

Spotlight Two

Greening Europe's growth

Europe's success in adopting an environmentally sustainable growth model depends on companies developing cutting-edge products, generating jobs at home, and competing successfully abroad. Gamesa, a Spanish wind turbine manufacturer, is considered a European green growth success story.¹ Founded in 1976, the company moved into wind energy in 1994, and within 10 years it became the world's second-largest turbine maker. Gamesa's experience shows how growth comes with both opportunities and challenges.



Emissions

Past to 1990

Present to 2008

Future to 2030

The maps show per capita CO₂ emissions from fuel combustion. 1990 and 2008 data by country are from the International Energy Agency's World Energy Outlook 2010. The 2030 map is based on an IEA scenario that limits atmospheric CO₂ concentrations to 450 parts per million (ppm), consistent with a global temperature increase of 2 degrees centigrade.



Very high



High



Medium



Low

Three points stand out:

First, Europe’s production is greening thanks to popular policies.² Consumption is becoming cleaner too, but less than one might think. Structural change plays an important role in these shifts. In much of Europe, the rise of high-tech companies making green products contrasts with an overall decline in manufacturing. Between 2000 and 2010, the manufacturing employment share in Spain dropped about 20 percent, while imports of consumer goods from China increased eightfold. Polluting industries left, reducing local emissions, but emissions embedded in products imported from China rose. Spain’s net emissions imports increased almost fivefold between 1998 and 2008, similar to those of many other European countries (figure S2.1). For a truly green economic model, Europe needs even cleaner production, but it also needs cleaner consumption.

Second, green policies and investments will create growth opportunities for European countries, but not all countries will benefit equally. Ambitious national and EU policies, motivated by environmental and job-creation objectives, encouraged Gamesa to enter the wind turbine business. These policies created a large home market for Gamesa’s products, which also helped enter export markets. By the mid-2000s, Gamesa had created more than 5,000 jobs, most of them in Spain. Besides Spain, Denmark and Germany were Europe’s main wind turbine manufacturers, together accounting for more than half of global production by 2007. These countries used incentives to create domestic demand and develop research and innovation capacity. As national green policies expand in Europe, will many countries see growth and jobs benefits? Or will such benefits be confined to a small group of early market leaders?

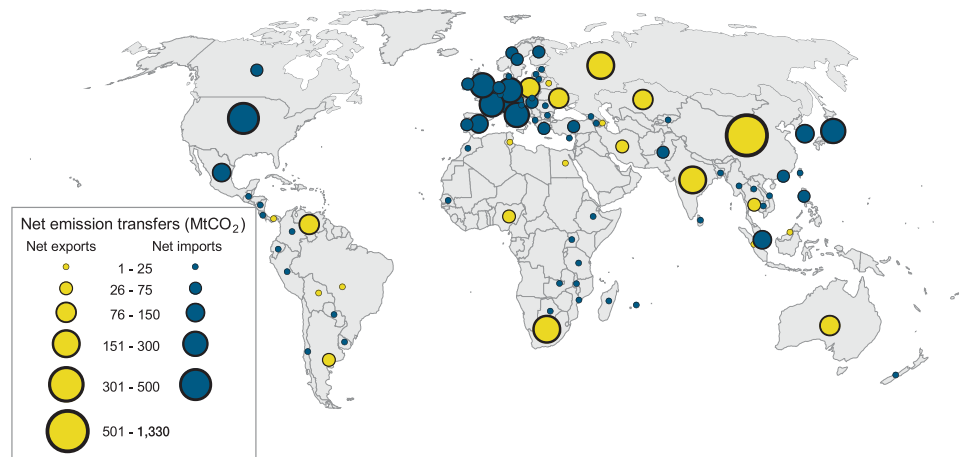
Third, some economic benefits of EU green policies will leak outside the European Union. This leakage is expected and should be welcomed. Addressing global environment imperatives requires that many countries contribute, especially the world’s largest economies: the European Union, the United States, and China. Gamesa’s experience is illustrative. In 2005, Gamesa held a third of the Chinese wind turbine market. Five years later, its market share was down

Figure S2.1: Europe is the world’s largest importer of carbon dioxide

(net carbon dioxide emission transfers [territorial minus consumption emissions], 2008)

Note: MtCO₂ = million tons of carbon dioxide.

Source: World Bank staff, using data from Peters and others (2011).





to 3 percent. The company entered the Chinese market early, but as green technology became a higher priority for the Chinese government, preferences for domestic industry forced Gamesa to transfer know-how and technology to Chinese suppliers. Some of the policies that helped Gamesa in Spain—including local content requirements and cheap land and credit—now helped Chinese wind turbine manufacturers. Today, some of Gamesa’s products are 95 percent Chinese, and 4 of the 10 largest wind turbine makers in the world are Chinese. Despite its shrinking market share, Gamesa’s Chinese business grew, and the company did not protest Chinese policies. In 2010, Gamesa opened its fifth manufacturing facility in China, from where it now ships equipment to North America. While Gamesa dropped to sixth place among global wind turbine companies, its revenues increased from \$1.7 billion in 2005 to \$3.3 billion in 2009. During this time, globally installed wind energy capacity rose from 60 gigawatts to 160, and by 2010 reached almost 200. Helped by technological progress and economies of scale, the price for wind power dropped about 27 percent.³

Europe’s efforts alone are not enough to tackle global environment problems like climate change. Green technology investments will happen sooner if global innovation and manufacturing networks are mobilized. Europe will not always be able to compete in mass-producing standardized green products. It will need to retain its strength in knowledge-intensive green services and technology and rely on cheaper production in places such as the EU12, the EU candidate and eastern partnership countries, and even in East Asia. If Europe succeeds, its growth model will not just be the best in the world in helping its poorer parts and neighbors prosper, it will also lead the world to a greener future.

The green golden rule

Environmental policies have been essential in Europe since the early 1970s (Hey 2005). They have been outlined in six environmental action programs and formalized in numerous directives.⁴ Early policies focused on local environmental quality: highly visible but mostly reversible environmental problems that could be eliminated or reduced by strict emission and effluent standards, such as air and water quality. More recently, Europe has focused on environmental problems with less visible impacts but nonetheless severe and potentially irreversible effects. Global threats such as climate change, biodiversity loss, and nuclear waste now command Europe’s attention.

This second type of environmental problem poses new challenges. These complex problems resemble other large societal problems, like poverty or public health, with long-term consequences and no easy solutions (Hulme 2009). There is great danger in postponing action until future welfare diminishes and the ability to manage or reverse harmful trends is lost. These long-term threats call for a “green golden rule”—achieve the highest level of growth and welfare that does not diminish future generations’ ability to benefit from environmental goods and services⁵

Considering the welfare of both current and future generations means that environmental policymaking must walk a fine line. Reducing carbon emissions, for instance, costs both firms and consumers. Given the uncertainty about the

effectiveness of policies and the impacts they avoid, determining the level of climate action that reduces emissions enough to avoid future damages without unduly affecting economic growth will be difficult. It implies determining the “optimal” or acceptable level of pollution—a controversial task.

Following the green golden rule, Europe has embarked on an ambitious program to ensure continuing growth with fewer environmental side effects. Policymakers still worry about employment, social stability, and fiscal balances, but protecting natural resources long considered practically free and inexhaustible is now prominent and, in some countries, just as important. If Europe overcomes the significant technical, financial, political, and social barriers to implementing a green economy, it will become a world model—one with lessons for both developed countries that urgently need to reduce their environmental impacts and developing countries that need to achieve higher incomes without excessive environmental degradation.

Greening

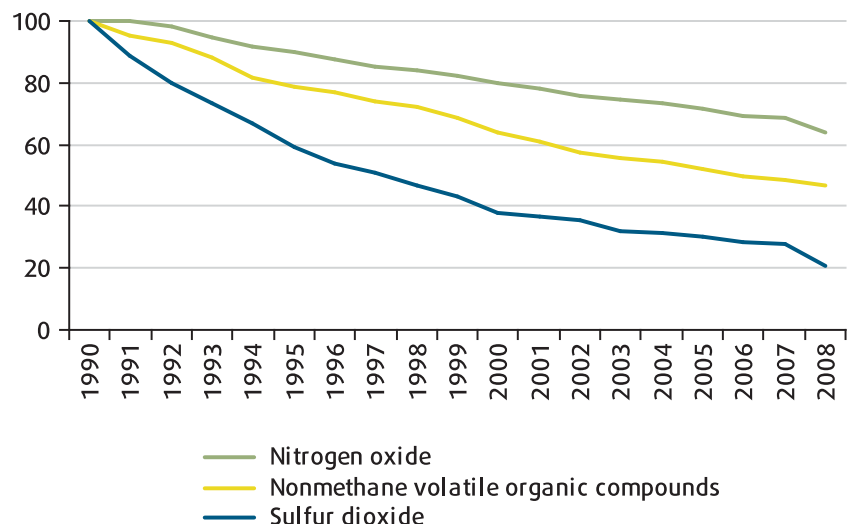
Over the last two decades, Europe has improved environmental quality in many areas and reduced the impacts of its production. Europe measures its environmental progress in climate change, environmental health, nature and biodiversity, and natural resources and waste. Major sources of local air pollution in the EU-15 dropped 30–70 percent over 1990–2008 (figure S2.2). Organic water pollution dropped almost 20 percent since 1998, and fine particulate matter dropped 20 percent on average (European Environment Agency 2010). Despite a commitment to reduce waste generation and materials consumption, both have increased modestly, but far less than economic output. But Europe’s progress on biodiversity conservation has been mixed. It did not reach its goal of halting biodiversity loss by 2010, despite making progress in habitat conservation and introducing biodiversity concerns in sector policies, such as the Common Agricultural Policy.

Figure S2.2: Advanced Europe has cut air pollution in half since 1990

(trends in air pollution in the EU15, 1990–2009, 1990 = 100)

Note: Excluding the United Kingdom (no pre-2000 data).

Source: European Environment Agency 2010.



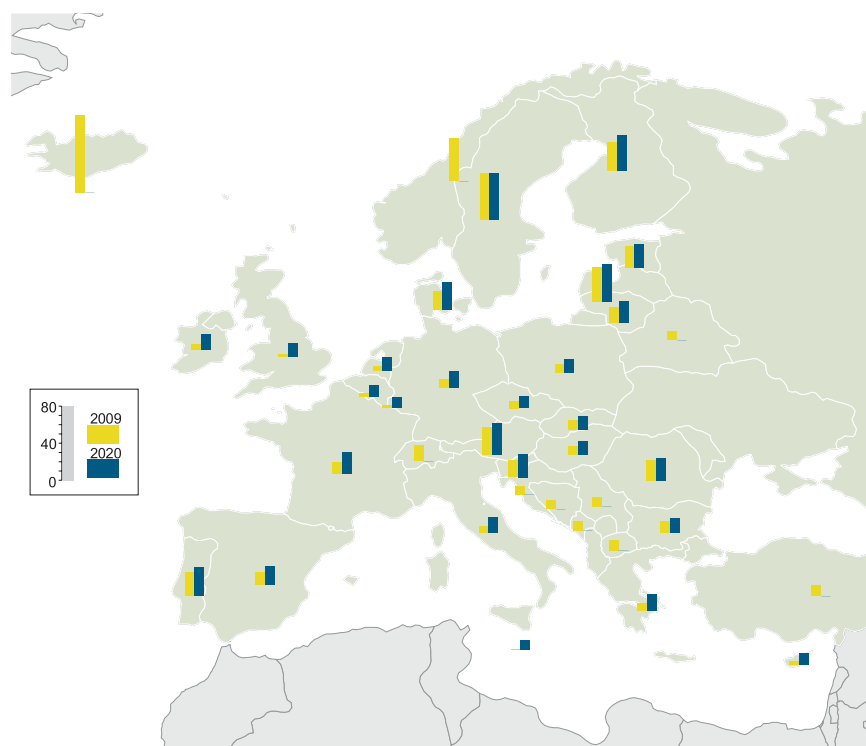


Figure S2.3: Europe’s north is leading the push for cleaner energy

(percentage of final energy from renewables in 2009—and the targets for 2020)

Source: REN21 2011.

EU climate policies sometimes veer into micromanagement (a recent directive limits carbon dioxide emissions in producing a ton of toilet paper to no more than 334 kilograms), but they have been effective. While in most parts of the world, greenhouse gas emissions have increased, over 1990–2008 they dropped 7 percent in the EU15 and 11 percent in the EU27, despite a considerable increase in economic activity (European Environment Agency 2010).⁶ Europeans are also using energy more efficiently. Europe’s 2008 economic output per unit of energy was twice that in 1990. By further decoupling economic growth from energy use and emissions, the European Union is on track to achieve its climate policy goals for 2020: reduce greenhouse gas emissions 20 percent below 1990 levels, lower primary energy use to 20 percent less than “business as usual,” and obtain at least 20 percent of energy from renewable sources. Some member states have already met some goals, for instance on renewable energy (figure S2.3). The targets are more ambitious for 2050, as the European Union aims for an 80 percent reduction in emissions.

These gains have come from popular policies. One instrument for climate action is the European Emission Trading Scheme, introduced in 2005. Despite criticism of the scheme’s effectiveness and susceptibility to windfall profits and fraud, industries now know there will be a long-term price on atmospheric carbon emissions. The scheme encouraged private investments in abatement technology and upgrading equipment. Europeans have shown a willingness to share the cost of environmental action. Indeed, 64 percent of EU15 residents believe that protecting the environment should be a priority, even at the

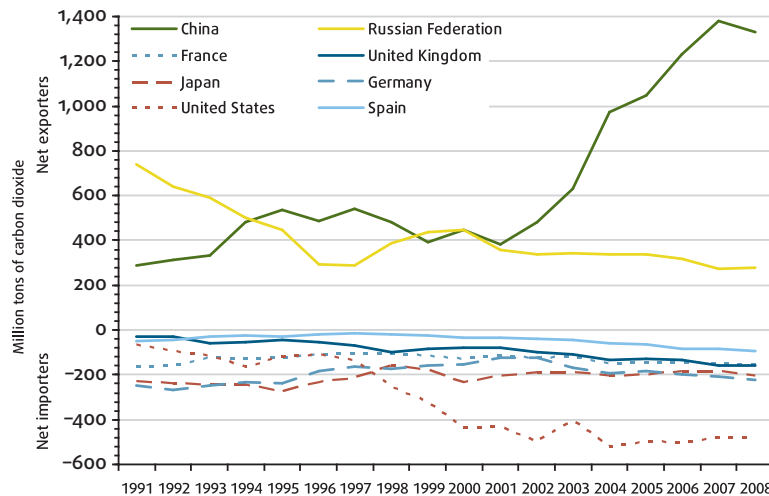
expense of job loss and slower economic growth, compared with 58 percent in the rest of the world (World Values Survey 2005–2008).⁷ Environmental policies can win increased popular support by spreading financial benefits. Many Danish wind turbines are owned by local cooperatives, preempting “not-in-my-backyard” opposition. And feed-in tariffs for renewable electricity generation have been turning home-based solar systems into investment opportunities.

Europe’s progress in reducing local air pollution and the climate impacts of production is substantial, but its gains in shrinking the environmental footprint of consumption are more limited. Lower industrial pollution is due at least in part to major structural economic shifts and trade expansion. As traditional, energy- and emission-intensive economic activities (such as iron and steel manufacturing) became uncompetitive in higher-wage European countries, they moved to other parts of the world, especially Asia. The EU15’s total steel output has stagnated since 1980, when Europe moved into more specialized and cleaner steel production. By contrast, India’s and the Republic of Korea’s output increased some 600 percent, China’s by almost 1,600 percent.⁸ Europe’s environmental dividend reduced local pollution from dirty industries and generally decreased use of local resources, a contrast with the increase in other regions.

Figure S2.4: Western imports, Eastern emissions

(net emission transfers, 1991–2008)

Source: Peters and others 2011.



Sometimes polluting industries quite literally moved to developing countries. In the late 1990s, Chinese companies purchased dozens of German industrial plants and dismantled, shipped, and rebuilt them in China. A Dortmund steel mill, for example, became a 250,000-ton three-dimensional puzzle (Kahn and Landler 2007). Air quality improved in Germany, but the shift increased air pollution in China (Chen, Hong, and Kan 2004).⁹ Many Asian products are made for European markets, leading to rising emissions embedded in imports. Between 1990 and 2008, the United Kingdom’s net imports of carbon dioxide emissions increased from 29 million tons to 159 million tons (figure S2.4). Overall, when considering only carbon dioxide emitted in rich (Kyoto Annex B)



countries, there has been a 3-percent drop. By contrast, consumption-related emissions in those countries increased 11 percent (Peters and others 2011).¹⁰ China alone has more than tripled its exports of emissions since 2000.

Europe has made progress in greening its production and has led the world in formalizing and implementing regional emission-reduction policies. But more action is needed. Marginal abatement costs will increase as cheaper clean-up solutions are implemented first, and tightening environmental regulations will become politically more difficult, especially at a time of economic uncertainty. Beyond its borders, Europe needs to green its consumption. One approach is to help other countries reduce the environmental impacts of their production while accelerating resource use. The European Union, already providing technical assistance for pollution and emission control, recycling, and other environmental priorities through bilateral and multilateral efforts (including through the World Bank), could do more by supporting European exports of environmental technology and more efficient capital goods to developing-country producers, through export credit guarantees, for example. Measures that encourage green foreign direct investment would help develop domestic environmental technology firms.

A more coercive approach would be to extend the reach of European emission policies to other countries through border tax adjustments (Umweltbundesamt 2009). This would level the playing field for domestic companies, and foreign firms exporting to Europe would then have the same incentives to reduce emissions as do domestic producers. The debate about the inclusion of foreign air carriers in the European Emission Trading Scheme in 2012 shows that this approach is controversial, but it might encourage domestic carbon restrictions so that revenues stay in the exporting country. The European Commission and several European countries contributed to the World Bank-led Partnership for Market Readiness, which helps countries set up carbon markets. The first round of countries includes China, Turkey, and Ukraine.

Green growth

Moving toward a European economy that puts a price on environmental goods and services involves a substantial structural shift. Further reducing local pollution and preventing global environmental problems from severely affecting current and future generations require massive transformations in energy, transport, and housing. Some observers have called for an energy industrial revolution.¹¹ But change of this magnitude is not unprecedented. Both the information technology revolution and the invention of the steam engine triggered upheaval far greater than what one might expect from a green-growth transformation (Fankhauser, Sehlleier, and Stern 2008). An energy industrial revolution will impose costs on some businesses but benefit others. How these costs and benefits are distributed will determine whether green growth will be a broadly accepted economic model in the EU27 and beyond.

Tighter environmental standards will be costly, at least in the short to medium term. Unilaterally internalizing the cost of environmental degradation will render European firms less competitive than firms not subject to strict pollution controls. The money that consumers and firms spend on pollution charges or

energy will not be available to spend or invest elsewhere (though these costs can be partly neutralized through appropriate revenue recycling). Predicting these costs of green policies is difficult. The costs of a proposed carbon cap-and-trade system in the United States, for instance, would range from \$69 to \$808 per household by 2020 (Winchester and others 2010). A study for the European Commission estimated firm-level costs of environmental compliance at 0.25–2 percent of production value (Vercaemst and others 2007). In Poland, the average cost to implement a comprehensive greenhouse gas abatement package is about 1 percent of GDP over 20 years, after which net benefits accrue (World Bank 2011). These costs, though significant, are not enough to explain the exodus of energy-intensive and polluting industries out of Western Europe. High labor costs and other production factors have likely played a larger role. Energy prices are already high, and most EU15 countries moved out of energy- and emission-intensive industries some time ago, such as the United Kingdom, with its 1980s decline in the coal and steel industry. The impact will be larger in Eastern Europe, where economies have not yet completed structural shifts and where national environmental policies are more lenient.

Environmental action comes with costs, but so too does inaction.¹² And sometimes doubted decisions become obvious in retrospect. The automobile industry and many consumers initially rejected catalytic converters as too expensive. But the averted costs of respiratory illnesses and other benefits from reduced urban smog have been significant. With increased production and technical progress, a catalytic converter today is a tiny fraction of the cost of a car. Proponents of stricter environmental standards argue that green policies have sizable growth effects. Vehicle pollution abatement has generated new business opportunities—for example, the global catalytic converter industry is worth \$20 billion today. And because green technologies are less mature, they require more innovation and research and development, which generate high-value jobs. At the lower end, investments in energy efficiency and cleaner energy generate jobs in installation, operation, and maintenance that cannot be outsourced.

The job gains in green industries are not small, though they are as difficult to determine as the costs of environmental regulation. By the late 2000s, the wind energy sector was thought to have generated some 100,000 jobs in Germany, 42,000 in Spain, and 22,000 in Denmark, and for the solar photovoltaic (PV) sector, some 70,000 jobs in Germany and 26,000 in Spain (REN21 2011). European firms are highly competitive in such areas as pollution-abatement technology and solid waste management, and job gains in these sectors are significant as well. Experience shows that policies matter. An ecological tax reform is credited with helping Germany reduce emissions and increase employment. The reform raised the cost of energy, triggering large efficiency gains. The increased revenue was used to reduce nonwage labor costs, which helped create 250,000 jobs (Rayment and others 2009, Iwulska 2011).

Economic gains have been concentrated in a few countries, mostly in the EU15. These countries have had government support, large home markets for green products, and the capacity to take advantage of green growth opportunities (figure S2.5). Denmark, France, Germany, Spain, and the United Kingdom, each accounting for between €5 billion and €15 billion in clean energy technology



sales in 2008, were far ahead of Poland (the leader in Eastern Europe), which had less than €300 million (van der Berg and van der Slot 2009). Figure S2.5 shows a similar pattern in value added from renewable power technologies. The market leaders ensured domestic demand through, among other steps, feed-in tariffs for clean energy and supported technology development. In 2009, Germany alone spent about €64 million on publicly funded research and development for solar PV technology, complementing €163 million in private research (Wissing 2009).⁷³ Employment and economic opportunities also exist in other EU countries. With carbon trading, one would expect abatement investments to flow to EU12 countries, where energy and emission intensities

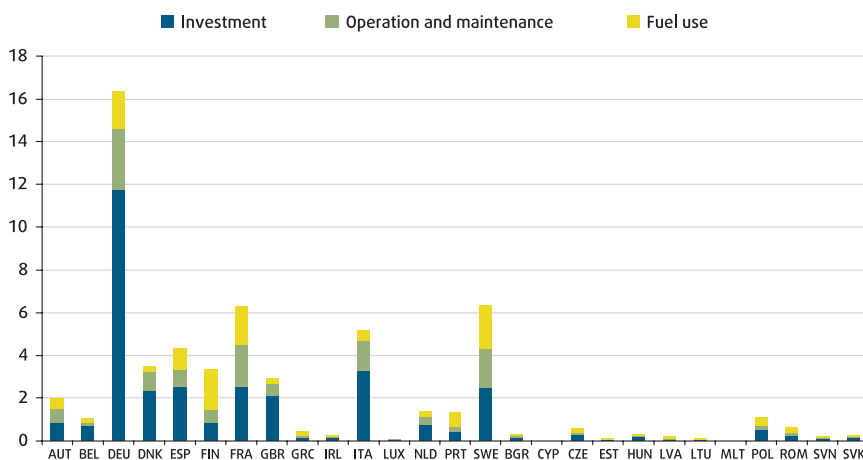


Figure S2.5: Germany, France, Sweden, and Italy have helped business by encouraging renewable energy

(total gross value added induced by renewable energy deployment in 2005, by expenditure category, billion euros)

Source: Ragwitz and others 2009.

remain higher than in the EU15. But the resulting jobs will likely be smaller in number and lower in skill and value added. Examples include manufacturing and assembling green products, upgrading building energy efficiency, and producing biofuel. High-value-added activities, green intellectual property, and earnings from green exports will likely remain concentrated in today's leading green economies.

All EU countries must adhere to the same environmental standards and carbon policy. While all EU countries bear the costs of green growth policies, not all have the structural endowments to take advantage of the opportunities these policies generate. An analogy to the eurozone is illustrative. Countries adopted a common currency without first resolving structural differences. The countries shared the benefits of adopting the euro, such as low interest rates and reduced trade friction. They also faced the constraints imposed by a single currency, but with different structural and economic capabilities to adjust to the loss of monetary flexibility. Over the last several decades, EU interventions (such as the structural funds) have tried to reduce these differences—but with limited success.

A single carbon price has similar advantages and drawbacks. The effectiveness of the European green-growth model—especially in Southern and Eastern Europe—will depend on policy instruments that help countries cope with the

burdens and share the benefits of the transformation to a cleaner economy. Besides external support (through carbon finance, for instance), green growth requires political commitment by countries that, rather than embrace new opportunities, often cling to sunset industries and fossil fuel-based energy systems. Europe missed many of the efficiency gains of the infotech revolution. It will have to be smarter to prosper in the green technology revolution.

Global green growth

Europe is serious about greening its economy. Strong policies opened economic opportunities that European firms like Gamesa were quick to exploit. But in an open economy, the incentives that benefit domestic producers also benefit foreign producers who export to the European market. This increases competition for European firms and implies a leak of taxpayer-funded subsidies and other support. If the goal is to tackle global environmental challenges, however, these leaks will be beneficial even as they make it more difficult for Europe's green enterprises to compete.

By far the biggest barrier to a green transformation is cost. Environmentally friendly technologies are often more expensive than conventional alternatives. For example, electricity from coal-fired power stations costs about \$0.06 per kilowatt hour (kWh), while the price of wind energy ranges between \$0.08 and \$0.14 per kWh. Solar photovoltaic power (PV) costs more than \$0.20 per kWh (REN21 2011). Even where life-cycle costs are lower—as with the new generation of energy-efficient lighting—high initial costs deter consumers. Reducing costs requires research and development, innovation, and economies of scale. With every doubling of production, wind energy is expected to become 15–20 percent cheaper, and solar PV prices to drop 25 percent (Neij 2008). Regulation, taxes and subsidies, and public investments that reduce the price of clean technologies (or increase the cost of dirtier ones) trigger private investment and lead to increased scale. These interventions are justified because they compensate for nonpriced costs incurred by conventional technologies, such as the health effects of air pollution, the loss of such environmental services as natural water filtration, and the damages from a warmer, wetter, more variable climate.¹⁴ The opportunity to get a foothold in emerging markets for green goods also motivates many countries.

Through EU directives and national policies, European countries have made credible commitments to support clean growth. These commitments should encourage investors to risk funding new products that are not profitable according to current market prices. Generous subsidies and tariff guarantees have been effective, helping European leaders emerge in many green technology areas. By the late 2000s, environmental technologies accounted for almost 10 percent of GDP in Germany, and German firms held global market shares of 6–30 percent in key green markets (BMU 2009).¹⁵

Public incentives have worked for European companies, but with open trade they are also attractive to foreign firms. U.S. companies, such as General Electric and smaller high-tech firms, quickly established distribution systems in Europe. As some green technologies move from research labs to mass production, Europe's comparative advantage vanishes and low-cost producers enter the



market. Solar PV panels are an example. Generous feed-in tariffs in Germany, Spain, and other European countries initially benefited domestic firms, even causing a bubble in solar company stocks. This attractive market triggered large investments in production capacity in China. Between 2006 and 2010, China's PV production increased twentyfold, from 400 megawatts to 8,000. During this time, the export share of panels in China never dropped below 94 percent, because the high price and low local subsidies meant that there was almost no domestic market.¹⁶ In wind energy, which is more cost-competitive with conventional sources, Chinese firms have also increased production. Most of the demand so far is domestic, as China deploys the largest installed wind capacity in the world. But that will change as producers increase capacity and eye new markets. European firms, such as Gamesa, should expect more competition.

Europe should welcome these developments. Competition and rising capacity have substantially reduced the prices of some green products. China's solar expansion coincided with a price drop of more than 40 percent,¹⁷ making it cheaper for Europe to reach its "20-20-20" targets (a 20 percent cut in greenhouse gas emissions by 2020, a 20 percent increase in the share of renewable energy, and a 20 percent cut in energy consumption) and creating room for cuts in subsidies. By indirectly contributing to faster price declines, European policies benefit green investments in the rest of the world, accelerating greener industrialization in developing and emerging nations.

The EU27 accounts for just 13 percent of global emissions (International Energy Agency 2010). This share will drop as the populations and economies of other regions grow faster than Europe's. To limit global warming and reduce other global environmental threats, Europe must spread technology and know-how to places where environmental pressures will be most severe. Sharing technology with other regions will also reduce the emissions embedded in European imports. Even if much of the resulting economic activity takes place elsewhere, Europe is positioned to capture a large share of what some expect to be a €3.1 trillion market for green technology by 2020 according to a study by Roland Berger Strategy Consultants in 2007.¹⁸ This will include exports of advanced green-tech products to China, which will require environmental technology investments estimated at 12 percent of GDP. Chinese solar panels, for instance, are produced with machines made in Europe.

Rather than compete on price, Europe should accept that manufacturing and assembly of basic green technology will move to countries with lower factor costs—including perhaps the EU12 and eastern partnership countries. Europe should promote innovative, high-tech companies that create green products and services that are less price-sensitive and less easily reproduced elsewhere. Europe needs "Green Apples"—the green-tech equivalents of an innovative info-tech company. Apple Inc. profits from innovation and design, not from manufacturing. Similarly, European green technology firms should focus on developing and retaining intellectual property and on specialized manufacturing, engineering, and related high-value-added activities. This focus will require support for applied research in Europe that makes the region attractive for non-European companies. Suzlon, a large Indian wind turbine manufacturer, maintains six of its eight research centers in Europe because of Europe's accumulated know-how.

Needed: will, ingenuity, and efficiency

Europe is already the leader in the transition to a greener economy. But environmental impacts, especially greenhouse gas emissions, are still too high per capita to reach global targets. And the picture is even grayer when considering the complete consumption footprint. In recent years, European policies have moved global climate goals forward. But the world’s second- and third-largest economies might soon match Europe’s green ambitions.

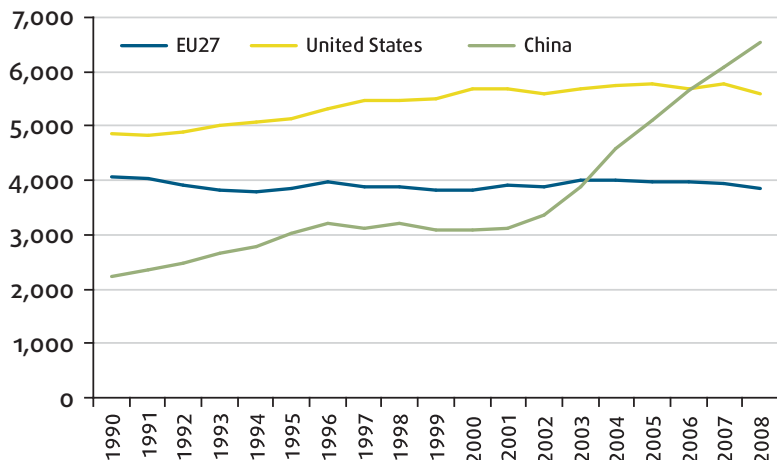
The United States has one of the largest environmental footprints. But it also has the most effective academic research capacity—and huge innovation potential. Much of basic climate-change science and many technical innovations—such as solar, wind, and battery technology—originated in U.S. labs. The United States is strong not only in technical innovation but also in financial and policy innovation. Venture capital funds in the United States channel vast resources to promising firms, including those in green technology. While Europe is strong in process innovation and technological improvement, U.S.-style risk-taking is more likely to lead to the breakthrough technical innovations that many believe are necessary to solve the climate problem.

Federal climate action in the United States has been inadequate, but state and local policies show American potential. California’s air pollution standards have affected car manufacturing globally, and the state’s energy policy began decoupling power consumption from growth in the 1970s (Iwulski 2011). Concerns about acid rain in New England spurred the development of a sulfur dioxide allowance trading system, which showed the feasibility of market-based instruments for pollution control. Ten eastern states joined the Regional Greenhouse Gas Initiative, a cap-and-trade mechanism to reduce carbon dioxide emissions from the power sector. Twenty-three states and many local jurisdictions have set quantitative targets to reduce their greenhouse gas emissions, and more than thirty states have adopted renewable energy portfolio standards for utilities (Pew Center on Global Climate Change 2011).

Figure S2.6: China now emits the most carbon dioxide

(total carbon dioxide emissions from energy use in the three largest global economies, million tons of carbon dioxide)

Source: International Energy Agency 2010b.



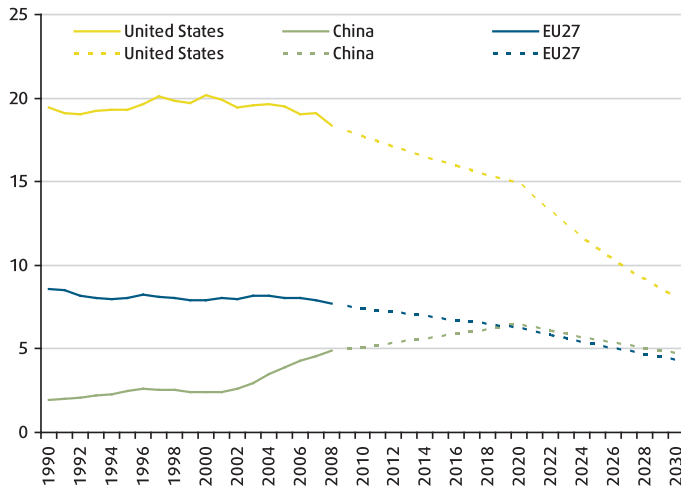


Figure S2.7: But China’s per capita carbon dioxide emissions may not significantly grow beyond the European Union’s

(per capita carbon dioxide emissions from energy use in the three largest global economies, tons of carbon dioxide per capita)

Note: Solid lines show observed per capita emissions, and dotted lines show a per capita emission scenario based on 450 ppm with ambitious mitigation.

Source: World Bank staff calculations based on International Energy Agency (2010) and UN (2011).

The capacity for policy experimentation and implementation at the state and local levels can lead to new, effective, and socially acceptable approaches to environmental management. When successful, innovation spreads quickly and regulatory diversity helps lift standards elsewhere. The “California effect” works even without strong federal action (Vogel 2000). But in the long term, state action cannot substitute for national policies.

China, the world’s largest emitter of greenhouse gases, faces severe problems from air and water pollution. But to further reduce poverty, China’s economy must continue growing—even if double-digit growth rates will become harder to achieve. At current emissions per unit of GDP, China’s economic growth implies that by 2030 the country would account for the entire global emission allowance—30–35 billion tons of carbon dioxide equivalent—that is consistent with the target of keeping Earth’s temperature from rising 2°C higher than preindustrial levels (Stern 2010). China has started tackling this enormous challenge. Aware of its own susceptibility to climate change, the country has embarked on an ambitious domestic greening program. The twelfth Five-Year Plan calls for a 15–17 percent reduction in energy and carbon dioxide intensity by 2015, expansion of wind farms, new solar capacity of more than 5 gigawatts, construction of a smart grid to integrate a larger share of renewables, an emissions cap-and-trade system, and a tax on coal.

China already contributes to global greening by lowering the cost of existing environmental technology, from light bulbs to solar water heaters to wind turbines. All seven strategic industries in the Five-Year Plan move the country from low-end manufacturing to a less resource-intensive economy. And three are explicitly green: new energy, new-materials and new-energy cars, and energy saving and environment protection. China’s huge market for green products will also reduce the price gap between clean and conventional energy and technology. Its goal is to become the world leader in green products like solar panels and electric cars, whose markets must grow if global emission targets are to be reached. China’s environmental impacts will continue to rise. But with strong commitments and better technologies, it could reverse the rapid

growth of emissions (figures S2.6 and S2.7) and reach higher incomes at lower levels of per capita pollution and atmospheric emissions than many of today's industrialized countries.

Europe can help the global environment by continuing to pursue a greener growth model. The region's continuing green growth will improve the quality of life for its current and future citizens, contribute to global sustainability, and offer economic opportunities for European firms. Europe will incur short-term costs, although the implications of failing to deal with long-term global environmental threats are less severe for Europe than other regions. Europe has already dealt with most local pollution and will be less severely affected by global climate change than many other regions.¹⁹ European leadership on environmental action is, therefore, even more remarkable. But despite Europe's leadership, solving the toughest global environmental problems will require all three major economies to accelerate the transition to greener growth and nudge the world forward. Indeed, global green growth requires European political will, American innovation, and Asian efficiency.

Uwe Deichmann contributed this spotlight.

Notes

- 1 Based on Lewis and Wiser (2007), Bradsher (2010), Gamesa annual reports, and market share information from Make Consulting and Emerging Markets Energy Research.
- 2 There are numerous definitions of "green growth" (OECD 2011) or "green economy" (UNEP 2011). This spotlight uses the term "greening" in a broader sense of reducing the environmental impacts of human activity; it uses "green growth" in a narrower sense of recognizing a shift to greater environmental sustainability as an opportunity for growth—through innovation and development of new products and markets. Both terms refer to traditional environmental problems (like water pollution or excessive resource use) as well as climate change.
- 3 Consistent cost estimates for wind power are hard to find. This figure assumes the widely accepted learning rate of 20 percent reduction with a doubling of capacity.
- 4 Refer to the European Commission's website on environment policies for a list of directives, available at ec.europa.eu/environment/policy_en.htm.
- 5 Beltratti, Chichilnisky, and Heal (1995) note that this is "the highest indefinitely maintainable level of instantaneous utility, in a framework where environmental goods are valued in their own rights, i.e., are a source of utility, and are used as inputs to the productive process" (p. 151).
- 6 Part of that decrease was due to industrial restructuring and inefficient socialist-era industries closing.
- 7 In the EU12, just 50 percent agree.
- 8 World Bank staff calculations based on data from the World Steel Association (www.worldsteel.org).
- 9 There appear to be no estimates of displaced industries' contributions to China's local air pollution. But it is likely significant through increased energy demand (much of it from coal) and direct emissions from industrial processes. More recently, China has reduced urban air pollution substantially, including through the World Bank-supported China Air Pollution Management Project.
- 10 Aggregate estimates for EU15 or EU27 are unavailable, because the data set does not allow netting out intra-European trade-induced emissions. Annex B countries are high- and middle-income countries subject to emissions reductions in the Kyoto Protocol, including Russia and Ukraine. See http://unfccc.int/kyoto_protocol/items/3145.php for a list.
- 11 For example, Nicholas Stern (presentation at the High-Level Dialogue on Low Emissions Development Policy Implementation, July 13, 2011, World Bank, Washington, DC. Available at climatechange.worldbank.org/content/climate-change-thinkers-converge-high-level-dialogue-low-emission-development).
- 12 See the extensive literature on the health burden of environmental pollution and the emerging literature on climate change adaptation costs (for instance, World Bank 2010a).
- 13 The private sector figure is for 2008. Globally, spending on clean energy research and development is considered far too low to support the kinds of technological breakthroughs needed to achieve climate goals (World Bank 2010b).
- 14 See, for instance, Gillingham, Newell, and Palmer (2009) for a discussion of market failures in energy efficiency that justify government intervention.
- 15 These markets include energy efficiency, sustainable water, sustainable transport, energy generation, waste management and recycling, and natural resources and efficiency of materials use.
- 16 International Energy Agency 2010c.
- 17 Price data are available on the website of Solarbuzz, an NPD Group Company, at solarbuzz.com/facts-and-figures/retail-price-environment/module-prices.
- 18 Presentation is available at www.rolandberger.com/media/pdf/rb_press/RB_Wirtschaftsfaktor_Umweltschutz_20071127.pdf.
- 19 For evidence of Europe's generally lower climate change risk compared with those of other regions, see Buys and others (2009) and the Climate Change Vulnerability Index released by Maplecroft, available at maplecroft.com/about/news/ccvi.html.

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