Human Capital: Implications of Green Growth Policies for Labor Markets and Job Creation

Key Messages

- Green growth cannot substitute for good growth policies, and employment is no exception: shortcomings in labor markets will not disappear with the adoption of environmental policies.
- But even if green jobs will not be a panacea, environmental regulation need not kill jobs either, and the net balance can be positive.
- To smooth the impacts on labor markets of the transition to green growth, policy makers need to tackle potential skill shortages and impediments to worker mobility—both of which have constituted barriers to other types of economic adjustment, such as trade liberalization.

For many countries the promise of new sources of growth and job creation is what lies behind the attractiveness of green growth. They look at Brazil, China, Denmark, India, and Japan—world leaders in exports of green products, who created entirely new industries in wind, solar, and biofuels. They hear about the promised double dividend of a green fiscal stimulus that can create jobs in the short run while laying the foundations for a more sustainable future.

For others the fear of diminished competitiveness and job losses remains one of the main barriers to pursuing green growth. They worry that tightening environmental policies could lead to industries relocating in countries with laxer environmental policies (so-called “pollution havens”)—and that these policies will lead to trade wars.

Yet, to some extent, this is an old debate—one that centers on the complex relationships between environmental regulation and competitiveness, and the ensuing job impacts. The topic of “green jobs” is just the latest round, prompted by global economic worries.

This chapter is based on Bowen (2012), except section “… and Learn from the Lessons of Trade Adjustment,” which draws from Porto (2012).
Does green growth create jobs? The supporters argue that green policies are “a new engine of growth” and “a net generator of decent jobs” (UNEP 2011). The recent global economic downturn triggered many proposals for “green” fiscal stimuli to promote growth and job creation (Pollin and others 2008). The Organisation for Economic Co-operation and Development (OECD) also suggested that investing in green activities has substantial potential to create jobs (OECD 2011b). Chinese analysts estimate that measures to save energy, protect the environment, and replace polluting industries with high-tech firms would lead to the net creation of some 10 million jobs over the next 5–10 years, and that exports of green goods could create some 4–8 million jobs (CCICED 2011, cited in World Bank and DRC 2012).

But the critics claim that the potential is overestimated and that environmental policies may actually hurt labor markets (Michaels and Murphy 2009; Morriss and others 2009). A recent study of South Africa finds that while developing green industries is appealing, it has little chance of succeeding unless structural problems (regulatory obstacles to creating small enterprises, a lack of skilled workers) are addressed (World Bank 2011a). Similarly, investments to promote research and development (R&D) in green industries will do little if educational and financial systems produce few skilled workers and little risk capital.

To shed light on this debate, this chapter explores the net impact of green job creation—that is, whether more jobs will be created than lost—and the relationship between labor markets and green growth policies. It first discusses what exactly green jobs are, then moves to the factors that influence whether green growth policies lead to job creation, and finishes with measures needed to smooth the transition to greener growth paths for labor markets.

The key finding is that environmental policies will lead to substantial job creation only if other inefficiencies—including those of labor markets—are tackled. In other words, green growth policies are no substitute for good growth policies. But while green growth may not be the answer to chronic unemployment and low competitiveness, fears that environmental regulations would result in job losses and lower competitiveness are misplaced—indeed, odds are that the impacts will be quite moderate. Meanwhile, better regulations (particularly those supported by training) support for R&D, and tax recycling (that is, using revenues from environmental taxes to reduce other taxes) will help minimize the risks posed by green growth policies and maximize co-benefits.

Green policies may create jobs, but are no substitute for sound labor markets

A first hurdle in framing the debate is that there is no agreement on how to define “green” jobs, even among economists. This lack of definition matters because it complicates the debate on the desirability of green policies.

Defining green jobs...

As “employment in ‘green’ industries”

Some definitions of green jobs are fairly narrow, including only jobs with an identifiable environmental focus or employment in industries (or specific projects) whose products are deemed to be of environmental benefit. This would include employment in renewable energy, energy efficiency, and environmental services or in developing less carbon-intensive products (such as building railways).

For the United Nations Environment Programme (UNEP), job content, as well as the characteristics of industry goods and services, also matters (UNEP 2008). UNEP defines green jobs as work in agricultural, manufacturing, R&D, administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce
energy, materials, and water consumption through high-efficiency strategies; decarbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution (UNEP 2008).1

This definition takes a broad industry perspective, extending beyond employment in narrowly defined environmental services. In principle it embraces employment in producing any goods and services that have smaller adverse environmental impacts than close substitutes.

Some definitions focus on industries producing environmentally desirable outputs. The OECD/Eurostat defines the environmental goods and services industry as “activities that produce goods and services to measure, prevent, limit, minimize, or correct environmental damage to water, air, and soil, as well as problems related to waste, noise, and ecosystems. This includes technologies, products, and services that reduce environmental risk and minimize pollution and resources” (OECD 1999). For example, air and resource pollution management would qualify.

Using the OECD’s definition, green jobs constitute a small but significant share of total employment—about 1.7 percent of total paid employment in Europe (European Commission 2007). That is probably a higher fraction than a global estimate along UNEP lines would suggest; as UNEP notes, much of the documented growth in green jobs has so far been in developed countries.2 Employees in many jobs might find that their jobs are not counted as “green” despite the nature of the goods and services that they help produce. For example, jobs in the car industry are excluded, even though some may be devoted to developing low-carbon vehicles.

As “the employment consequence of green policies”

Some definitions of green jobs follow a different track, focusing on what happens when public policies to correct environmental externalities are introduced—opening the possibility of including jobs created and destroyed across the whole economy. In effect they try to answer the question, “What are the employment consequences of introducing green policies (such as cap and trade) relative to a baseline case?” This approach requires implicit or explicit economic modeling of the policies.

Some studies in this vein count only jobs directly created by the policies—that is, “direct employment effects. They focus on the specific labor requirements of technologies (“bottom-up” estimates, using simple spreadsheet-based analytical models in conjunction with engineering estimates). An important issue is the timing and duration of job creation. There is a key distinction between construction, manufacture, and installation—where jobs may be fairly short-lived—and ongoing operation, maintenance, and fuel processing—where the length of jobs depends on the durability of the relevant plant.

Other studies include both jobs created and jobs destroyed in sectors disadvantaged by green policies—that is, indirect and net employment effects. This net concept of employment change is crucial for evaluating the overall labor market impacts of environmental policies. It can be done through input-output tables or general equilibrium modeling. They include jobs created by the aggregate demand generated by the extra direct and indirect employment (“induced” employment effects). This approach allows jobs to be counted as green if they are created by green policies, even if they are in sectors with no obvious direct relationship to environmental objectives (such as communication) or with only a secondary relationship (such as financial services). It also includes other economic feedbacks and mechanisms triggered by environmental policies, thus hopefully capturing jobs lost owing to higher prices and lower real wages, lower final demand, and lower investment. But many studies do not follow through with this netting-out process.

Another approach considers different time horizons—the further the time horizon, the more economic variables can be adjusted.
For example, a study of the impact of carbon price policies on U.S. industry considers outcomes along four time scales (Ho and others 2008):

- The very short run, where firms cannot adjust prices and profits fall accordingly.
- The short run, where firms can raise prices to reflect the higher energy costs, with a corresponding decline in sales as a result of product or import substitution.
- The medium run, when in addition to the changes in output prices, the mix of inputs may also change, but capital remains in place, and economy-wide effects are considered.
- The long run, when capital may be reallocated and replaced with more energy-efficient technologies.

It concludes that employment consequences of green policies differ strongly, depending on the time horizon. Short-term employment losses mirror output declines and are substantial in energy-intensive sectors, but gains in other industries would fully offset those losses in the longer term.

But few studies account for labor market rigidities and other obstacles to job creation, and yet they may impair any positive effect of green policies. As the World Bank study on South Africa (World Bank 2011a) noted, green policies cannot correct all the problems holding back job creation—such as skill mismatches and the dualism (insider-outsider) of the job market. Thus, the scope for green job creation is limited in the absence of parallel economic policy changes.

**Evaluating the impact of green policies on jobs: Gross versus net job creation**

What is the overall job creation impact of green policies in developing countries? Few studies have explicitly focused on this, and those that have suffer from many definitional issues, making comparisons difficult. They also fail to look at economy-wide effects. That said, the few that do exist suggest that climate-change policies in general and renewable energy policies in particular can generate considerable extra employment:

- In South Africa, a study finds that an “energy revolution” scenario—that is, a scenario with a strong transition toward renewable energy—creates 27 percent more jobs than the International Energy Agency’s business-as-usual scenario and 5 percent more than the growth-without-constraints scenario (Rutovitz 2010).
- In India, a study finds that low-carbon employment is one of the key co-benefits of promoting the renewables sector. It notes that solar power is more labor-intensive than wind power and better able to meet India’s requirements for small-scale, off-grid power. Biomass, green transport, and public works in water and forest management are also attractive ways of achieving both employment and environmental objectives (GCN 2010).
- In China, a study emphasizes the possible employment losses from the planned sharp reduction in the energy intensity of Chinese industry, but notes that this could be outweighed by increased employment in renewables and—quantitatively, much more important—the shift of the Chinese economy toward services and away from heavy industry (GCN 2010).
- In Brazil, a study argues that renewable energy sources have a stronger potential in Brazil than is envisioned in official studies and government policies, both in contributing to CO₂ mitigation and generating jobs (GCN 2010).

What is the record of green fiscal stimuli on job creation in developing countries? The evidence is scant, but a few studies do show some job creation, with substantial variation in jobs created per dollars spent.

- In the Republic of Korea, forest restoration generated nearly eight times as many jobs per dollar as the least labor-intensive green objective, “vehicles and clean energy” (Barbier 2009).
- In China, biomass spending was found to be nearly 30 times more effective in generating jobs per dollar than wind...
power (UNEP 2008). That suggests that the focus on renewable energy and low-carbon manufacturing prevalent in studies for Europe and the United States may miss the opportunities for employment creation from changes in land management and agriculture in developing countries, where these economic sectors are fairly more important.

• In Latin America, water network rehabilitation and expansion in Honduras is much more effective (by a factor of more than 10) in creating jobs than hydroelectric schemes in Brazil, with rural electrification in Peru falling in between (Schwartz and others 2009).

While useful, these studies have limitations. They do not discuss the capital constraints that may hamper the (public or private) investments needed to create the green jobs. They assume people will move seamlessly from one sector to another and ignore labor market rigidities. They tend to focus narrowly on the energy sector when green growth options (even when limited to climate change concerns) exist in other sectors that may be more labor-intensive. And they do not always distinguish between substitution (using more labor and less capital, energy, and other inputs) and lower productivity (using more inputs to produce the same amount of output). This distinction matters because capital-labor substitution is desirable, at least for countries with excess labor supply, large unemployment, and limited access to capital; lower productivity is not.

Another question worth asking is whether green spending is a good way of creating short-term employment during a crisis. The argument in favor of green fiscal stimuli is that they can both create jobs and lay the foundations for more sustainable growth. But experience suggests the need to look across the range of possible green works (from renewable energy to reforestation) as not all are equally labor-intensive and “shovel-ready.”

To begin with, if employment creation is the objective, higher spending in sectors with lower capital intensities than either conventional or renewable energy—such as reforestation programs or even education and health services—may be more effective. But there may be tradeoffs between rapid employment creation and “green-ness.” Road building, for example, is fairly labor-intensive and can help to provide valuable infrastructure, but it is not particularly green. And some sectors, such as energy, will not top the list for sustainable rapid job creation, given that they require a long lead time for replacing capital.

And programs that yield larger employment effects tend to lead to more employment gains for largely lower skilled workers, so that the long-term growth effects are fairly small. Long-term development, including sustainable development, requires more of a focus on growth-enhancing infrastructure investment, which is not necessarily labor-intensive.

More analysis is needed of how global markets will affect job creation—leakages of green jobs and spending to other countries depend on endowments of skills, existing industry structure, the nature of the technologies newly deployed, and the ways that comparative advantage is exploited (GCN 2010).

The last point is a useful reminder that general equilibrium effects matter. Yet these are largely ignored in the green jobs literature. That may be particularly misleading for developing countries, as the next section discusses.

The effect of green policies on employment depends on labor market structure and the specific policy considered

The problem with studies that discuss job markets is that they tend to either model them as perfectly competitive, and thus adapting instantly to all shocks with no involuntary unemployment (the neoclassical model)—or as having involuntary unemployment that could be cleared with a fiscal stimulus (the Keynesian model). The first set of assumptions implies that green jobs are
likely to displace as many jobs elsewhere in
the economy. The second, that there will
be no crowding out of jobs by green fiscal
stimuli.

Neither approach is realistic. Most
developing countries have surplus labor
economies, so estimates limited to direct
employment creation in the green jobs
literature might be less misleading for
developing countries than for industrial
economies closer to full employment. But
it is more complicated in “dual” economies
with modern and traditional sectors or in
three-sector economies with a traditional
rural sector and both formal and informal
urban sectors characteristic of many devel-
opling countries (Harris and Todaro 1970;
Mazumdar 1976). In that case the (skilled)
formal urban labor market is often very
shallow and green job creations can have
crowding-out effects on other activities.

So knowing how best to model how the
aggregate labor market works—and, indeed,
how the macroeconomy as a whole works—is
crucial to properly assess overall (net) job cre-
the value of the implicit or explicit macro-
economic framework, showing how climate
policy could increase unemployment in the
presence of real wage rigidities or barriers to
the sectoral reallocation of labor. Guivarch
and others (2011) highlight that climate pol-
icy costs depend significantly on labor mar-
ket rigidities and that policy cost estimates
are much higher in models with imperfect
labor markets. Overall, labor market impacts
can also be influenced by how the revenues
from other environmental taxes are used, as
the literature on the “double dividend” from
environmental taxation shows (Fullerton and
Metcalf 1997; Sartzetakis and Tsigaris 2007).
Studies tend to show that if tax revenues are
used to reduce payroll tax—a tax on labor
supply—employment will fall by less or even
increase.

The key point is that the overall effects of
green policies on employment depend on the
characteristics of the economy’s labor markets
and the nature of the policy interventions,
including their funding, not just the input
requirements of rival energy technologies.

Indeed, underemployment can have multiple
causes, and the consequences of green pol-
icies will differ depending on these causes. It
thus helps to consider the implications of a
wider range of theories of underemployment
and labor market adjustment in different
types of economy (box 4.1).

But environmental regulation
need not kill jobs either

A major fear being voiced in the green jobs
debate is that environmental regulation—
needed to price externalities and encourage
firms to change their production processes—
will destroy jobs.

A tale of two antithetical hypotheses:
the “pollution haven” and “Porter”
hypotheses

For the past 20 years the debate on the
implications of environmental policies on
competitiveness (and jobs) has revolved
around two antithetical hypotheses: the
“pessimistic” pollution haven hypothesis,
which contends that firms will flee locations
with strong environmental regulations; and
the “optimistic” Porter hypothesis, which
argues that environmental regulation will
lead to innovation (Porter and van der Linde
1995). In the latter, innovation reduces the
cost of regulation (weak Porter hypothesis)
and may lead to increased competitiveness
and profitability (strong Porter hypothesis).

What is the latest thinking on this issue?
As chapter 3 reported, there is no evidence
that environmental policies have systemati-
cally led to job losses because of an exodus
of firms to pollution havens. Tighter environ-
mental regulation may cause firms to relo-
cate, but they will choose locations that are
more attractive overall, as pollution abate-
ment costs represent a small share of pro-
duction costs for most industries (Copeland
2012). Factors such as availability of capital,
exchange rates, labor abundance, location,
institutions, and agglomeration effects are
more important than environmental policy
in determining firm location and competi-
tiveness. Empirical evidence from existing
How can policy makers determine if green policies will create jobs? The following provides a framework to assess labor market consequences, exploring what would happen in an economy with two sectors: a clean one and a dirty one. The products are imperfect substitutes that are produced with many inputs, including labor. The first two cases explore the impact of green growth policies that focus on the demand side, and the rest deal with policies that focus on the supply side.

Case 1. Demand deficit and a green stimulus

In this case, the economy is typified by “Keynesian” unemployment—that is, with insufficient overall demand. The green policy involves a fiscal stimulus with spending focused on the clean sector. What would happen? Greater demand for the clean sector’s product would stimulate greater employment in the clean sector, in turn pushing up wages in this sector, and thus increasing final demand. Increased demand in the labor market would put upward pressure on wages throughout the economy, possibly causing a slight decline in employment in the dirty sector. Overall, employment would be expected to rise as long as job creation in the clean sector outweighs the (indirect) job losses elsewhere, facilitating a virtuous outcome.

Case 2. A green paradox: demand deficit and a green stimulus meet a skills deficit

Here again we have a Keynesian economy, but there is a skills deficit in the clean sector. The green policy involves a fiscal stimulus with spending focused on the clean sector. Higher demand for the clean sector’s products would feed into higher wages across the economy, because employment in the clean sector cannot expand, but overall employment levels would not expand much, and may even decline. Thus, the green fiscal stimulus would be largely ineffectual, generate higher wages, and create little (if any) additional employment. (In an open economy the green stimulus may trigger imports, in which case it would have little impact on employment.)

Case 3. Pollution regulation with virtuous initial conditions

Now the green policy involves a pollution tax to correct a pollution externality in the dirty sector, and there are no wage or price rigidities in the economy. Faced with an emissions tax, the optimum response would be a contraction of output and an investment in pollution abatement. What would happen? The regulations would be expected to destroy jobs in the dirty sector, given that the tax raises production costs with the dirty technology and the price of these goods rises. As a result, demand for the clean substitute good rises and employment in the clean sector increases—imparting incentives to reduce the externality either through new production techniques or end-of-pipe abatement, which would boost jobs in pollution abatement.

This scenario suggests that overall employment would increase when there exists a close and clean substitute produced with more labor-intensive technology or when abatement is feasible and more labor-intensive than dirty production (on the margin). This situation might apply to economies such as Japan’s or the Republic of Korea’s that are well endowed with labor skills and technology for cleaning up.

Case 4. Pollution regulation with immiserizing initial conditions

This is similar to the previous case but with two key differences: no clean substitute for the dirty good, and pollution abatement is either far too costly or unavailable, or is highly capital intensive. Production and employment in the dirty sector would decline, with little or no offsetting increase in cleaner jobs. This situation most likely applies to economies reliant on extractive industries—such as artisanal mining, where pollution abatement is typically far too costly for the small producers and there is no clean substitute available for the mineral.

Case 5. Renewable resource regulations—restore rents but not necessarily jobs

Here we have a classic open-access common-property resource such as a fishery. Entry occurs until the payoffs from harvesting decline to zero (or to the opportunity cost). If there is a tax or restriction on harvesting, this would lower employment but increase resource stocks and the payoffs. Thus, while employment may decline, economic returns increase and environmental benefits accrue. Conversely, if the policy were accompanied by expenditure on ecosystem restoration, there would be offsetting changes in employment, with ambiguous net impacts.

The bottom line is that the labor market consequences of green policies depend on the policy under consideration, technological parameters, and the state of the economy. There are cases where a given policy can create jobs, and other circumstances when it can destroy jobs.

Box text contributed by Richard Damania.
regulation or environmental taxes confirms this result (Anger and Oberndorfer 2008; Ellerman and others 2010; Martin and others 2011; Morgenstern and others 2002; Quirion 2011; Sartor 2012). But this evidence is based mostly on existing regulations in developed countries, and future research needs to ascertain whether these results extend to developing countries and to more ambitious environmental policies than have been applied to date.

For sectors intensive in natural capital—with which many developing countries are well endowed—the pollution haven hypothesis is even less likely. After all, without sound environmental policies, the increased pressures coming from trade could rapidly deplete natural capital, and then the short-term benefits from increased trade would be wiped out by the subsequent collapse of the resource base of the activity (Copeland 2012).

The reality is that stringent environmental provisions are essential for guaranteeing the long-term sustainability of the economic activities (and jobs) that depend on natural capital. If a natural resource base is well managed, it can be used to create jobs (moving up the value chain by creating a downstream processing sector, for instance) and seize opportunities in global markets.

At the firm level, studies show that the impact of more stringent environmental regulation on productivity and competitiveness is modest and sometimes even positive, thanks to innovation (Ambec and others 2011). The large body of literature triggered by the seminal paper by Porter and van der Linde (1995) supports the weak version of the Porter hypothesis: innovation does reduce costs.

Further, recent studies have found an increasing number of cases where environmental regulation had positive impacts on profits (Ambec and others 2011). This may be due to the fact that regulators have become better at designing smart regulatory policies, as well as that the models used to assess the effects of environmental regulation on innovation and competitiveness were refined to account for the lagged structure of innovation (essentially they wait a few more years to evaluate the impact, giving the firm more time to adapt).

Thus, the overall effect of environmental regulations on jobs is likely to be limited. In the United States, an econometric study of highly regulated industries finds that the impact of stringent environmental regulations on U.S. jobs was negligible in most cases—across all industries, 1.5 jobs were created per $1 million spent in additional environmental spending, with a standard error of 2.2 jobs (Morgenstern and others 2002).

**Types of adjustment needed across countries**

There is much variation across developing countries in the likely ease of transition to a low-carbon growth pathway. Chapter 3 shows that developing a comparative advantage in the production of equipment for low-carbon electricity depends on the manufacturing base of the country and on whether there are scale and learning economies in the technology. Some countries have a comparative advantage in particular renewable energy sources because of natural endowments. Brazil has the right climatic conditions and soils to give it a substantial cost advantage in biofuels, though other characteristics of the Brazilian economy also help, in addition to being very well endowed in hydroelectric potential (Kojima and Johnson 2005).

Developing countries that produce a high level of greenhouse gas emissions per unit of GDP face a more difficult challenge of structural adjustment. They are the ones in which more labor is likely to have to be reallocated from greenhouse gas–intensive activities, either by switching technologies within an industry or by moving labor between industry sectors. Given the importance of CO₂ emissions from energy production, energy-intensive economies will compose a large part of this group.

Endowments of fossil fuels combined with industrial development strategies that have favored carbon-intensive industry make a transition to low carbon much more challenging (EBRD 2011). If such economies
impose a carbon tax, the standard economic policy instrument to internalize the greenhouse gas externality, the relative returns to different factors of production are likely to change. The few empirical studies focusing on how carbon taxation might affect factor returns suggest that the incidence of a carbon tax is likely to be regressive when emission abatement measures are capital-intensive, requiring complementary policies (Fullerton and Heutel 2007, 2010). Countries such as Kazakhstan and Mongolia, with a much larger-than-average proportion of the labor force in mining and energy supply, are more likely to suffer as a result of this adjustment and also from the difficulties of reallocating displaced labor to other sectors. Chapter 3 discusses how industrial and other sector-specific policies can facilitate this transition.

**Smoothing the transition to greener growth paths for the labor market**

**Policy makers need to worry about skills that can limit job creation...**

To what extent are the skills needed in the labor force for greener growth being altered? This matters because if the skills required are unavailable, that could place a major obstacle in the way of the transition to green growth.

Overall, “green restructuring” brings with it the usual challenges to policy makers trying to facilitate restructuring and reduce the labor market adjustment costs, including those from a changing skill mix. Many of the expanding industries are likely to be using new products and processes, reflecting the transition to low-carbon technologies, so the generic skill requirements of many of the newly created jobs are likely to be higher than average, as they have to allow for assimilation of unfamiliar tasks and working methods and “learning-by-doing.” But a larger proportion of jobs in the renewable energy sector and in energy efficiency are lower skilled than in the fossil fuel energy sector (Pollin and others 2009). Contrary to the coal industry—which employs many low-skill workers in developing countries—the oil and gas industries tend to have fairly well-paid workers and a large proportion of highly qualified engineers and technicians.

Perhaps the most thorough study of green growth and skills so far is ILO/CEDEFOP (2011), which reports and synthesizes the results of 21 country reviews. It notes that the demand for skills is being affected in three ways by the transition to green growth:

1. Induced structural change across industries increases the demand for skills specific to expanding industries such as renewable energy and reduces the demand for skills such as those for coal mining.
2. Some new occupations are emerging—such as photovoltaic (PV) fitters and carbon-footprint assessors—though there appear to be fairly few unique green skills.
3. The content of many jobs in current industries is changing, as companies focus on achieving better energy efficiency, switching from fossil fuel sources to renewable energy, and producing capital equipment for expanding green industries. In agriculture, low- and no-till agriculture and reduced use of fertilizers and pesticides will entail changes in farmers’ practices, as will increased production of biofuel crops and efforts to increase forest cover—a development likely to have the most pervasive effects on labor markets, particularly in developing countries.

What is worrisome is that skill shortages may already be impeding the transition to green growth (box 4.2). In 2011 the OECD (2011a) drew attention to widespread skill shortages in energy-efficient construction and retrofitting, renewable energy, energy and resource efficiency, and environmental services. Many countries have reported specific bottlenecks, such as the shortage of skilled PV workers in Germany and the lack of design engineers for smart grids in the United Kingdom. Karp and Stevenson (2012) identify similar shortages in developing countries. In India, maintaining and operating the
renewable energy systems deployed by the Remote Village Electrification is complicated by the lack of skilled workers (IEA 2010).

In 2001 China started the Township Electrification Program to bring electricity to rural communities using solar PV, small hydro, and wind. While installation appears to be working well, there are problems with maintenance and operation, partly because of a lack of qualified electricians. Reasons for these reported shortages include the underestimation of the growth of certain green sectors, the general shortage of scientists and engineers, the low reputation and attractiveness of some sectors important for the green transition such as waste management, and a shortage of teachers and trainers in environmental service (ILO/CEDEFOP 2011).

Many of the skill shortages already reported in connection with green growth strategies appear to result from generic failings in education and training. And they reflect long-standing issues such as the lack of functioning universities and research centers, the mismatch between students’ choices of discipline and the needed skills, the lack of incentives for employers to invest in developing the transferable skills of their workforces, the lack of access for the disadvantaged to time and finance for training, and the stickiness of relative pay rates.

Fortunately, there is a potential for synergies between green policies aimed at skill development and growth policies aimed at increasing labor capital, worker education, and labor productivity. Figure 4.1 shows that many developing countries need to increase their enrollment in technical tertiary education. Such an increase would accelerate growth and help with skill limitations created by green policies.

**BOX 4.2 Shortage of skills and inadequate training provisions can undermine green programs**

The problems that can arise when training provision is not up to the challenge of the induced structural change are illustrated by Australia’s experience with a new Home Insulation Program introduced in February 2009 as a key part of the government’s fiscal stimulus.

The program was designed partly to generate jobs for lower skilled workers in the housing and construction industries. At the start of the program only supervisors were required to satisfy one of three minimum competences—prior experience in the insulation industry, qualifications in an approved trade, or insulation-specific training. The program proved popular. At its peak, demand was running at almost 2.5 times the anticipated level and some 1.1 million roofs of 2.7 million eligible were insulated. But fires, fitters’ deaths, and reports of fraud undermined public confidence, and the program was canceled in February 2010. A subsequent sample of inspections revealed that nearly 30 percent of installations had some level of deficiency. Investigations showed that low skill levels in the industry, inadequate provision of training, and poor management of the program were among the factors responsible.

The importance of competent project management and national policy making in this case is a reminder of the key role of higher level management and planning skills in a policy-induced transition to green growth that is likely to take sustained effort and policy credibility over a long period.

*Source: Australian National Audit Office 2010.*

...and learn from the lessons of trade adjustment

Green growth is about transforming our production and consumption processes from a dirty, environmentally unsustainable model to a sustainable one. Like any structural transition it inevitably entails transition costs, which green growth policies must seek to minimize. As such, the trade literature, which has extensively documented adjustment costs associated with trade liberalization, offers interesting insights.
Adjustment costs, whether stemming from trade shocks or a transition to green growth, are fundamentally driven by factor immobility—sluggishness in capital or labor market adjustments. These costs would be zero were workers able to adjust instantly to the changing demand for skills (moving instantly from one industry to another) and were firms able to instantly modify their fixed capital following changes in carbon prices or pollution standards.

In the real world, labor markets are sluggish, as experience with trade liberalization shows. Trade liberalization creates and destroys jobs within industries. But the flow of labor across sectors—from shrinking to expanding ones—is slow. In Brazil it took several years for workers displaced from deprotected industries to be absorbed by sectors with comparative advantages (Muendler 2010). In addition, large wage differences persist among workers with similar qualifications and status across industries, suggesting limited mobility of workers across industries (if workers were mobile, they would switch to the highest paying industry until wages equalized). This “industry-effect” explains a large fraction of wage differences across workers, and prevails in both developed and developing countries, for skilled and unskilled workers (Krueger and Summers 1989).

What does this sluggishness stem from? Slow labor market adjustments reflect demand-side (industries requiring specific skills) and supply-side (worker characteristics) factors. Whether sector-specific knowledge and training are a bigger impediment to mobility than labor market frictions (the time and costs associated with search and matching) depends on the extent to which worker experience is specific to each sector (Cosar 2010; Dix-Carneiro 2010). And there appears to be significant variation in the mobility of different types of workers, with lower adjustment costs for younger workers and skilled workers. The policies needed to help transition may thus differ by country (depending on the nature of the adjustment) or by affected worker categories (depending on age, skill, and so on).

As for capital stocks, a shift toward greener production processes is likely to require substantial changes, as firms may need to invest in new product lines, machines, and equipment. Yet, as experience with trade adjustment shows, the process may be quite costly—for example, following Argentina’s trade reform, the required capital adjustment averaged 14.5 percent of firms’ capital stock (Bet and others 2011). Thus, the capacity of economies to adjust to green policies may be limited by capital constraints, which could affect labor demand.

Because adjustment costs are a direct function of factor immobility, efforts to increase labor or capital mobility will be critical. And support policies should be targeted to facilitating the transition rather than cushioning potential losses. Simple unemployment insurance tends to hamper reallocation and skill formation. But employment subsidies can be useful if made conditional on working in the export-oriented (or green) sector (a form of industrial policy; see chapter 3).
Ultimately, the cost of the transition will depend on the overall economic policy framework and the extent to which it facilitates the emergence and growth of new sectors and firms. So the ability to carry out and reap the benefits of a green growth policy will depend on good economic policy.

In sum, fears that environmental regulations will lead to massive job losses or loss of competitiveness are probably as unfounded as the hope that green jobs will single-handedly solve countries’ employment problems. That said, it is vital to invest in human capital to accelerate growth and to green growth. This is one of the inputs to economic production. Natural capital is another critical input, and the next chapter will look at why it is important to invest in this domain, too.

Notes
1. UNEP also includes a provision that “green jobs need to be decent jobs” (UNEP 2008).
2. At the same time developed countries are responsible for, by far, the largest share of the stock of greenhouse gases in the atmosphere. They have also probably made a disproportionate contribution to long-lived solid waste. So some of the green jobs reflect the unsustainability of developed-country economies.
4. Further, studies use a range of methods, reflecting the different definitions of green job creation discussed above, differ in coverage of countries and sectors and as to whether they include gross or net effects and whole value chain effects, and make varying assumptions concerning economic growth and business-as-usual scenarios (Bacon and Kojima 2011; Fankhauser and others 2008; GCN 2010; GHK 2009; Kammen and others 2004; Wei and others 2010). The few studies of developing countries conclude to significant job creation, but offer no analysis of the net impact (see box 4.2).
5. In such models implementing carbon pricing will tend to both redistribute labor to low-carbon activities and reduce overall labor supply due to the higher relative price of carbon-intensive goods and services. There can be net job destruction, depending on how the revenues from carbon pricing are used as in a study of the potential implications of a cap-and-trade system for the United States, which found significant reductions in labor input in 29 of 35 U.S. industries without revenue recycling (Goettle and Fawcett 2009).
6. For instance, Guivarch and others (2011) model economic transaction costs due to a climate policy with different levels of rigidity in the labor market, finding that mitigation costs are much larger when labor market imperfections are considered.

References


