessing the impact on job opportunities within each country through advancing a clean energy transition. That is, with countries that are large-scale fossil fuel producers, we have to allow that the shift away from fossil fuels to clean renewables and energy efficiency will also entail a significant decline in employment opportunities in these countries' fossil fuel industries. For this set of countries—Brazil, China, India, Indonesia, South Africa and the United States—I am assuming for our discussion that a 1.5 percent of GDP increase in clean energy investments in the countries is equally matched by a 1.5 percent of GDP decline in spending on fossil fuel production. Thus, net job creation occurs in these countries through their clean energy investment project only when spending a given amount of money on clean energy investments creates more jobs within the country than spending the same amount of money on fossil fuel production.

In the United States, for example, if clean energy investments and fossil fuel production both generate 10 jobs per $1 million in spending, then shifting $1 million out of fossil fuel



production and into clean energy investments will produce no net gains in jobs at all. In fact, for the U.S., as we see in Table 6.1, spending $1 million on clean energy investments generate, on average, 8.7 jobs while fossil fuel production generates 3.7 jobs. Shifting energy-sector spending from fossil fuels to clean energy therefore produces an average of 5 new jobs per $1 million in spending within the U.S. economy. The upper panel of Table 6.1 reports the figures for the U.S. and the other fossil-fuel producing economies. The upper panel of Table 6.2 then shows the net gains in job creation for the fossil-fuel producing countries from shifting 1.5 percent of GDP into clean energy production and out of fossil-fuel production.

In our second, smaller group of fossil-fuel importing countries—Germany, South Korea, and Spain—the jobs generated by investing 1.5 percent of GDP in clean energy is not counteracted by an equivalent shift out of domestic spending on fossil fuel production, but rather only a decline in fossil fuel imports. In the lower panel of Table 6.1, I therefore show for Germany, South Korea and Spain the figures for job creation through clean energy investments, without also reporting figures on job created by fossil fuel production. In the lower panel of Table 6.2, I then show job creation in each of these economies through channeling 1.5 percent of GDP on clean energy investments.[2]

Beyond these specific issues on job creation, it is important to recognize, more generally, that the heavy fossil fuel importing countries will enjoy greater proportional benefits through their clean energy investment programs: first, these countries produce jobs through their clean energy investments without facing counteracting fossil fuel sector job losses; and, second, equally critically, they reduce their dependency on imported

energy sources. In the next chapter, I consider the benefits for Germany, South Korea and Spain, and other heavy oil importers of reducing their oil import dependency. We focus on job creation effects in our present discussion.

### Job Creation Estimates by Country

As we see in Table 6.1, the number of jobs created through spending within the energy industry varies widely by country. For example, among the six fossil-fuel producing countries, we see that investing $1 million on clean energy investments generates about 9 jobs in the United States, 37 jobs in Brazil, 71 jobs in South Africa, 133 jobs in China, and 262 jobs in India. For the three fossil fuel importing countries, clean energy investments generate about 10 jobs in Germany, 13 jobs in Spain, and 15 jobs in South Korea.

These differences are driven mainly by the wide range of average wage levels. For example, as of 2010, average manufacturing wages were about $1.50 in India, $11 in Brazil, and $44 in Germany. Such differences need to be kept in mind. But our main interest is with the relative job creation figures *within each of the countries*. This is especially the case for the fossil-fuel producing countries, in which we need to counterbalance job gains from clean energy investments against job losses through declining spending within domestic fossil fuel industries.

We see in the upper panel of Table 6.1 that in all six fossil fuel producing countries, investing in clean energy generates more jobs per $1 million in spending than channeling that same amount of money into each country's fossil fuel industry. In most cases, the net increase in job creation is substantial. The largest difference is in Indonesia, where clean energy



**Table 6.1** Jobs Generated through Spending $1 Million on Clean Energy versus Fossil Fuel Production

Large-scale Fossil Fuel Producing Countries

| | Clean Energy Jobs per $1 million | Fossil Fuel Jobs per $1 million | Job Increase through Clean Energy Spending relative to Fossil Fuels |
|---|---|---|---|
| Brazil | 37.1 | 21.2 | +75% |
| China | 133.1 | 74.4 | +79% |
| India | 261.9 | 129.1 | +103% |
| Indonesia | 99.1 | 22.0 | +350% |
| South Africa | 70.6 | 33.1 | +113% |
| United States | 8.7 | 3.7 | +135% |

Large-scale Fossil-Fuel Importing Countries

| | Clean Energy Jobs per $1 million |
|---|---|
| Germany | 9.7 |
| South Korea | 14.6 |
| Spain | 13.4 |

Sources: See Pollin et al. (2015a) Chapter 6 and Appendix 2 for estimating methodology.

investments generate 99 jobs per $1 million, while spending on fossil fuels produces only 22—a difference of 350 percent. In Brazil, China, South Africa, and the United States, clean energy investments generate between 75 and 135 percent more jobs than spending on fossil fuels. With Germany, South Korea and Spain, again, we do not need to match the job increases per $1 million in clean energy investments against job losses through withdrawing $1 million from fossil fuel spending.

Focusing now on the fossil fuel producing countries, why is it that in all six cases, clean energy infrastructures generate

more—often significantly more—jobs per $1 million in spending than the existing fossil fuel infrastructure? The reason has nothing to do with climate stabilization per se. There are two separate factors at play.

The first is the higher level of *labor intensity* that results from spending on clean energy. More money is spent on hiring people and less on machines, supplies, and energy consumption. This is not surprising if we imagine channeling investment funds to, for example, hiring construction workers to retrofit buildings or install solar panels as opposed to drilling for oil. We would see a lot more people on the retrofitting job site than at the oil drilling rig relative to the size of the project. The second factor is the *domestic content* of spending—how much money stays within the domestic economy as opposed to buying imports. When an economy retrofits its existing building stock, improves its public transportation system, or invests to install solar panels, a much higher share of overall spending and job creation will remain within the country than when it is purchasing imported oil.

### Scaling the Job Effects to 1.5% of GDP

In Table 6.2, showing the employment effects of channeling 1.5 percent of GDP into clean energy investments, we again first see that the differences in the job creation figures between countries are large. Among the fossil fuel producing countries, investing 1.5 percent of GDP on clean energy investments will produce around 250,000 jobs in South Africa, 1.5 million jobs in the U.S., between 925,000 – 950,000 jobs in Brazil and Indonesia, and between 11.4 and 12 million jobs in China and India. For our three fossil fuel importing countries, clean energy investments at 1.5 percent of GDP generates 175,000



**Table 6.2** Jobs Generated through Spending 1.5% of GDP on Clean Energy versus Fossil Fuels

Large-scale Fossil Fuel Producing Countries

| | Total Clean Energy Jobs Created through Investing 1.5% of GDP | Net Clean Energy Jobs Created after subtracting Fossil Fuel Job Losses | Clean Energy Job Creation as Share of Total Labor Force | |
|---|---|---|---|---|
| | | | Total Job Creation | Net Job Creation |
| Brazil | 925,000 | 395,000 | 0.9% | 0.4% |
| China | 11.4 million | 6.4 million | 1.5% | 0.6% |
| India | 12.0 million | 5.7 million | 2.6% | 1.4% |
| Indonesia | 954,000 | 752,000 | 0.8% | 0.6% |
| South Africa | 252,000 | 126,000 | 1.4% | 0.7% |
| United States | 1.5 million | 650,000 | 1.0% | 0.5% |

Large-scale Fossil-Fuel Importing Countries

| | Total Clean Energy Jobs Created through Investing 1.5% of GDP | Clean Energy Job Creation as Share of Total Labor Force |
|---|---|---|
| Germany | 330,000 | 0.8% |
| Spain | 320,000 | 1.4% |
| South Korea | 175,000 | 0.6% |

Sources: See Pollin et al. (2015a) Chapter 6 and Appendix 2 for estimating methodology.

jobs in South Korea and between 320,000 and 330,000 in Germany and Spain. These large differences are driven both by relative wage rates country-by-country and by large differences in each country's GDP.

But here again, our main interest is with the total levels of jobs *within each country* as well as the net job creation after we subtract jobs lost to the contraction of the fossil fuel industry in our six fossil fuel producing countries. Of course, among the six fossil fuel producing countries, it is not necessarily the case that the country's fossil fuel spending will contract by the same amount that the clean energy economy expands. But this assumption provides a simple illustration of the net job gains that will occur through a clean energy investment project in fossil fuel producing countries—even when the expansion of each country's energy efficiency and renewable energy investments are matched dollar-for-dollar by fossil fuel industry retrenchments.

Table 6.2 also shows, for each country, the level of job creation as a share of each country's overall labor force. These figures are not large, with respect to both the fossil fuel producers as well as the fossil fuel importers. They range between 0.6 and 2.6 percent for total job creation and between 0.4 and 1.4 percent for net job creation, after subtracting the jobs lost through fossil fuel retrenchments—including the cuts in the oil refining sectors in Germany, South Korea and Spain. Of course, we would not expect these job figures to be much larger, given that we are setting the overall increase in clean energy investments (and fossil fuel retrenchments) at no more than 1.5 percent of each country's GDP.

What these figures make clear is that clean energy investment programs, scaled at 1.5 percent of GDP, will not, by themselves, deliver full employment in any given country. But clean energy investments will nevertheless be a positive new source of job opportunities. Certainly these net job increases—roughly 6.4 million in China, 5.7 million in India, 750,000 in Indonesia, 650,000 in the United States, 400,000 in Brazil, 300,000 in Germany and Spain, 175,000 in South Korea, 125,000 in South Africa—are not trivial. Politicians in all nine countries would be very pleased to claim credit for job gains of this magnitude. Moreover, for all countries, clean energy investments will mean more overall job opportunities relative to maintaining the country's existing fossil fuel energy infrastructure. In other words, overall, building clean energy economies in all regions of the world will not require sacrifices by working people. Working people will rather benefit, in many cases substantially, from the overall growth in job opportunities.



At the same time, employment conditions will not improve for *all* workers under all circumstances through clean energy investments. Who is likely to fare better or worse through a clean energy investment agenda? To answer this question, we need to address three additional important issues beyond the figures we present in Tables 6.1 and 6.2: the impact of labor productivity growth over time on job creation, the *quality* of the jobs being generated, and the inevitable difficulties that will be faced by workers dependent on the fossil fuel industry. We take these up in turn.

### Labor Productivity Growth and Job Creation

The employment effects reported in Tables 6.1 and 6.2 are based on the production methods currently used in each country. So spending $1 million on clean energy investments will generate, on average, 8.7 million jobs in the United States and 261.9 jobs in India, based on what we know about the current production methods being used today. But clean energy technologies

will certainly improve over the twenty-year investment cycle. Such technological improvements will typically increase average labor productivity. This means that fewer workers will be needed to raise energy efficiency levels or expand clean renewable energy production. What will be the impact of such labor productivity improvements on our overall finding that clean energy investments will be a positive source of job creation throughout the world?

In fact, gains in employment opportunities should increase over time, even after we allow that average labor productivity improves every year. Considering past patterns of productivity growth, my co-workers and I find that, since the mid-1990s, the rate at which productivity has improved in the clean energy sectors varies considerably by country. For example, productivity gains have been relatively modest in Brazil, Indonesia, South Africa, and the United States but have been rapid in India and South Korea. Of course, we cannot know from these past productivity trends what is likely to happen moving forward. Still, if anything, we should generally expect labor productivity in the clean energy sectors to accelerate, as a result of much faster rates of investment in these sectors. This should, in turn, encourage innovation and productivity improvements.

Nevertheless, regardless of how slowly or quickly labor productivity improves in various countries, the key to achieving strong gains in employment opportunities is rapid expansion of investment in energy efficiency and clean renewables. Indeed, based again on past economic trends in all countries, it is almost certain that the growth in investment spending and operational activities will outpace improvements in labor productivity. As a result, the expansion in employment opportunities should



increase over time, even in countries where labor productivity grows at relatively rapid rates.

### Job Quality and Skill Requirements

Increased employment opportunities will be spread widely in all countries. Moreover, the majority of jobs created by clean energy investments will be in the same areas of employment in which people already work. For example, constructing wind farms creates jobs for sheet metal workers, machinists, and truck drivers, among others. Increasing the energy efficiency of buildings through retrofitting relies, among others, on roofers, insulators, and building inspectors. Expanding public transportation systems employs civil engineers, electricians, and dispatchers. Increasing demand for bioenergy will mean a significant increase in employment in standard agricultural activities. At the same time, we do still need to address several issues: where the new employment opportunities are most likely to open up, the likely pay levels and other conditions on these jobs, the likely gender balance among them, and the kinds of new educational and skill requirements that might be needed.

*Expanding job opportunities by sector.* Three economic sectors, broadly defined, will see relatively large increases in employment. The first is agriculture, where increasing job opportunities will result from the expansion of bioenergy production. Second, construction jobs will also increase substantially, due to both energy efficiency building retrofits and infrastructure investments to upgrade electrical grid and public transportation systems. Third, manufacturing jobs will increase to meet the increased demand for solar panels, wind turbines, and other renewable energy equipment.

Of course, not all countries will expand employment equally in all of these areas. The agriculture and construction jobs will most likely grow in all countries in rough proportion to the overall expansion in clean energy investments, since agriculture and construction activities typically rely mainly on their own domestic work force and other resources. By contrast, many countries will rely on imports to meet at least some of the increased demand for renewable energy manufacturing products. As such, the employment gains through expanding clean energy will be lower when a country purchases imports as opposed to producing these goods domestically. But even when, for example, a country is importing solar panels, a growing reliance on solar energy will still generate more jobs for workers who are transporting, installing, and maintaining the solar equipment as well as upgrading the electrical grid system for transmitting solar power.

Countries importing a large share of their manufactured clean energy products can also consider policies to expand domestic production. When domestic production increases, domestic job opportunities will expand as well. I consider this issue further in Chapter 7, on policy options.

*Informal employment.* In all but the most advanced economies, employment in agriculture and construction is, at present, mostly informal. This means that there is a high proportion of very small enterprises and self-employment. Most of the time, working in informal enterprises means low pay and benefits and little to no job security.

At the same time, the new agricultural and construction jobs are not necessarily consigned to being bad jobs. The major increase in investment flowing into construction and agriculture could create new opportunities to raise labor standards in



these sectors. For example, in Brazil, the expansion of its bioenergy sectors has slowly encouraged increased agricultural mechanization and rising productivity. The growth of employment resulting from Brazil's bioenergy investments has therefore been less than it would have been if traditional agriculture methods had continued to prevail and productivity had consequently remained low. But this mechanization trend does also create greater opportunities for better pay and working conditions for the large numbers of jobs that will remain in agriculture. Of course, nobody should expect that mechanization and faster productivity growth will, by themselves, deliver better jobs. But such gains in productivity will create new opportunities for workers and their representatives, along with public policymakers, to support major upgrades in labor standards.

*Opportunities for women.* Throughout the world, the construction and manufacturing sectors are heavily dominated by male workers. If this situation were to continue, clean energy investments that rely heavily on construction and manufacturing would yield relatively few new employment opportunities for women. These investment areas include hydro, wind, solar, and geothermal power, as well as efficiency investments in building retrofits and electrical grid upgrades. The share of female employment generated by these clean energy investment areas ranges between 20 and 30 percent in most countries, including both advanced and developing economies. Clean energy investment projects should be used as an opportunity to highlight the need for much greater gender equity in these currently male-dominated areas.

*Education and skill requirements.* The general level of educational attainment for workers in the clean energy sectors is not, for the most part, significantly different than those for workers presently

employed in the oil, coal, and natural gas sectors. Thus, as jobs in the fossil fuel sectors are reduced, there will be an increased supply of workers available to operate within the clean energy sectors with appropriate levels of general educational credentials.

At the same time, some of the newly created jobs generated by clean energy investments will also require new skills. For example, installing solar panels on roofs and wiring these panels so they supply electricity are distinct tasks relative to the jobs that are traditionally performed by either roofers or electricians. Similarly, refining agricultural wastes into biofuels is different than refining corn into ethanol or, for that matter, refining petroleum into gasoline. Countries advancing clean energy investment projects will need to make provisions for these and similar areas that demand new types of training and skill acquisition. But how extensive will be the need for new training and skills?

A recent study by the International Labour Office, *Skills for Green Jobs: A Global View*, concluded that clean energy and other green-economy occupations will, for the most part, require updating existing skills as opposed to training workers for entirely new occupations. For example, the authors observe that:

> The number of existing occupations that will change and update their skills content by far exceeds the number of new occupations that will emerge.... The greening of established occupations implies incremental changes in qualifications. New skills are needed because specific competencies are currently lacking [and] some existing skills relating to job tasks that become obsolete cease to be used.[3]

Inevitably, there will be some difficult transition periods and bottlenecks in most countries as the growth in clean energy investments generates increasing demands for workers with new types of specific skills. Still, these bottlenecks will be less



severe than they might be otherwise. This is because, as we have discussed, most jobs and skill requirements in the clean energy economy are not significantly different than those already required of most people currently working in other sectors. In addition, the general educational attainment levels for most jobs within the clean energy sectors will be roughly comparable to those within the fossil fuel sectors facing retrenchments. The net result is an increase in the number of workers that can move into clean energy. In addition, countries facing shortages of skilled workers in specific areas can rely on imports to cover these gaps until the country's own supply of qualified workers expands.

### Just Transition for Fossil Fuel Sector Workers

There is no denying that workers and communities throughout the world whose livelihoods depend on people consuming oil, coal, and natural gas will lose out in the clean energy transition. In order for the global clean energy project to succeed, it must provide adequate transitional support for these workers and communities.

The United Nations Environmental Program (UNEP) addressed this issue in a 2008 study, *Green Jobs: Toward Decent Work in a Sustainable, Low-Carbon World*. The authors describe what they term a "fair and just transition" for workers and communities that are currently dependent on the fossil fuel industries:

> The shift to a low carbon and sustainable society must be as equitable as possible. . . . From the point of view of social solidarity, and in order to mobilize the political and workplace-based support for the changes that are needed, it is imperative that policies be put in place to ensure that those who

> are likely to be negatively affected are protected through income support, retraining opportunities, relocation assistance and the like.[4]

The arguments made in this study for a "fair and just transition" build from the ideas of late U.S. labor and environmental leader Tony Mazzocchi, who developed the idea of a "Superfund" for workers who lose their jobs as a result of necessary environmental transitions. Mazzocchi's use of the term refers to the U.S. environmental program that was implemented in 1980 to clean up sites at which corporations had dumped hazardous wastes from petrochemical, oil, and nuclear energy production. As Mazzocchi wrote as early as 1993:

> Paying people to make the transition from one kind of economy—from one kind of job—to another is not welfare. Those who work with toxic materials on a daily basis...in order to provide the world with the energy and the materials it needs deserve a helping hand to make a new start in life. . . . There is a Superfund for dirt. There ought to be one for workers.[5]

The critical point in Mazzocchi's idea is that providing high-quality adjustment assistance to today's fossil fuel industry workers will represent a major contribution toward making a global climate stabilization project viable. It is a matter of simple justice, but it is also a matter of strategic politics. Without such adjustment assistance programs operating at a major scale, the workers and communities facing retrenchment from the clean energy investment project will, predictably and understandably, fight to defend their communities and livelihoods. This in turn will create unacceptable delays in proceeding with effective climate stabilization policies.



Still, the impact on workers and communities from retrenchments in the fossil fuel sectors will not depend only on the level of support provided through explicit adjustment assistance programs, no matter how generous their provisions. The broader set of economic opportunities available to workers will also be critical. The fact that the clean energy investment project will itself generate a net expansion in employment in all regions of the globe means that there will be new opportunities for displaced fossil fuel sector workers within the energy industry itself. There will be more jobs for, among other occupations, operations managers, mechanical engineers, construction managers, farmers and ranchers, roofers, electricians, and sheet metal workers.

But further than this, the single best form of protection for displaced workers in all countries is an economy that operates at full employment. A full employment economy is simply one in which there is an abundance of decent jobs available for all people seeking work. In a full employment economy, the challenges faced by displaced workers—regardless of the reasons for their having become displaced—are greatly diminished simply because they should be able to find another decent job without excessive difficulties. It also follows that, in a full employment economy, the costs to taxpayers of providing reasonable levels of financial support for displaced workers would be greatly diminished. Overall then, in the realm of overarching social, economic, and environmental policy priorities, a commitment to full employment should be understood as fully consistent with and supportive of the project of building a clean energy economy.