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2. Conclusions and Recommendations

This report is being published at a time when interest in green jobs has reached extraordinary levels. With this interest has come an infectious optimism regarding the potential of green employment. In a sense, the green job has become something of an emblem for both a new and sustainable economy and a more just society.

Much of the present optimism around green jobs is justified. The growth of green employment in many countries is already very significant. This report presents a series of quantifications, estimates, and projections of green jobs around the world, in addition to anecdotal and circumstantial evidence of green jobs growth and potential.

There are, of course, many remaining data gaps. Governments must establish statistical reporting categories that recognize and help capture relevant employment in both newly emerging industries and green employment in established sectors. As the German government has done, governments should also commission in-depth modeling and econometric efforts to analyze not just direct green jobs but also those that are related in a more indirect manner. Business associations and trade unions can play a useful part as well. Some have begun to do job surveys and profiles, but far more of these kinds of efforts are needed. Attention also needs to be given to disaggregating data on the basis of gender in order to ensure that there is equality of opportunity for women and men for green jobs. And greater scrutiny of supply chains is warranted, to better understand just how much many traditional businesses and occupations are positively affected and reinvigorated by the greening of the economy.

Key Job Findings

Energy Supply

- ❑ **Renewables.** Renewable energy sources are expanding rapidly. We estimate current employment at about 2.3 million jobs worldwide. Given incomplete data, this is in all likelihood a conservative figure. The wind power industry employs some 300,000 people, the solar PV sector an estimated 170,000, and the solar thermal industry more than 600,000, many of the latter in China.
- ❑ **Biofuels.** About half of all present renewables jobs are found in the biofuels industry. However, there are rising doubts about the environmental benefits and economic impacts of at least some types of biofuels. In addition, the bulk of biofuels jobs are found at sugarcane and palm oil plantations, where wages are low, working conditions often extremely poor, and worker rights at least in some cases suppressed. Many of these jobs can hardly be described as good or decent employment.

- ❑ **Fossil Fuel Industry.** A greening of the economy implies a much-reduced role for fossil fuels. But the oil, natural gas, and coal industries are not major employers, and with each passing year, growing automation and mechanization translates into fewer jobs—sometimes even in the face of expanding production. The coal industry epitomizes these trends. Countries like China, the United States, Germany, Britain, and South Africa have all shed many hundreds of thousands of jobs. In the United States, coal output rose by almost one-third during the past two decades, yet employment has been cut in half.
- ❑ **CCS.** Carbon capture and sequestration has been offered by the coal industry and a number of trade unions as a way to reduce coal's carbon footprint. There are many remaining questions regarding how much carbon emissions could be reduced in this manner, whether the technology actually works, and whether carbon can reliably remain sequestered for long periods of time. Being capital intense, it appears unlikely that CCS could become a significant source of employment. And there is a danger that CCS will absorb scarce investment resources that otherwise might be devoted to renewables and energy efficiency.

Buildings

- **Energy Efficiency.** Nearly all efficiency measures, especially in the building sector, show positive employment and economic effects. A 2000 study by the U.K. government concluded that for every \$1.4 million (€1 million) invested in residential energy efficiency, 11.3 to 13.5 FTE (full-time equivalent) jobs were created.
- **Green Buildings.** Using current technology, high-performance buildings have the potential to save energy by at least 80 percent compared with traditional building construction. Jobs in this sector are likely to be performed by people who already work in the building sector, but redefined in terms of new skills, training, and certification requirements. Currently there are over 40,000 LEED-Accredited Professionals in the United States.
- **Retrofitting.** In the building sector, retrofitting has the largest potential to reduce greenhouse gas emissions by 2030, creating jobs in construction, building operations, auditing, architecture, engineering, manufacturing, and administration, among others. Most of the jobs are performed directly at the work site, which is significant for rural and developing economies. From 2001–2006, through \$5.2 billion (€3.8 billion) in public investment and \$20.9 (€15.2 billion) in private investment, Germany's retrofitting program resulted in 342,000 apartment retrofits and the creation of 145,000 additional FTE jobs in 2006.
- **Efficient Building Components.** According to the McKinsey Global Institute, the building sector has four out of the five most cost-effective ways to reduce emissions: lighting, insulation, air conditioning and water heating. The U.S. Department of Labor estimates that higher standards for clothes washers, water heaters, and fluorescent lamp ballasts would create 120,000 jobs in the United States through 2020.

Transportation

- **Railways.** By dint of their high degree of energy efficiency, railways can generally be regarded as sources of green employment. Unfortunately, the trend over the last few decades has been

away from railways in many countries, and toward cars, trucks, and planes. Employment—both in operating rail lines and in manufacturing locomotives and rolling stock—has fallen accordingly. Railway jobs in China and India fell from 5.1 million to 3.3 million during 1992–2002. In Europe, railway employment is down to about 900,000 jobs; the number of workers in manufacturing rail and tram locomotives and rolling stock there has declined to 140,000.

- **Urban Mass Transit.** Employment statistics for urban transit are incomplete and trends vary considerably by city and country. But some 1.3 million people work in public transit in the European Union and the United States alone. Bus Rapid Transit systems are being put in place in growing numbers of cities around the world, providing affordable and reliable transit options. There are also substantial green employment opportunities in retrofitting diesel buses to reduce air pollutants, and in substituting cleaner CNG or hybrid-electric buses. In New Delhi, the introduction of 6,100 CNG buses by 2009 is expected to lead to the creation of 18,000 new jobs.
- **Automobiles.** An assessment of the most efficient cars available today suggests that relatively green auto-manufacturing jobs may number about a quarter million out of roughly 8 million direct jobs worldwide. The bulk of these are in Europe and Japan. The number of green jobs elsewhere, including the United States, China, and India, is still very limited. But Thailand has launched a promising initiative to produce more fuel-efficient cars and thus to green a good portion of its 182,000-strong vehicle manufacturing workforce.
- **Two- and Three-Wheelers.** Highly polluting two-stroke engines are ubiquitous in developing countries, and particularly in Asia. Pilot projects in the Philippines suggest that retrofits cut fuel consumption by 35–50 percent and emissions of air pollutants by as much as 90 percent. Many jobs can be created through installing and servicing retrofit kits.

Basic Industry

- **Steel.** Secondary steel production, based on recycled scrap, requires 40–75 percent less energy than primary production and can therefore be seen as a proxy for greener production. Worldwide, 42 percent of output was based on scrap in 2006. Possibly more than 200,000 jobs are involved in secondary steel production worldwide. Scrap use is particularly pronounced in Turkey, Spain, the United States, South Korea, Germany, and Japan. Reusing byproducts such as steel slag is another way of greening parts of the industry; in the United States alone, close to 3,000 people are employed in slag recovery.
- **Aluminum.** Recycling aluminum scrap uses only 5–10 percent the amount of energy it takes to make aluminum from scratch. About one-quarter of global production is scrap-based. No global employment numbers exist for such secondary production. But the United States reports about 6,000 employees in secondary production, and Japan has about 12,000. Europe has an estimated 10,000 direct and indirect jobs in aluminum recycling. China's numbers are unknown, but given the country's large production and low labor productivity, they must be substantial.
- **Cement.** The cement industry can become greener through energy-efficiency improvements and by using alternative and recycled content. Although these measures may make existing jobs a pale shade of green, it is not expected to be a major source of new green employment.

- ❑ **Pulp and Paper.** Recycling paper is the fastest-growing source of new green employment in the pulp and paper industry. The World Bank estimates that in 2002, Brazil had over 28,000 formal jobs in paper recycling. In developing countries, paper recycling is often performed by an informal network of scrap collectors. In countries like Brazil and Colombia, scrap collectors have begun to form cooperatives in order to increase working conditions and pay.
- ❑ **Recycling.** The Bureau of International Recycling in Belgium estimates that its members in 60 countries employ more than 1.5 million people. But this is a serious undercount. Recent reports put the number of recycling and remanufacturing jobs in the United States alone at more than 1 million. Jobs in this sector in Western Europe and Japan can be assumed to be even more numerous, as these regions have achieved higher rates of recycling than the United States. In China, an estimated 10 million people are employed in all forms of recycling, with 700,000 alone in electronics recycling. Brazil is thought to have some 500,000 recycling jobs. Communal recycling and composting efforts in all likelihood add many additional jobs.

Food and Agriculture

- ❑ **Organic Farming.** With sales reaching \$100 billion in 2006, organic farming is beginning to register an impact. Greener and somewhat more labor intensive than industrialized agriculture, the conversion of more farmland for organic production could provide a good source of green employment in the future. A study of 1,144 organic farms in the United Kingdom and the Republic of Ireland showed that they employed one-third more full-time equivalent workers per farm than conventional farms. Organic agricultural land amounts to 4.3 percent and 1 percent of the total farm area in these two countries, respectively. If 20 percent of farmland became organic in both countries, there would be an increase of 73,200 jobs in the United Kingdom and 9,200 in Ireland.
- ❑ **Urban Agriculture.** An estimated 800 million people already grow their own food in urban areas. This may generate few jobs in the conventional sense, but individual families and groups organized in cooperatives working to grow their own food are sustaining themselves and helping the environment.
- ❑ **Sustainable Small Farming.** Small farms are more labor and knowledge intensive than agro-industrial farms and use fewer energy and chemical inputs. But today, hundreds of millions of smallholders are being squeezed by excessive liberalization and the power of big retail. Poverty and exploitation are rampant. However, with adequate technical and infrastructural support, yields from small farms using crop rotation, manuring, natural pesticides, and other sustainable methods can match the larger (but more environmentally damaging) facilities. A policy-driven conversion to this type of farming will perhaps take decades, but the potential for green and decent work is considerable and the environmental benefits could be enormous.
- ❑ **Payment for Environmental Services, Improved Natural Resource Management.** Paying rural dwellers for repairing and protecting the natural environment could generate very large numbers of jobs. In South Africa, a public “Working for Water” program has provided work for 25,000 previously unemployed people. Terracing or contouring of land, building irrigation structures, water conservation, and other such activities are labor intensive and will also provide employment, as will the rehabilitating of dams, barrages, and embankments.

- ❑ **Climate Change Adaptation.** Climate change adaptation and mitigation can create green employment as well, although the numbers involved are difficult to estimate. Soil conservation efforts such as conservation tillage and the rehabilitation of degraded crop and pasture land promise to create employment and sustain rural livelihoods.

Forestry

- ❑ **Afforestation/Deforestation.** Planting trees creates large numbers of jobs, but these jobs are often part-time, seasonal, and low paid. Greening these jobs will require more rigorous project requirements for labor standards.
- ❑ **Agroforestry.** Concentrated mainly in Africa, Asia, and Latin America, agroforestry, which combines tree planting with traditional farming, has been shown to create employment, food, and fuel security and provide supplementary income for small farmers. Agroforestry projects rely on external funding to pay for upfront costs and are therefore limited by the lack of funding sources available.
- ❑ **Sustainable Forestry Management (SFM).** Certification schemes like FSC and PEFC represent a fraction of the global wood market, but are rapidly increasing their shares. The employment consequences of SFM have been mixed. In the short term, adopting certification schemes often leads to layoffs and a decrease in employment. However, in the long run, such schemes provide more stable employment over a greater period of time and opportunities to increase labor standards.

Main concepts

Two concepts are important. First, not all green jobs are equally green. We employ the term “shades of green” to indicate that some policies will yield greater environmental benefits than others. Pollution avoidance is better than pollution control. Mass transit is preferable to automobiles, even if they are reasonably fuel-efficient. Still, lighter shades of green can play an important role in the overall process of putting the economy on a more sustainable footing, particularly to the extent that they provide the time and flexibility needed to pursue the deeper shades of green for long-term sustainability.

A similar picture unfolds with regard to the question of whether green jobs are decent jobs. There is an enormous range in terms of skill requirements, occupational profiles, career prospects, and wages among green jobs. And there is a panoply of working conditions and worker rights. Green jobs can be good jobs, but this depends to some extent on technical aspects (that is, the extent to which certain types of work expose workers to hazards), and on the degree to which union organizing and collective bargaining are permitted.

As previously noted, many biofuel plantation jobs are unlikely to meet decent work standards. Recycling can entail dirty, undesirable, and hazardous work—as is the case in the electronic scrap industry and for the many thousands in ship dismantling in South Asia. Much of this work is also informal and, by definition, irregular. Here, the North-South divide is stark. In the richer countries, recycling is regulated and linked to environmental protection, and the jobs involved are relatively

decent. But in middle-income and poor countries, millions engage in informal and poorly regulated forms of recycling as a means to earn a meager living. The sight of children wading through piles of garbage to find something of value presents an enduring image, one that says as much about the global world of recycling than any other.

Second, the creation of green employment in key parts of the economy has the potential to “radiate” across large swaths of the economy, thus greening commensurately large sections of the total workforce. For instance, providing clean energy supplies means that any economic activity has far less environmental impact than today, when fuels and electricity are still produced largely from dirty sources. Likewise, greening vehicles (that is, producing cars, trucks, and buses that run on cleaner fuels and are more efficient) means that the many millions of jobs in transportation services are by implication also greener. Green buildings to an extent help green the jobs of those who work in them. Nonetheless, such effects do not obviate the need for additional environmental measures, such as phasing out the use of toxic materials, reducing waste, and so on. But it does imply that beyond the numbers of green jobs that can be quantified in specific sectors, such as renewables, there is a far greater realm of sustainable employment.

Real Potential, Formidable Challenges

The potential for further green job growth is tremendous. Renewable energy is poised for continued expansion, and may generate more than 8 million jobs in wind and solar alone over the next two decades. If most or all new buildings were constructed according to higher efficiency standards, it would revolutionize the construction industry. Many additional green jobs can be created through extensive weatherization and retrofitting of existing buildings. Similar change is possible in agriculture—switching the bulk of the world’s farming to organic and sustainable methods.

Manufacturing the world’s motor vehicles by incorporating the very best in fuel-efficient technology would dramatically lessen their environmental footprint and create green jobs in this key industry. Modern efficient public transportation systems could be established where today poor-quality and inefficient ones operate or, as in many cities of the global South, do not yet exist at all. Industrial operations have enormous greening potential by boosting the efficiency with which they use energy and materials and minimizing the waste streams they leave behind. Some basic industries can also further improve the rate at which they rely on recycled scrap rather than mining and smelting virgin materials. The expansion of a broad range of recycling and remanufacturing activities could generate huge numbers of jobs.

Imagine if economic stimulus packages and other government and business programs around the world were truly aimed at spawning a revolution in innovative green technologies—that is, they provided funds to retrofit buildings so they no longer require heavy air conditioning in the summer and expensive heating in the winter, or they boosted public mass transit and encouraged or even required developers to build communities that are less sprawling and more walkable.

The numbers of additional green jobs that could be generated through such pathbreaking measures is unknown, but obviously enormous. Table III.2-1 offers a broad look at the greening potential of different sectors of the economy—that is, the extent to which their environmental impacts can be reduced. It also characterizes green job growth in these areas to-date and offers orders-of-magnitude estimates of future green job growth. In doing so, it demonstrates the wide variety of greening potential, and the diverging degree to which this potential has so far been translated into reality.

Table III.2-1. Green Job Progress To-Date and Future Potential

		GREENING POTENTIAL	GREEN JOB PROGRESS TO-DATE	LONG-TERM GREEN JOB POTENTIAL
ENERGY	Renewables	Excellent	Good	Excellent
	CCS	Fair	None	Unknown
INDUSTRY	Steel	Good	Fair	Fair
	Aluminum	Good	Fair	Fair
	Cement	Fair	Fair	Fair
	Pulp and Paper	Good	Fair	Good
	Recycling	Excellent	Good	Excellent
TRANSPORTATION	Fuel-Efficient Cars	Fair to Good	Limited	Good
	Mass Transit	Excellent	Limited	Excellent
	Rail	Excellent	Negative	Excellent
	Aviation	Limited	Limited	Limited
BUILDINGS	Green Buildings	Excellent	Limited	Excellent
	Retrofitting	Excellent	Limited	Excellent
	Lighting	Excellent	Good	Excellent
	Efficient Equipment and Appliances	Excellent	Fair	Excellent
AGRICULTURE	Small-Scale Sustainable Farming	Excellent	Negative	Excellent
	Organic Farming	Excellent	Limited	Good to Excellent
	Environmental Services	Good	Limited	Unknown
FORESTRY	Reforestation/ Afforestation	Good	Limited	Good
	Agroforestry	Good to Excellent	Limited	Good to Excellent
	Sustainable Forestry Management	Excellent	Good	Excellent

A bright green future is possible. There is additional job potential with regard to reactive measures—dealing with the accumulated environmental ills of the past. The building of much-needed adaptation infrastructure to protect communities from extreme weather events has barely started, but presumably would employ large numbers of people, even if only temporarily. Sustainable management of the world’s forests, which could involve replanting and cultivation of billions of trees, barely exists today in countries with rampant deforestation, but could form the basis of reinvigorated livelihoods for many communities. Afforestation and reforestation efforts, too, would provide work for many people.

The evidence presented in this report suggests that moving forward on these and other fronts simultaneously will result in green jobs being created in quantities that will make today’s numbers seem insignificant by comparison.

This optimistic assessment of the potential for future green job growth—and the policies discussed in the remainder of this section—must, however, be seen against the backdrop of some pressing and unavoidable realities. These include:

- ❑ ***Green jobs are expanding, but are not yet growing rapidly enough***—especially when one considers the fact that the global labor market is expanding by some tens of millions every year. Moreover, employment levels are generally lagging behind the supply of new workers. In 2006, the ILO reported that the number of unemployed people is at record levels—195.2 million. Together, the unemployed and underemployed (working hard without earning sufficient incomes) amount to 1 in 3 of the world’s workers. Unemployment has hit young people (aged 15 to 24) the hardest, with 86.3 million young people representing 44 percent of the world’s total unemployed in 2006.
- ❑ ***Green employment has gained an important foothold in the developed world; however, it is still quite exceptional in most developing countries.*** Yet these same countries account for some 80 percent of the world’s workforce. China and Brazil appear to be making progress in this regard, but much more needs to be done to ensure that green employment becomes a truly global phenomenon.
- ❑ ***The rising level of informality in the global economy constitutes a major challenge to green job growth.*** Moreover, the chronic and worsening levels of inequality both within and between countries are a major impediment. The effort to advance decent work and pro-poor sustainable development is critical to building green jobs across the developing world in particular.
- ❑ ***Unsustainable business practices are still prevalent—and often remain more profitable than green ways of doing business.*** Short-term pressures of shareholders and financial markets are not easily overcome. The early adopters of green business practices have to contend with companies—manufacturers and retailers—that command consumer loyalty through low prices achieved on the back of “externalized” costs. And surprisingly often, market failures, coupled with lack of green knowledge, impede action.

Pathways to a Sustainable Future

As daunting as these challenges are, there are a number of concrete steps that should be considered by governments, businesses, and civil society that can further expand green employment and the green economy. These are discussed below.

Business and Government Action

It is now widely accepted that employment losses from *not* addressing the environmental crisis are likely to be very serious. Resource depletion, loss of biodiversity, and storms, floods, and droughts induced by climate change will exact ever-growing costs, and increasingly undermine the viability of many businesses and of livelihoods in agriculture. Green innovation helps businesses stay at the cutting edge and hold down costs by reducing wasteful practices. This is essential for retaining existing jobs and creating new ones. Late adopters, by contrast, run the risk of falling fatally behind on innovation.

In some instances, green employment creation is due to the conscious decisions of companies to adopt more-sustainable business practices—and the recognition by venture capital firms that clean technology development offers significant business opportunities. Many of the companies driving renewable energy solutions prize employees who are skilled, take individual initiative, and are oriented toward problem solving. While many of them are small and medium-sized companies, larger, more established companies are also playing a role. In solar PV development, the leading companies include both start-ups and well-known consumer electronics firms—even large oil companies like BP and Shell. Large firms such as auto manufacturers are by nature less nimble and fast-moving, but they too will need to embrace sustainability concepts far more quickly and comprehensively. Toyota has demonstrated the possibilities with its Prius hybrid.

Major companies are talking about investing in climate solutions. For example, in February 2008, nearly 50 leading U.S. and European investors representing more than \$8 trillion of assets met at the U.N. to lay out a timetable for their commitments to global climate change and to call on governments and other investors to act with their money as well.¹⁰⁶⁴ These investors collectively pledged to commit \$10 billion to green investments from 2008–2010.¹⁰⁶⁵

Private companies have an important role to play in terms of investments and green job creation. However, the risk and profit appraisals typical of modern business behavior, the seemingly ever-rising expectations of shareholders, as well as concerns about protecting intellectual property, may together impede the flow of capital into the green economy. Current experience in various areas—from vehicle fuel economy to carbon trading—suggests that a purely market-driven process will not be able to deliver the changes needed at the scale and speed demanded by the climate crisis. Truly sustainable development requires a long-term approach, whereas today's business practices are too often driven by short-term considerations.

Governments must therefore establish an ambitious and clear policy framework to reward, support, and drive sustainable economic and social activity, and be prepared to confront those whose business practices continue to pose a serious threat to a sustainable future. Recent business,

governmental, and U.N. reports underline this point. McKinsey & Company does not mince words in stating that, “Without a forceful and coordinated set of actions, it is unlikely that even the most economically beneficial options would materialize at the magnitudes and costs estimated here.” And the UNDP’s *Human Development Report 2007/2008* concludes that a range of barriers to a breakthrough in climate protection “can only be removed through government action. Public policies on regulation, energy subsidies and information have a central role to play.”¹⁰⁶⁶ Timely action on the scale needed will occur only with a clear set of targets and mandates, business incentives, public investment, ecological tax reform, and genuine public-private partnerships.

Private and public policies must pursue “low-hanging fruit” even as they lay the groundwork for the more challenging technical and structural transformations needed to move toward a greener, low-carbon economy. There are many ways in which immediate energy savings or other environmental benefits can be realized at little or no cost. In the building sector, efficient lighting and appliances are widely available at increasingly low cost. A global switch to replace one in five light bulbs by 2030 would save 400 million tons of CO₂ emissions.¹⁰⁶⁷ Accelerating tree planting and forestry maintenance efforts would advance climate stabilization goals and create large numbers of jobs in a relatively short time frame.

Beyond short-term measures, the Stern Review calls for “a strong technology policy framework that drives action by the private sector.” Such a policy “is vital to bring forward the range of low-carbon and high-efficiency technologies that will be needed to make deep emissions cuts.”¹⁰⁶⁸ The possibilities of farther-reaching technological change are evident in the field of renewable energy, where innovative feed-in laws (securing access to the electrical grid at guaranteed prices) and production targets have been a major driver. Markets with strong consistent political support (such as Germany) have clearly thrived, while those with stop-start mechanisms (such as the United States with its unsteady Production Tax Credit) have developed unevenly.¹⁰⁶⁹ In the auto industry, a concerted international fuel-efficiency and low-emission strategy is needed. That, along with the pursuit of alternative fuels, hybrid and plug-in electric vehicles, and hydrogen/fuel cell-powered cars, could portend many job opportunities in the future. Other technological options—like those involved in carbon capture and storage (CCS)—may ultimately produce few employment gains but the environmental benefits could be considerable.

Competition or Cooperation?

The expedited development and diffusion of green technologies is critical to a global green jobs future. But what is good for the environment may not always intersect with what is good for companies from a commercial standpoint or countries from the standpoint of economic competitiveness. The competitive calculus of private companies often appears to be at odds with the need to share cutting-edge green technologies as rapidly as possible. In the case of China, wind power companies have been eager to invest there, but have not deployed the latest designs—for fear that domestic companies will reverse-engineer and copy them. Another obstacle to firms making large investments in technology innovation is that energy companies cannot easily capture all of the future returns on these investments.¹⁰⁷⁰ Engineering patents are harder to define

than, say, pharmaceutical patents, and can be more easily circumvented.¹⁰⁷¹ R&D-related skills and knowledge “spills over” to benefit other companies, discouraging investment.¹⁰⁷²

Nations leading in green technologies are understandably averse to freewheeling technology sharing. These countries will want to press their advantage and capture or maintain export markets in addition to serving their own domestic markets. Indeed, countries like Germany and Japan see the environment as a key dimension of their future economic strategy. Even as they develop wind and solar technologies, China and the United States increasingly adopt a similar outlook. Meanwhile, countries may seek to privilege domestic producers that are technologically several steps behind the market leaders. This may make sense from an industrial policy perspective, but it constitutes a drag on the global effort to address climate change and green the world economy.

The fact that some countries are further ahead than others with regard to clean technologies does not, however, alter the fact that greenhouse gas emissions do not respect national borders and that the world must face the problem of global warming collectively. This can and must be done in a way that shares knowledge, skills, and expertise. Developed countries have a particular role and responsibility in this regard, but larger developing-country economies like China, India, and Brazil can make a big contribution to an international cooperative RD&D effort aimed at expediting technology sharing and transfer. China, for instance, has invested \$930 million in climate change technology innovations since 2001, and the Chinese Ministry of Science and Technology recently launched a Scientific and Technological Actions on Climate Change initiative with the aim of “enhancing the role of science and technology in responding to climate change.”¹⁰⁷³

New mechanisms need to be developed that overcome obstacles to expedited technology diffusion. Innovative public-private partnerships can be part of the solution. Cooperative R&D centers that anchor green technology development in the public realm are another. And an adequately endowed global fund to expedite the spread of green technologies and climate adaptation measures, as proposed by China and others, also deserves urgent consideration. Without an integrated international framework the fight to reduce carbon emissions will be unsuccessful, and the promise of a massive increase in green jobs will be unfulfilled—with tragic consequences.

Financing a Green Jobs Agenda

Investment creates employment. The good news is that global investments in “clean tech” (mostly renewable energy)—including venture capital, project finance, public markets, and R&D—expanded by 60 percent from \$92.6 billion in 2006 to \$148.4 billion in 2007.¹⁰⁷⁴ A report by UNEP’s Sustainable Energy Finance Initiative, involving some 170 financial institutions, estimates that the market providing finance for clean and renewable energies could reach \$1.9 trillion by 2020.¹⁰⁷⁵

But other areas offer less reason for celebration. The Stern Review notes that investment levels in energy-saving technology in power generation have actually declined by as much as 50 percent over the last two decades in real terms.¹⁰⁷⁶ For energy conservation, investments stood at a paltry

\$1.1 billion in 2006.¹⁰⁷⁷ The IEA also concludes that, “R&D investment is not adequate given the magnitude of the climate challenge. Government spending on energy R&D has fallen, while the private sector is focused on projects with short-term payoffs.”¹⁰⁷⁸

No one knows how much a full-fledged green transition will cost, but needed investments will likely be in the hundreds of billions, and possibly trillions, of dollars. It is still not clear at this point where such high volumes of investment capital will come from, or how it can be generated in a relatively short period of time. This challenge, formidable though it is, needs to be viewed in proper context. In the first place, inaction will be far more costly. The Stern Review estimates that climate change could reduce global GDP by at least 5 percent, and perhaps as much as 20 percent, by 2050.¹⁰⁷⁹ Secondly, huge sums continue to flow into fossil fuel extraction and conventional utility projects. Capital spending for just one project—tar sands extraction in Alberta, Canada—totaled \$55.3 billion from 1999–2006, and a further \$100 billion might be invested from 2006 to 2015.¹⁰⁸⁰ The oil industry recorded revenues of \$1.6 trillion dollars and profits of more than \$140 billion in 2005.¹⁰⁸¹ The problem is therefore not simply a shortage of capital, but more a matter of where capital is being invested and for what reasons.

Thirdly, conventional fossil fuels are also subsidized. Significantly, the annual investment in clean energy technologies is, according to the Stern Review, “dwarfed by the existing subsidies for fossil fuels worldwide that are estimated at \$150 billion to \$250 billion each year.”¹⁰⁸² Phasing out subsidies for fossil fuels, taxing “windfall” oil profits, and adopting carbon taxes are among possible sources of revenue for the employment-creating transition to a sustainable and low-carbon economy.¹⁰⁸³ Fourthly, the auctioning of pollution allowances could generate many billions of dollars. Climate protection legislation being developed in the United States could generate anywhere between \$30 billion and \$250 billion annually.¹⁰⁸⁴ In 2006, carbon trading under the EU’s Emission Trading Scheme was valued at \$24 billion.¹⁰⁸⁵ However, the levels of revenue generated are contingent upon the portion of permits that are auctioned under the respective schemes.¹⁰⁸⁶ Fifthly, the issue of investment often boils down to priorities and policy choices. One obvious example is military expenditures. A reduction in these expenditures would also free up large quantities of public money for green investments. In 2006, global military spending topped \$1.2 trillion.¹⁰⁸⁷ In fiscal year 2008, the United States planned to spend \$647.2 billion on its military, more than the rest of the world combined. In contrast, federal government budget requests for fiscal year 2008 would provide a mere \$7.4 billion for climate change-related programs.¹⁰⁸⁸

The development of green employment across large swaths of the developing world is being seriously hindered by the abysmally low levels of financial assistance from developed countries. A large portion of multilateral aid continues to favor fossil fuels and large-scale hydropower.¹⁰⁸⁹ Meanwhile, the money that was supposed to be set aside for adaptation to climate change has not thus far materialized. The 2007/2008 edition of the *Human Development Report* notes that, “To date, international cooperation on adaptation has been characterized by chronic under-financing, weak coordination, and a failure to look beyond project-based responses.”¹⁰⁹⁰ While countries like the United Kingdom, Germany, the Netherlands, Italy, and the United States have spent billions of dollars on flood defenses and other protection measures, only \$26 million has been spent multilaterally for adaptation measures in developing countries—a figure equivalent to one week’s

worth of spending on flood defenses in the United Kingdom.¹⁰⁹¹

An effective global adaptation financing strategy is clearly needed. The UNFCCC estimates that by 2030, developing countries will require \$28 to \$67 billion in funds to enable adaptation to climate change.¹⁰⁹² UNDP has estimated that to adequately finance “climate-proofing” development investments and infrastructure will require \$44 billion per annum by 2015; a further \$40 billion per year will be needed to adapt poverty reduction programs to climate change, and thus strengthen human resilience. Climate-related disaster response could add another \$2 billion. This total of \$86 billion would require developed countries to mobilize around 0.2 percent of GDP in 2015—or roughly one-tenth of what they currently spend on defense.¹⁰⁹³

Another way of financing green employment is through micro-lending programs that poorer families and communities can access and afford. Countries like China, Nepal, and Bangladesh have successfully used low-interest (subsidized) loans and micro-lending to introduce biogas, solar energy, small hydro, and wind projects. This reorientation toward renewables could make a huge difference with regard to poverty eradication and job creation.

The Clean Development Mechanism (CDM) and Joint Implementation (JI) instruments included in the Kyoto Protocol have been cited as potential funding mechanisms for green projects. In 2006, the combined value of CDM and JI projects amounted to about \$4.4 billion.¹⁰⁹⁴ But some major problems need to be overcome. There is the fundamental question of whether these mechanisms can even achieve their stated goals.¹⁰⁹⁵ And there are more pragmatic issues such as the highly slanted distribution of projects (many being undertaken in China, but very few in Africa), the high costs of certification, and the piecemeal character of these projects, which have been driven more by the needs of private companies looking for cheap carbon credits than by a strategic assessment of the investment needed in moving toward sustainability.¹⁰⁹⁶

Equity Concerns, Just Transition, and the Workforce of the Future

The creation of a sustainable economy will require a new policy framework grounded in social solidarity and equity. Progress will require addressing disparities both between countries and within countries. It will require farmers being paid a fair price for their produce, and workers being treated equitably in terms of their pay, conditions, and basic rights. It will also require governments to be proactive in their efforts to ensure that all citizens have access to a decent standard of health care, education, and habitation. A sustainable economy cannot be built on “green for a few”—a few countries, a relatively limited number of workers, and with regrettably few positive outcomes overall. It must mean “green for all”—creating decent work and stable communities and allowing for a fairer distribution of wealth.¹⁰⁹⁷

Green investment (and thus most of the green jobs in the foreseeable future) is currently found primarily in a relatively small number of countries. Those nations that lead technological development with regard to renewable energy, energy and materials efficiency, etc., are likely to reap the bulk of the associated R&D and manufacturing jobs—among them Japan, Germany, and other OECD countries, but also China, Brazil, and others. Employment in installing, operating, and

maintaining green technologies and equipment, by contrast, will be more widely spread.

And yet the vast majority of the world's working population lives in poorer countries where not just green, but also decent work is scarce, jobs are often precarious, and levels of informality, unemployment, and underemployment are alarmingly high. A green jobs strategy needs to address these tremendous challenges. In essence, this is not so much a question of technology, but rather of broad social and working conditions, rights, and empowerment. As such, there is no quick fix. But a green jobs strategy would be remiss to ignore this dimension.

Moreover, much of the world's urban growth is measured in the rise of slum conditions. Today 1 billion people inhabit the Earth's 200,000 slums.¹⁰⁹⁸ In principle, greening these teeming urban agglomerations presents an unparalleled economic opportunity—providing decent and efficient housing; replacing inefficient and hazardous wood and coal stoves in people's homes with alternatives that do not endanger their health; developing affordable and non-polluting transportation networks; establishing waste management and recycling operations that raise sanitary standards; and providing clean drinking water, among other measures. The green employment that would result is many magnitudes larger than anything currently on the drawing board. But it will happen only if governments and businesses alike adopt radically different philosophies and operating principles.

Equity concerns are intertwined with the issue of Just Transition and the need to train and educate a green workforce ready to both build and drive the green economy. Just Transition was discussed in some detail in the previous section of this report. At its core, Just Transition recognizes that green employment gains need to be balanced against significant and unavoidable job losses incurred as a result of the movement toward a low-carbon and sustainable society. Overall, far more green jobs will be created in the move toward a sustainable economy than jobs lost. Skills profiles will also change, and there is clear evidence that much of the green employment of the future will be high skilled and thus might be expected to be better paid. But for workers who lose their jobs, as well as their families and communities, transition assistance is needed. Where industries are highly concentrated in one or a handful of regions, job losses can have serious consequences for the local economy and the viability of communities. These regions will need proactive assistance in creating alternative jobs and livelihoods, acquiring new skills, and weathering the transition to new industries.

Active labor market policies and broad social protections are therefore essential to ensure a fair and just transition for workers and their communities. This must involve income protection as well as adequate retraining and educational opportunities and, where necessary, resources for relocation. However, Just Transition is today still more principle than reality.

Policymakers and public officials must also pay more attention to the fact that, when it comes to supplying the green economy with the kind of workers it needs, a "skills gap" already exists. In many OECD countries, deindustrialization and offshoring of manufacturing have created a situation where companies in the fledgling green economy are struggling to find workers with the skills needed to perform the work that needs to be done. Indeed, there are signs that shortages

of skilled labor could put the brakes on green expansion. A 2007 survey of Germany's renewables industry, for instance, concludes that companies in this field are already suffering from a shortage of qualified employees, and especially those needed in knowledge-intensive positions. There is thus a need to put appropriate education and training arrangements in place. The best approach—whether to focus on trade schools, universities, on-the-job training in the workplace, or some other arrangement—will vary from country to country, given different educational systems.

Solid R&D, engineering, and manufacturing capacities are a critical aspect of building green industries and jobs. Indeed, some occupations in the renewables sector or in energy efficiency require highly educated and even quite specialized personnel, including a variety of technicians, engineers, and skilled trades. At the cutting edge of technology development for wind turbine or solar PV design, for instance, specialization has progressed to the point where universities need to consider offering entirely new study fields and majors. Still, green employment is not limited to high-end skills. There are many positions that demand a broad array of skill and experience levels, especially in installation, operations, and maintenance.

In both developing and industrialized countries, there is increasing need for what some have termed “green collar” training in a broad range of occupations besides the most highly educated positions. This is important both to prepare the workforce at large for the skill requirements inherent in green jobs and to ensure that green industries and workplaces do not face a shortage of adequately trained workers. It is also important as a commitment to people in poorer and disadvantaged communities—providing a ladder out of poverty and connecting green jobs with social equity. For example, proposed U.S. legislation would provide funding of up to \$125 million to establish job training programs, curricula, and job standards on the federal and state levels, and the “Green for All” campaign is working to secure \$1 billion by 2012 to “create green pathways out of poverty” for 250,000 people in the United States.

Promoting such job training is equally important in developing countries. A variety of U.N. and other international agencies such as UNEP, ILO, UNIDO, and CGIAR, working in conjunction with business, trade unions, and community organizations, could play a critical role in setting up green training and expertise centers in developing countries.

In all countries, it is important to link green subsidies, tax breaks, and other incentives provided to companies with job quality and training standards, to ensure the creation of what the Apollo Alliance and Urban Habitat have called “high-road jobs”—decent pay and benefits and safe working conditions. Training and education for green jobs will also need to emphasize gender equality. The German experience suggests that women are strongly under-represented in the renewables sector, and especially in science and technology-intensive jobs.

The Next Great Transformation

In his epic work *The Great Transformation*, Karl Polanyi described how in the century or more leading to World War II, governments provided the structures and policies to support and shape a modern market economy.¹⁰⁹⁹ At the same time, those governments needed to mitigate the harsh

social effects of unregulated and uncontrolled economic practices. The next transformation will actually be greater still in the sense that it will need to be much faster, more global, and altogether more equitable than anything yet seen in human history. Such a rapid and thoroughgoing change will require government, business, and civil society to rethink their traditional roles. A new balance between competing interests needs to be struck so that commonly established targets and objectives can be pursued.

A central feature of the next transformation will be green jobs. This report has documented and discussed how green jobs are already emerging in certain industries, sectors, and regions and their growth will surely accelerate in the coming years. On the evidence presented here, the potential for a qualitative increase in the numbers of green jobs is almost unlimited. However, it is also clear that only a very tiny portion of the work being performed in the world today can be described as green.

Under different historical circumstances, the pace of green job growth might be considered satisfactory, even in some respects impressive. However, in just two or three decades the entire global economy will need to be well on the way to being low-carbon and sustainable. The historical circumstances therefore demand that bold measures be taken to both expand the green economy and grow green jobs at a much faster pace in the developed world, and to ensure that the same process begins in earnest in the developing countries.

The international community must also approach this challenge in new ways. Almost 15 years after the world began negotiating the Kyoto Protocol, the levels of greenhouse gases are not only increasing, they are accelerating. A full 20 years after the Brundtland Report alerted the world to the urgency of moving toward sustainable development, the planet's stock of natural resources continues to be depleted and degraded at an alarmingly rapid rate. Many of the targets established in the year 2000 around the Millennium Development Goals will not be met by 2015. In the words of Mary Robinson, the former president of Ireland and former U.N. High Commissioner for Human Rights, "This is tragic and unacceptable because we know what works and what kinds of actions are needed to make faster and more equitable progress."¹¹⁰⁰

The same is true of green jobs. We know what works and what types of action are needed. Green jobs are emblematic of a low-carbon and sustainable future, and it is imperative that decisive action be taken now to advance their growth and to remove all obstacles in their path—whether those obstacles take the form of insufficient investments, irresponsible consumption, or the blind imperatives of competition and profit. It is encouraging that the recent global deliberations on climate protection and sustainability reveal higher levels of urgency and determination. The stage is set for action to commence.

Today, sustainability should be non negotiable, as should the notion of an equitable transition. If these were to become the main principles guiding policy, business practices, and—over time—the behavior of individuals, then green jobs and decent work can be expected to grow both exponentially and hand in hand.

