McKinsey&Company

McKinsey on

Sustainability & Resource Productivity

Highlights

From liability to opportunity: How to build food security and nourish growth

Rethinking the water cycle

Building the cities of the future with green districts

Sustainability & Resource Productivity June 2015

McKinsey on Sustainability & Resource Productivity is written by consultants from across sectors and geographies, with expertise in sustainability and resource productivity.

To send comments or request copies, e-mail us: McKinsey_on_SRP@McKinsey.com.

Editorial Board:
Anne-Titia Bové, Scott Nyquist, Jeremy Oppenheim, Matt Rogers, Sunil Sanghvi, Martin Stuchtey, Steven Swartz, Jonathan Woetzel

Editor: Cait Murphy

Art Direction and Design:
Leff Communications

Managing Editors:
Michael T. Borruso, Venetia Simcock

Editorial Production:
Runa Arora , Elizabeth Brown, Heather Byer, Torea Frey, Heather Gross, Shahnaz Islam, Katya Petriwsky, John C. Sanchez, Dana Sand, Karen Schenkenfelder, Sneha Vats

Cover photo:
© nightman1965/ Getty images

McKinsey & Company Practice Publications
Editor-in-Chief:
Lucia Rahilly

Executive Editors:
Michael T. Borruso, Allan Gold, Bill Javetski, Mark Staples

Copyright © 2015 McKinsey & Company. All rights reserved.

This publication is not intended to be used as the basis for trading in the shares of any company or for undertaking any other complex or significant financial transaction without consulting appropriate professional advisers.

No part of this publication may be copied or redistributed in any form without the prior written consent of McKinsey & Company.

Table of contents

© nightman1965/Getty images

Introduction

Jeremy Oppenheim

To look at the news is to invite despair about the future of the environment. Natural disasters, species extinctions, rising greenhouse-gas levels, foul urban air, drought in California—it's not a pretty picture. But it is an incomplete one. Over the last two generations, the world has also taken important steps to improve the environment, such as international limits on the release of chemicals in order to contain damage to the ozone layer. Many individual countries have seen their air and water quality get much better; every major economy has improved energy efficiency. Globally, in 2014, for the first time, emissions from the energy sector did not increase—even though the world economy grew 3 percent. In the countries that make up the Organisation for Economic Co-operation and Development, emissions have actually fallen 4 percent over the past five years, even as their economies grew. The link between emissions and economic growth may be weakening.[1]

While acknowledging the gravity of the sustainability challenges before us, we believe that a mindset that focuses on costs, burden sharing, and the immense difficulty of tackling environmental problems is far too narrow. There is a broader, stronger case to be made for optimism—that efforts to deal with climate change and other issues can actually unleash the innovation and dynamism that drive economic growth. This will not be easy, and there will be losers as well as winners in the transition. But strong leadership from both business and government, along with commitment to the right policies, can put the world on the path to greener, more equitable growth.

That was the conclusion of last year's report from the Global Commission on the Economy and Climate, on which I served as program director. Established at the request of seven countries (Colombia, Ethiopia, Indonesia, Norway, South Korea, Sweden, and the United Kingdom), this group of economists, heads of government, finance ministers, activists, and corporate leaders came to a strong consensus: "By shaping the major processes of structural and technological change now occurring in the global economy, we can create lasting economic growth while also tackling the immense risks of climate change."[2]

That view also informs many of the articles in this compendium. McKinsey's experts on sustainability

and resource productivity agree there is a real chance to build a better, cleaner global economy—one that reduces poverty, enhances quality of life, and squarely faces the risks associated with climate change.

That may sound like a utopian vision, but it is grounded in analytics and in the fact that we do not need to invent anything new to achieve it. The principles of green design and construction are well established. We know how to restore degraded land and to grow food more sustainably. We know how to create effective urban transit systems. We have a good sense of what kinds of policies (for example, price signals) foster sustainability and what kinds (resource subsidies) generally do not. There are good examples of effective action at the corporate, city, and country levels. Moreover, the costs of the status quo are also becoming clearer. According to the commission's estimate, in the 15 countries with the highest greenhouse-gas emissions, taking all factors into account, the health damage alone from poor air quality averages more than 4 percent of GDP. And in 2012, outdoor pollution contributed to an estimated 3.7 million premature deaths. The high-carbon, resource-intensive economic model that has defined the past century and more has its own challenges.

This is not just a matter of carbon emissions and climate risk. For example, Martin Stuchtey notes in "Rethinking the water cycle" that under the business-as-usual scenario, the demand for water will swamp supply by 2030. Better stewardship, then, is an urgent matter for social and economic reasons as much as environmental ones. Stuchtey goes on to suggest an approach—reusing water again and again—that not only can solve the problem but also could "replace scarcity with abundance." This method could also create new business opportunities in irrigation, biological digestion, energy, and water-related services.

The same dynamic holds true for food, as Nicolas Denis, David Fiocco, and I note in "From liability to opportunity: How to build food security and nourish growth." The world grows more than enough food to feed everyone; nevertheless, millions go hungry. At the same time, massive land degradation and deforestation continue and are a significant factor in global greenhouse-gas emissions. With global population set to approach nine billion people by 2050, doing better is a matter not just of urgency, but of decency. Technology is and will be helpful; it could, for example, help to close the productivity gap. The dozen most productive countries have grain yields ten times higher than the least productive ones. But this is not strictly a matter of finding the right technical fix: we argue that it is at least as important "to establish the right policies, incentives, and structures so that the right investment goes to the right places." Shifting some spending from subsidies to social support and targeted investment, for example, would not only do a better job of feeding people but would also provide a platform for further economic activity. And again, there is no need to reinvent the plow; the skills and policies required are known and have worked. China, for example, has reversed soil erosion and losses on millions of acres of the Loess Plateau. This not only has improved the livelihood of local farmers—their incomes have doubled, and 2.5 million have lifted themselves out of poverty—but also has created a valuable "carbon sink" to absorb emissions.

Important as agriculture is, one of the defining characteristics of both the last and the current century is the movement of people into cities. According to the World Health Organization, a third of the world lived in cities in 1960; by 2015, that amount was up to 54 percent, and it is on track to reach 66 percent by 2050. The McKinsey Global Institute estimates that the world will need to spend at least $57 trillion on infrastructure by 2030 just to keep up.[3]

One way of coping with the inevitable demands of urbanization, say Shannon Bouton, David Newsome, and Jonathan Woetzel, is by "Building the cities of

the future with green districts." Green districts are defined areas that consciously deploy technologies and make design decisions to limit pollution and sprawl and minimize resource use. Green districts are still a relatively new idea and are more expensive to build than traditional developments. But their running costs are also lower—and they are simply more likable places, with better air quality and more green spaces. And again, the price of business as usual needs to be taken into account. The Global Commission estimates that in the United States, for example, the costs of suburban sprawl are as much as $400 billion a year, in the form of higher costs for infrastructure, public services, and pollution. Already, the world's cities account for roughly 80 percent of economic output and 70 percent of energy-related greenhouse-gas emissions. With 65 million people a year moving into cities, they are on the front lines of environmental action, and green districts are an intriguing tool.

On all of these topics—water, food, and urbanization—energy plays a critical role. So it is interesting to think about what kinds of energy will power the future. In "Solar power comes of age," Dickon Pinner and Matt Rogers take a close look at prospects for photovoltaic solar—and are optimistic. Drawing on a wide body of research, they argue, "This time really is different: solar power is ready to compete on its own terms." The main reason for their optimism is that costs have been coming down while technological proficiency keeps improving and new business models are taking hold. Because of these trends, the International Energy Agency has suggested that by 2050, solar could generate as much as 27 percent of global electricity demand—a huge step up from the current level of less than 1 percent. As a result of all this, the authors conclude, "The momentum behind solar power has become unstoppable."

Further evidence to support that argument comes from recent history. Not that long ago, a plunge in oil prices would have meant a plunge in prospects for renewables. Not anymore. In 2014, the global price of oil fell by more than half—and investment and deployment of renewables continued to grow. The reason, writes McKinsey's Scott Nyquist in "Lower oil prices, but more renewables: What's going on?," is that the renewables sector is more resilient than ever, chiefly because it is economically more competitive.

We are encouraged that the issues surrounding climate change and sustainability are getting substantial attention from business leaders; in fact, they constitute a major, and growing, influence on how top executives think about strategy. In an article that appeared in the book *Perspectives on the Long Term: Building a Stronger Foundation for Tomorrow* (Focusing Capital on the Long Term, February 2015), former US treasury secretary Henry Paulson explains his thinking on why climate change must be near the top of the corporate agenda. The article, "Short-termism and the threat from climate change," compares today's climate issues with the financial crisis of 2008. Paulson believes the world is underestimating the cost of the buildup of greenhouse gases, making future action more costly and traumatic than it needs to be (for more on long-termism, see sidebar, "The future of action on climate change: A conversation with Nicholas Stern").

The article "How companies can adapt to climate change," by Hauke Engel, Per-Anders Enkvist, and Kimberly Henderson, examines how companies can address that concern. While the authors note that relatively few companies (less than a third) have completed climate assessments, they argue that evaluating such risks up front can help companies identify new products and markets and prune their supply chains. The "circular economy" is one example of how business can find new opportunities in greener growth; reusing inputs and optimizing the flow of materials not only saves money but has also created new sources of profit. "Remanufacturing,"

meaning the restoration of used products for resale, is growing fast. The practice produces new products and revenues while reducing waste and emissions.

Another proven approach is the idea of resource productivity—essentially, using inputs more efficiently. In their new book, *Resource-Productive Operations: Five Core Beliefs to Increase Profits Through Leaner and Greener Manufacturing Operations* (McKinsey & Company, March 2015), Markus Hammer and Ken Somers make the case that resource productivity must be a major priority for industry. In the excerpt that appears here—"Manufacturing growth through resource productivity"—they set out five "core beliefs" that need to absorbed by management teams, workforces, and the organization as a whole for this transformation to take hold.

It's true that we live in an era of structural change, but that does not mean business is at the mercy of markets, technology, or blind, impersonal forces. Leadership matters. There are several important implications for businesses that want to get, and stay, ahead of the curve:

- Leaders need to be more thoughtful about efficiency and waste elimination, particularly in areas that are energy intensive.
- They need to start investing in scalable, lower-carbon energy alternatives.
- They need to prepare their operations and supply chains for more, and more extreme, weather events; on the positive side, a diverse set of energy options improves flexibility and operating resiliency.
- They need to work with governments, regulators, and other stakeholders to contribute to better policy outcomes.
- They need to factor in a carbon price of at least $25 a ton (and probably more in the next decade) when making their investment decisions.

Companies that can get these things right will, we believe, thrive in the emerging climate economy.

■ ■ ■

"The world's economic leaders face a remarkable opportunity to set the world on the path to sustainable prosperity," the Global Commission concluded. "The prize is immense, and the moment of decision is now. We can achieve both better growth and a better climate." The world is changing fast, and there is no reason to believe that the pace of structural and technological transformation is going to falter. The real question is whether the global economy can be nudged decisively enough onto a lower-carbon, less resource-intensive path. Today's mixed signals in many major economies will not be enough to do the trick. ■

[1] "Global energy-related emissions of carbon dioxide stalled in 2014," International Energy Agency, March 13, 2015, iea.org.
[2] *Better Growth, Better Climate: The New Climate Economy Report,* Global Commission on the Economy and Climate, September 2014, newclimateeconomy.report.
[3] *Infrastructure productivity: How to save $1 trillion a year,* McKinsey Global Institute, January 2013, mckinsey.com.

Jeremy Oppenheim is a director in McKinsey's London office.

Copyright © 2015 McKinsey & Company.
All rights reserved.

The future of action on climate change: A conversation with Nicholas Stern

Nicholas Stern, president of the British Academy, is chair of the Grantham Research Institute on Climate Change and the Environment at the London School of Economics; he led the Government Economic Service under Prime Minister Tony Blair and Chancellor of the Exchequer Gordon Brown. In 2005–06, he led the team that produced the Stern Review on the Economics of Climate Change, which concluded: "With strong, deliberate policy choices, it is possible to 'decarbonize' both developed and developing economies on the scale required for climate stabilization, while maintaining economic growth in both."[1]

In these edited abstracts of a conversation with McKinsey's Jeremy Oppenheim, Lord Stern details his thinking about long-term issues related to climate change and growth.

On growth versus the environment

The low-carbon growth story is the growth story of the future. There's no spitting contest between growth on the one hand and climate responsibility on the other. The story is of better growth. And I think that growth could be just as fast as going down a "traditional" route. It will surely be better, cleaner, quieter, safer, more community oriented. And it will be associated with a better climate. This is the growth story of the future, and it's a very attractive one.

On the future of the energy industrial revolution

You're talking about an energy industrial revolution, in some sense. And that can mean dislocation, for example, of coal. A strong carbon price means that hydrocarbons are more expensive than they would otherwise have been. Now, there are lots of other things you do at the same time, like pressing ahead with energy efficiency, bringing down the costs of renewables, and so on. Not everybody's energy costs will go up. Of course, a carbon price would push up energy prices for a while for those who are intensive in hydrocarbon energy. But I don't think it would last very long, and there are lots of efficiency actions that you can take.

On China

China has recognized that the way it has developed—with its emphasis on coal, sprawling urbanization, and individual motorization—has led the country into real difficulty, with cities that, by their description, are "unlivable." China's growth pattern, President Xi has said, is "unsustainable." So it's not simply a GDP story, and it's not about sacrificing growth. It's about better growth. Other countries that are dependent on coal—India, Indonesia, South Africa, other places—would do well to reflect that they've got a chance to do things differently from China.

On India

I think India's changing. Shortly after he was elected [in May 2014], Prime Minister Narendra Modi announced he wanted to bring solar lighting to 400 million Indian people without electricity by 2019. That's important. So there are positive things in India. But you have to keep in mind India's refusal to be dictated to and that India sees poverty reduction as the paramount objective. That is entirely understandable.

On the private sector and government policy

Most investment will come from the private sector, and that will be affected by where policy is going and what governments are doing. It's genuinely a two-way story. Government sets the policy environment, and also sets expectations about the policy environment. And it's influenced by firms in so doing. There's a real to and fro there—not all of it comfortable, but it can and should be constructive.

On leadership

If we were to put together something like an international dream team to take climate action forward, I would choose Donald Kaberuka, the president of the African Development Bank Group and Rwanda's former minister of finance and economic planning. He is a very thoughtful policy maker who understands growth, who's delivered growth, who's got a view right across Africa and thinks hard about finance.

You will also need people from India and China. From India, I would be inclined to pick Arvind Subramanian, who is the chief economic adviser to the government of India. He is a very good, independent-minded economist who understands this subject very well. In China, we have very good collaborators. He Jiankun, chairman of China's Advisory Committee on Climate Change and director of the Laboratory of Low Carbon Economy at Tsinghua University, has been at the heart of Chinese energy policy. When it comes to analytical ability, experience, and the ability to persuade the people who count, I think he would be particularly valuable.

I'd also like someone from Latin America. Maybe Luciano Coutinho, head of the Brazilian Development Bank; it's one of the biggest development banks in the world and lends more than the World Bank Group. He is a very thoughtful person, very experienced. If we wanted an industrialist, there's Francisco Gil Diaz of Mexico. He was a very good finance minister for that country.

I also think you need some hard-nosed international business leaders with real vision, someone like Unilever CEO Paul Polman; Eric Schmidt of Google would be great, and Jerry Brown, the governor of California. And I would want the Pope, too. In May 2014, he said, "If we destroy creation, then creation will destroy us."

On the near future

In the course of doing this work, it really struck me how important the next 15, 20 years are going to be. And with respect to the level of the opportunities that technology has brought us—our experience with policy, our understanding about the health costs of hydrocarbons, our knowledge of how cities work, and so on—we have learned much in the last decade, indeed in the last few years. We are at a moment where we can really understand what we have to do to foster the great economic transformations that are taking place. I don't think that was true five years ago.

But it also is true that if we do not seize this opportunity—if we just go on with the old high-carbon investments and build our cities in not very clever ways—then, after 20 years, it's going to be much more difficult. ■

[1] Nicholas Stern, *The Economics of Climate Change: The Stern Review*, Cambridge, United Kingdom: Cambridge University Press, 2007.

© fototrav/Getty images

Short-termism and the threat from climate change

The former US treasury secretary argues that by not acting now, we're allowing the future costs of the greenhouse-gas crisis to compound. Eventually, the consequences will be irreversible.

Henry M. Paulson Jr.

It's fitting to gather views on the long term for a business audience, given the pervasive short-term pressures CEOs are under to demonstrate performance. We all know that outstanding companies and real value can only be built over the long term. The challenge for a CEO is to balance the drive for long-term goals with the need to keep the organization strong in the here and now.

That job is made even harder because the business community is not the only sphere in which short-termism thrives. Nowhere is it more rampant than in our political system. One of the things I learned in Washington is that it's very hard to get Congress to do anything controversial or difficult unless there's an immediate crisis.

Learning from the financial crisis

Climate change is where short-term thinking and long-term consequences collide for businesses and governments alike. Meeting the challenge of climate change calls for both to assess the risks and act before the economic and environmental consequences of failure are irreversible. As someone who has spent a good deal of time assessing risk and dealing with crises, I'm struck by the similarities between the climate crisis and the financial crisis of 2008.

Today, we're making the same mistakes when it comes to climate change that we made in the lead-up to the financial crisis. We're building up excesses (debt in the 2000s; heat-trapping greenhouse-gas emissions now). Our government policies are flawed

(providing incentives for borrowing too much to finance homes then; providing incentives for the use of fossil fuels now).

The greenhouse-gas crisis, however, won't suddenly manifest itself with a burst, like that of a financial bubble. Climate change is more subtle and cruel. It's cumulative. And our current actions don't just exacerbate the situation—they compound it. Indeed, our failure to make decisions today to avert climate disaster tomorrow is even more serious than our failure to avert the credit crisis in 2008. The carbon dioxide and other greenhouse gases that we emit into the atmosphere today will remain there for centuries, and government will not be able to avert catastrophe at the last minute.

We're already feeling the impact. For example, the higher sea levels off the coast of New York City—sea levels that led to a storm surge that devastated parts of the city during Hurricane Sandy—are the result of public- and private-sector decisions made decades ago.

So what does this mean for businesses and investors trying to plan for the future? It means that even as we're spending money to adapt to the current state of our climate, we're also making decisions today that risk locking us into long-term consequences that we'll certainly have to adapt to, at far greater cost, far into the future.

In an effort to better understand these risks and to measure their cost to specific sectors of the US economy, I recently joined with former New York City mayor Michael Bloomberg and the investor and philanthropist Tom Steyer to cochair the Risky Business Project. Our goal was to take a standard risk-management approach to climate change. We asked independent researchers to model the specific consequences of continuing along our current emissions pathway for three major industries—agriculture, energy, and real estate.[1]

The results were sobering. The US economy faces multiple and varied risks from unmitigated climate change. These are disproportionately significant in certain regions, and they are not all decades in the future: for example, projected changes in sea levels, combined with changes in hurricane activity, will likely increase the cost of coastal storms along the East Coast and Gulf of Mexico by 11 to 27 percent in 15 years, representing an additional $3 billion to $7 billion in average annual damage. This has serious implications for developers, insurers, bond raters and issuers, and local governments in these areas—not to mention current property owners and businesses located along the coastlines.

In the Midwest region, some states, including my home state of Illinois, will likely experience significant losses in crop yields for our major commodity crops of corn, soy, wheat, and cotton. Absent major adaptation efforts on the part of farmers and agribusiness, some states in the Southeast, lower Great Plains, and Midwest risk up to a 50 to 70 percent loss in average annual yields for the same crops by the end of this century.

And for states across the South, hotter conditions will make outdoor work nearly impossible for large portions of the summer. Texas, for instance, experienced an average of 43 days a year with temperatures above 95 degrees Fahrenheit over the past 30 years. This number will likely reach up to 80 days over the next 5 to 25 years, nearly doubling, and rise to more than 100 days a year by midcentury.

We took a conservative approach in the Risky Business Project report, looking only at the most clearly foreseeable effects of climate change. But the data we didn't consider are even more disturbing. Most scientists believe that the single biggest tipping point on climate change will come with the melting ice sheets in the Arctic and Antarctic.

Fewer than ten years ago, scientists projected that melting Arctic sea ice would result in virtually ice-free Arctic summers by the end of this century. Now, the ice is melting so rapidly that such a result could be a reality in the next decade or two.

More troubling, two new studies reveal that one of the biggest thresholds has already been crossed. The West Antarctic ice sheet has begun to melt, a process that scientists say may take centuries but that could eventually raise sea levels by as much as 14 feet. Now that the melting has begun, we can't undo the underlying dynamics, which scientists say are "baked in."

Managing climate risk in the private sector

Understanding these potential impacts is one thing. Seriously planning for them is another. As my friend and Risky Business Project cochair Mike Bloomberg likes to say, "If you can't measure it, you can't manage it." Well, now we've measured. It's time to manage.

What does managing climate risk mean for the private sector? In the short term, it includes a significant amount of adaptation. Businesses need to take steps to shore up their supply chains and physical infrastructure to guard against disruption from the extreme heat and weather events that are the hallmark of a changing climate. We're already seeing these adaptive efforts from companies such as Colgate-Palmolive, which (as part of a larger restructuring program) reduced its exposure to climate risk by closing, relocating, or strengthening sites that were increasingly exposed to severe weather conditions.

Companies are also beginning to make future infrastructure-investment and siting decisions based on the latest climate science. Shell, for instance, employs advisers to conduct assessments of future climate-change conditions for large new projects in regions such as the Arctic (projecting sea-ice conditions for 2030 to 2050), the North Sea (wave conditions for 2010 to 2020), and tropical areas (cyclone severity for 2010 to 2030).

While these businesses may be doing better than many governments in dealing with a crisis, there is still much that needs to be done. The business community can't stop at adaptation. We need to reduce the risk of future climate events.

Individual companies can do some of this. For example, utilities can build renewable-energy facilities to meet the power demands that will come with increasing temperatures rather than defaulting to carbon-based energy sources.

Disclosing climate risk and actions in financial reporting would also sharpen the focus for management and investors. An even greater service would be for businesses to take a more active role in working with government to put in place the kind of long-term, consistent policy framework we need to ensure a more sustainable economic future.

Thinking long term in the public sector

Climate change is not just an issue that poses significant economic risk for businesses; it also poses a huge fiscal risk to the United States. Government has a responsibility to take the long view on this issue—and there is every incentive to do so.

When natural disasters strike, government intervenes, spending billions of taxpayer dollars on disaster relief and recovery and on shoring up infrastructure to guard against future events. Indeed, this is the proper role of government. However, policy makers can no longer afford to ignore the underlying reasons for the increase in the number and severity of natural disasters. To do so jeopardizes our

fiscal future, particularly given the severity of climate risk. If we don't change course, wide-scale government interventions will increasingly add to the national deficit, which will hamper growth and competitiveness while siphoning off public dollars that could be spent in other critical areas.

Instead, the federal government should be addressing the fiscal realities of inaction, first by investing in basic research on new technologies, which only the public sector can do at a scale commensurate with the magnitude of the problem. Also, government must put policies in place that let the market direct resources toward smart investments. A price on carbon, for instance, would help unleash a wave of innovation for new technologies, promote efficiencies, and change corporate and consumer behavior.

Unfortunately, politics sometimes stands in the way of smart decision making. That's why it's incumbent on business leaders, who create jobs and economic opportunities in every district of this country, to stand up and push our policy makers to take action to avert the looming climate bubble.

The global challenge of climate change

Of course, climate change is not just America's problem. This is an issue of vast proportions, which knows no geographic borders, and stemming it requires a global full-court press. I believe this must begin with bilateral action between China and the United States—the world's largest economies, energy users, and carbon emitters—to demonstrate leadership that will, in turn, prompt global action. The climate deal struck by President Obama and President Xi is an important and commendable step in this effort. Frankly, continuing to work closely with China may be our only real hope for solving the climate crisis.

This is one of the areas where our countries' private sectors, governments, and nonprofit institutions have a strong shared interest to work in complementary ways to push for action and to develop and deploy new technologies on a cost-effective basis in the developing world. The challenge will be the speed with which we can come together in meaningful ways around a problem of this scale. But the good news is that no nation on Earth innovates better than the United States, and China can roll out and test new clean-energy technologies on a speed and scale like no other.

Here in the United States it's frightening, but not surprising, that our business leaders and lawmakers far too often either dismiss the topic on political grounds or relegate climate change to the back burner to address issues that seem more immediate.

Meanwhile, China's air quality has reached a crisis point, and the government has no choice but to act. Spend a day in Beijing, which suffered more than 60 days last year from air pollution that reached hazardous levels and where annual average particulate levels are four times the World Health Organization (WHO) maximum. On especially bad days—those that rate as "beyond index," or off the scale—pollution can reach 20 times the WHO maximum. No wonder China's leaders feel pressure to act.

Recognizing the urgency of the problem, Premier Li Keqiang has declared war on pollution and launched a new plan for economic reform to set China on a more sustainable environmental path. As a result, we're seeing a noticeable policy shift among the country's leaders.

For instance, the government has introduced new performance indicators for officials based not only on economic performance and social stability but also on environmental management and the quality of growth. China is also taking steps toward pricing greenhouse-gas emissions. Seven regional pilot carbon markets have been up and running in major cities since 2013, with the goal of developing a model for the country—and a nationwide system could be announced within a year.

These are commendable actions, but China has been losing ground from the impact of breakneck growth that has overwhelmed the economy at a significant environmental cost. China is the fastest-growing greenhouse-gas emitter, accounting for some 30 percent of all global emissions. So it's no wonder the country's leaders have placed a high priority on cleaning up its polluted air. China's citizens demand that—as will the rest of the world.

The long term is now

It's time for the United States to get its house in order through policies to curb and price carbon emissions. We must lead, first, because the stakes are high for our environment and for our economy. Moreover, when our own house is in order, we are in a better position to press China and other developing countries to take difficult but necessary steps to curb this crisis.

Given the stakes for our environment and for our economy, it's also time for the business community to urge government to enact smart and sustainable policy solutions. After all, politicians listen to the business leaders in their states and districts—in addition to the general public that elects them.

We can't afford to ignore this crisis. ■

[1] To assess the risks of rising temperatures, the Risky Business Project relied on an analysis of both high- and low-probability outcomes and the economic consequences on a regional basis, as well as for specific sectors of the economy. Those costs included the loss of property along coastlines as a result of rising sea levels and increases in hurricane activity, changes in commodity-crop yields attributable to temperature and precipitation changes, and increased electricity demand corresponding to hotter days across much of the continental United States. The research found additional costs associated with heat-related mortality and losses in labor productivity.

This essay is from *Perspectives on the Long Term: Building a Stronger Foundation for Tomorrow*, a book published by Focusing Capital on the Long Term (FCLT). For more information about FCLT, an initiative cofounded by McKinsey & Company and the Canada Pension Plan Investment Board, visit fclt.org.

Henry Paulson is the founder and chairman of the Paulson Institute at the University of Chicago and former US treasury secretary and chairman and CEO of Goldman Sachs.

Copyright © 2015 McKinsey & Company.
All rights reserved.

© Easy_Company/Getty images

How companies can adapt to climate change

Taking effective action can turn risk into competitive advantage.

Hauke Engel, Per-Anders Enkvist, and Kimberly Henderson

From the early days of seafaring trade, dealing with the weather has been an integral part of doing business. Today, however, concerns over climate change are taking this to a whole new level, and companies will have to adapt to growing regulatory, environmental, and consumer pressures.

This is a daunting prospect. That may explain why, in a survey of S&P Global 100 companies by the Center for Climate and Energy Solutions, only 28 percent said they had done climate assessments, and an even smaller number (18 percent) said they use climate-specific tools or models to assess their risks.[1] But delay is not a strategy. Organizations can benefit by taking action to recognize and even anticipate such climate-related risks as changing government policies, product-preference shifts, and price volatility.[2]

There are, in broad terms, six different kinds of climate risks (Exhibit 1). These can be divided into two interconnected groups: value-chain risks and external-stakeholder risks.

Value-chain risks

Physical risks are those related to damage inflicted on infrastructure and other assets, such as factories and supply-chain operations, by the increased frequency and intensity of extreme weather events, such as wildfires, floods, or hurricanes. According to the *New England Journal of Medicine*, the frequency and severity of climate-related disasters like floods, droughts, and storm surges has increased markedly since the 1970s.

This can affect company performance in real and visible ways. In 2012, for example, Cargill, one of

the world's largest food and agricultural companies, posted its worst quarterly earnings in two decades, in large part because of the US drought. While no single event can be attributed to climate change, of course, this is an example of how climate can and does affect business prospects. Western Digital Technologies, a major supplier of hard disk drives, posted a sharp decline in revenues in 2011 after flooding in Thailand, where most of its production was located. That loss of production meant global supply slumped, with severe reverberations for computer manufacturers.

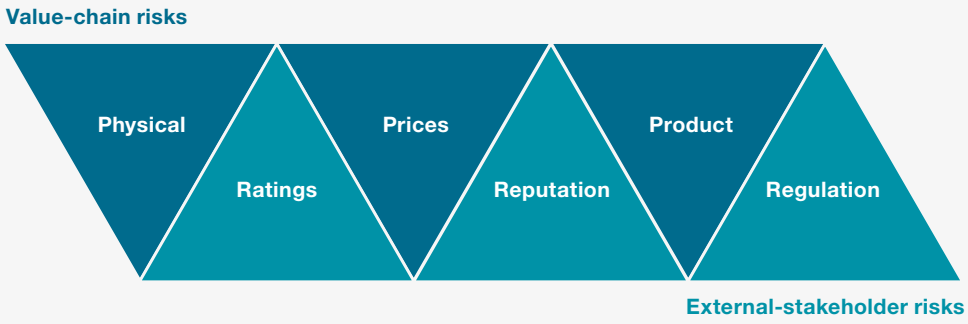
Such physical risks are impossible to control, but companies can take steps to prepare for the changes that could occur in years and decades to come. First, it helps to forecast a range of reasonable scenarios; doing so may require the help of specialized climate modelers. Climate forecasting can highlight high-level risk probabilities by region, such as for flood, drought, or sea-level rise, and for long-term changes in such factors as temperature, humidity, or rainfall patterns. The scenarios should help reveal which parts of the business are vulnerable. A variety of mitigating risk processes, technical standards, and capabilities can then be put in place. In the long term, risk management could call for changes to supply chains (to build in geographic variability or redundancy), including moving away from suppliers and/or locations that are highly exposed.

Price risks refer to the increased price volatility of raw materials and other commodities. Drought can raise the price of water; climate-related regulation can drive up the cost of energy. High-tech and renewable-energy industries, for example, face price risks in the competition for rare earths, which are used in the production of computer hard drives, televisions, wind turbines, solar photovoltaic systems, and electric vehicles.

For more than a decade, the prices of many resources have been both rising and volatile.[3] An unstable climate could ratchet up the pressure further, forcing companies to cope with uncertainty around inputs to production, energy, transport, and insurance.

Some companies are taking significant steps to get ahead of this concern. IKEA is in the process of substituting renewables for conventional sources of energy; in time, it hopes to be largely self-sufficient with regard to power. In that event, the retailer will have

Exhibit 1 **We have identified the types of risks climate change poses to businesses.**



Source: McKinsey analysis

a good idea of what price it will pay for power and will insulate itself against global and regional energy price spikes.[4] Volkswagen is doing something similar. To hedge against the possibility of rising fossil-fuel prices, the German car maker is investing €1 billion in renewable-energy projects and is aiming to power its manufacturing sites mainly through on-site production.[5] These are just two examples: we expect more and more companies to go "off grid" for both strategic and economic reasons.[6]

Product risks refer to core products becoming unpopular or even unsellable. Effects could range from losing a little market share to going under entirely. Alternative cooling technologies, for example, could conceivably displace air-conditioning systems; ski resorts that no longer can count on snow or cold weather could go under. Regulatory and production costs could raise the price of coal in some markets above that of lower-carbon competition, with ripple effects for mining-equipment manufacturers and related industries.

This kind of risk, of course, is familiar; new products, by definition, displace older ones. The difference is that responding to climate-related pressures can change the entire context in which a business operates, not just a specific segment. It's more like the change from the horse-and-buggy era to the car than shifting from manual to automatic transmission. Utilities, for one, know this; they are seeing their traditional business model threatened in markets where renewable energy accounts for a greater part of new generation.

On the positive side, however, greener products are emerging in a number of industries. The construction and infrastructure sectors are developing new products and services that cater to cleaner cities, such as electric-vehicle charging infrastructure, renewables integration, smart metering, smart grids, congestion-fee systems, and high-performance building technologies.

In the business-to-consumer sectors, especially retail and consumer products, new segments are making inroads as people make it clear they are willing to pay for greener products. Groceries advertised as sustainable, for example, are growing fast in the United States, and the organic-food sector has seen double-digit growth for the past decade. This is a testament to the emergence of a significant cohort of customers for whom environmental consciousness is a factor in where and what they buy.

How can companies adapt? One approach is to adopt a "design to sustainability" approach, in which new products are designed to minimize waste and to be broken down for reuse or recycling. Another is to redefine corporate strategy to align business interests with climate-change mitigation and adaptation. Siemens, for instance, has developed a dedicated "environmental portfolio" of carbon-efficient products, while Saint-Gobain, the construction and packaging giant, puts sustainable housing technologies at the core of its product-development strategy.

External-stakeholder risks

We define *ratings risk* as the possibility of higher costs of capital because of climate-related exposure such as carbon pricing, supply-chain disruption, or product obsolescence.

While the ratings risk varies widely between and within industries, even companies with carbon-intensive activities can start to manage it. Already, more than 4,000 organizations are reporting their exposure to the CDP (previously known as the Carbon Disclosure Project), a first step in dealing with the issue. A number of oil majors use an internal carbon price to guide some of their strategic decisions.

Regulation risk refers to government action prompted by climate change. This can take many forms, including rules that add costs or impede specific business activities, subsidies in support of a competitor, or withdrawal of subsidies. In many

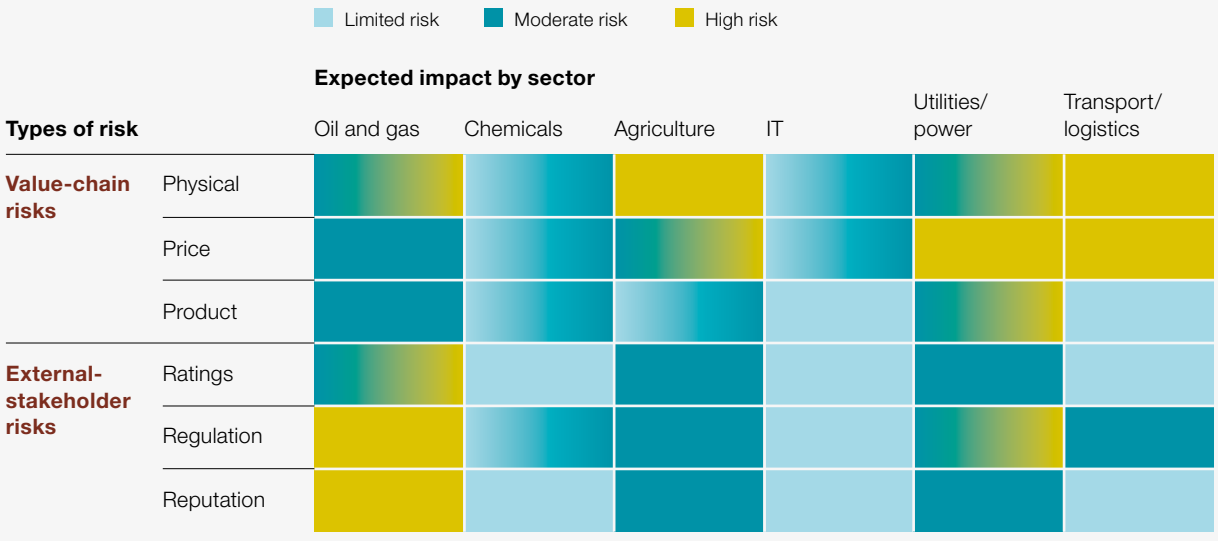
industries, government plays a crucial role in setting the rules of the game; with climate change in mind, many of those rules are changing.

Around the world, we are seeing governments respond to the possibility of climate change in ways that necessarily affect business prospects. To cite just a few examples: China is launching carbon-trading programs in seven regions in preparation for a potential national plan by 2020. Most US states have introduced renewable portfolio standards, which require a certain proportion of the state's electricity to be produced from renewable sources. Ethiopia has charted a course to become a middle-income country through low-emissions growth with its Climate-Resilient Green Economy strategy.

One complication is that on the national and international level, climate-change policies often change, sometimes with the speed of an election result. That makes it difficult for businesses to make long-term investment and operating decisions. Businesses can, however, take the initiative in managing regulation risk. The first step in preparing for and helping to shape future regulation is to understand the policy options. The second step is to develop an internal strategy on climate change to put the company in a position to react effectively to regulations and policy changes. The final step is to work with external stakeholders, such as regulators and industry groups, to get their perspectives.

Reputation risk can be either direct, stemming from a company-specific action or policy, or indirect, in the form of public perception of the overall industry. In the climate-change context, reputation risk can be understood as the probability of profitability loss following a business's activities or positions that the public considers harmful. A poor reputation on climate can hurt sales through consumer boycotts or local community protests. It could damage the regulatory environment and investor relationships.

Exhibit 2 **Climate-change risks will be felt differently by industry.**



Source: McKinsey analysis

And it could make the company less attractive to current or future employees.

This is part of a larger trend: the changing expectations of stakeholders. Investors are asking for disclosure of carbon emissions and starting to lodge concerns about "stranded" assets—those that become unusable due to climate-policy regulation or physical climate change. Many employees want sustainability to be part of the day-to-day operations of their companies. Nongovernmental organizations are getting more prominence when it comes to their ability to measure and compare corporate actions.

In response, some companies have taken very public steps to adopt climate-change strategies. Unilever, for example, leads the FTSE CDP Carbon Strategy risk and performance index and has improved its carbon efficiency by 40 percent since 1995. Its stated goal is to reduce the carbon and water footprints of its products to half of 2010 levels by 2020. The retailer Kohl's has been recognized for its efforts to green its operations and reduce emissions.[7] IBM has also gotten positive attention for its actions on climate, such as setting rigorous greenhouse-gas-emission standards for suppliers. IBM won a 2013 Climate Leadership Award from the US Environmental Protection Agency for supply-chain leadership[8] and was also recognized in 2014 for its greenhouse-gas management.[9] Just about every company in the Fortune 500 touts its commitment to sustainability. There is still a long way to go in many respects, but it can be said that action has well and truly started.

The big picture

Based on case studies, industry interviews, and our analysis, Exhibit 2 evaluates the climate-change risk exposure of seven different industries.

Results for individual companies will vary, of course, depending on geography, target markets, and management. But this chart is a useful way to look at the economic landscape.

One truth is evident across all these industries: companies that ignore climate-related risks are likely to feel the consequences. Those that identify the most pertinent risks, think through how they relate to one another, and then put in place appropriate measures can begin to manage the challenges ahead. These companies will not only put themselves in position to ride out the storm; they could rise above it. ■

1 *Weathering the Storm: Building Business Resilience to Climate Change*, Center for Climate and Energy Solutions, 2013, c2es.org.
2 "The business of sustainability: McKinsey Global Survey results," October 2011, mckinsey.com.
3 For more, see *Resource revolution: Tracking global commodity markets*, McKinsey Global Institute, September 2013, on mckinsey.com.
4 "Ikea unveils plans to use 100% clean energy by 2020," *Guardian*, October 23, 2012, theguardian.com.
5 "VW will unabhängig von Stromversorgern warden," *Handelsblatt*, October 12, 2012, handlesblatt.com.
6 Antonio Volpin, "How businesses can address the risks related to energy consumption," *Energy World*, January 2014, energyinst.org.
7 *Partner Profile*, United States Environmental Protection Agency, 2015, epa.gov.
8 *EPA Recognizes IBM for Climate Change Leadership,* IBM, 2013, ibm.com.
9 *2014 Climate Leadership Award Winners,* United States Environmental Protection Agency, 2015, epa.gov.

The authors wish to thank Blandine Antoine and Julien Cochard for their contributions to this article.

Hauke Engel is a consultant in McKinsey's Frankfurt office, **Per-Anders Enkvist** is a principal in the Stockholm office, and **Kimberly Henderson** is a consultant in the London office.

Copyright © 2015 McKinsey & Company.
All rights reserved.

INDUSTRY
VIEWPOINT

© RonFullHD/Getty images

Lower oil prices but more renewables: What's going on?

Why the renewables sector is more resilient than ever.

Scott Nyquist

Not that long ago, the plunge in oil prices that has occurred over the past year would have been to renewables what kryptonite was to Superman, as the *Financial Times* put it.[1] Not any more. Yes, it's true that American investors would have been better off putting their money into the S&P 500 from April 2014 to April 2015 than in clean-tech funds. That was the period that saw oil prices drop from almost $100 to less than $50 a barrel, before recovering a bit. But in the first quarter of 2015, many clean-tech funds handily outperformed the S&P. Moreover, the sector did not see a wave of bankruptcies and pullbacks like the one that scarred it a decade ago, when a glut of Chinese manufacturing drove dozens of solar companies into oblivion. In fact, global clean-energy investments increased 17 percent in 2014, reaching $270 billion, reversing two years of declines. While government-policy support remains crucial, renewable companies also did well raising money in the markets; equity investment rose 54 percent in 2014.

There are other reasons for optimism. One is that deployment of renewable technologies continues to rise. The United States is on course to install 12 gigawatts of renewable capacity this year, more than all conventional sources combined.[2] Wind capacity grew by 8.1 percent in 2014, and based on its analysis of projects in the works, the US Energy Information Administration (EIA) estimates capacity will grow another 13.1 percent in 2015 and 10.9 percent in 2016. Solar is growing even faster, though from a smaller base. Between now and 2022, the EIA predicts that renewables will account for

the majority of new power; by 2040, its US market share could be 18 percent, up from 13 percent in 2013.

Globally, 2014 saw a record 95 gigawatts of new wind and solar, and the International Energy Agency (IEA) expects renewables to account for 25 percent of power generation in 2018, up from 20 percent in 2011. In 2014, nonhydro renewables accounted for almost half (48 percent) of net new power capacity. This was the third year in a row the figure was above 40 percent. Solar, in particular, is hitting its stride and has grown an average of almost 30 percent a year for the past decade.

Why haven't the much lower oil prices been kryptonite for renewables? And what does this mean for the future?

Trends and possibilities

There are four main reasons why the link between oil and renewables appears to be weakening.

They operate in different markets. Oil is predominantly used for transport—cars, trucks, planes. Very little of it is used for power; oil accounts for less than 1 percent of power generation in the United States and Canada, for example, and not much more in Europe. Globally, the figure is around 5 percent. Renewables, in contrast, are used mostly to create electricity. The more important factor for renewables, then, is not the price of oil, but the price of electricity, and the latter is not entirely a function of the cost of fuel. The electrical grid itself is expensive, which is why US power costs, which are relatively low in global terms (an average of 12 cents per kilowatt-hour), have been rising. In Europe and Japan, electricity costs are significantly higher, and the relative position of renewables is correspondingly better.

In some markets, oil is linked to the price of gas, which is a major player in power production (27 percent in the United States and 18.6 percent in Europe). In effect, gas becomes the floor price for power, and in most markets, most renewables are still more expensive. So it is certainly possible that cheap gas can drive out or at least slow the growth of renewables. But that need not be crippling. To the extent that gas displaces coal, that's good for the environment, because gas is cleaner when it comes to both greenhouse-gas emissions and air pollution. And this shift is already happening. In the United States, the use of coal for power generation has fallen from almost half in 2005 to 39 percent in 2014. That is a large part of the reason that greenhouse gas–related emissions in the United States actually fell over the same period.

And because energy investment is long term, changes in the spot price of gas will not in themselves derail investment in other sources. As long as renewables keep getting cheaper, there is room for both. Also, it bears remembering that wind and solar are inherently intermittent: the wind doesn't blow on demand, and the sun sets every day. Therefore, a backup source of power that can be switched on and off at will—as coal, gas, and nuclear can—is essential for the industry. In this sense, cheap gas can actually complement renewables.

The economics of renewables are improving. In 2011, when annual global investment in renewables peaked at $279 billion, 70 gigawatts were installed. In 2014, almost 40 percent more (95 gigawatts) was installed, though investment was slightly lower, at $270 billion. In that comparison lies the most important reason that renewables have held their own, and then some, even as the oil price fell so drastically. To put it simply, renewables are getting cheaper all the time. Moreover, most regulatory supports, such as portfolio standards, tax credits, and feed-in tariffs, remain in place. These do protect the sector to some degree, but the larger story is that of fast-increasing competitiveness.

In the United States, the National Renewable Energy Laboratory (NREL) estimated in 2014 that the cost of residential and commercial solar photovoltaic (PV) systems fell an average of 6 to 7 percent a year (depending on size) from 1998 to 2013, and by 12 to 15 percent from 2012 to 2013. Costs kept falling in the first half of 2014 and are expected to continue to do so for the foreseeable future.

In fact, when it comes to the price of solar, even the most optimistic estimates have not been optimistic enough. As NREL notes, today's price projections to 2020 are about half of what was being predicted a decade ago. The IEA, which has had a reputation of being cautious about renewables, now estimates that the "levelized" cost of solar PV (total lifetime costs divided by total output) is at or near parity in many markets. In the United States, McKinsey projects, solar will be competitive with conventional fuels in most states by 2020. As for wind, it is generally the cheapest nonhydro renewable; since 2009, its cost has fallen 58 percent, thanks to less expensive materials and greater efficiency. As a result, wind is either at or near to being competitive, on a cost-per-watt basis, without subsidy, in a number of markets.

Crucially, there is no reason to believe that the economics of renewables are going to deteriorate. Coal could get cleaner, but no one really expects a big change in its efficiency, and tighter regulation is driving up costs. For gas, the best technologies in use are already highly efficient. But for renewables, particularly solar, substantive improvements in cost and efficiency are not only possible but likely.

In production, for example, economies of scale can be expected to continue driving down costs. More significant savings are likely to come on the service side, known as "soft costs," such as permitting, licensing, and maintenance. In the United States, there is a wide variation in the cost of installation; if and when best practices spread, one would expect to see convergence at the lower end of the scale. And even the cheapest US states (Florida, Texas, and Maine) are considerably more expensive than Germany, which has driven down soft costs markedly. In 2013, it cost Californians $4.94 to install a watt of solar; the figure for Germany was $2.05. Cutting tariffs on foreign (meaning Chinese) modules would also lower costs. There is a lot of room for improvement, and this holds true for many global markets.

Counterintuitively, there is even a way in which much lower oil and gas prices can actually help renewables. Many countries have helped pay for the cost of fossil fuels through consumer subsidies; in 2012, the IEA estimated that these subsidies cost governments $544 billion. As all subsidies do, these policies led to higher consumption than if people had to pay the market price. When oil prices crashed, several countries in Africa, as well as Egypt, India, Indonesia, Ukraine, and others, took the opportunity to cut these subsidies. China raised gas taxes, which had the same effect of dampening demand. When oil and gas prices increase, as they have already begun to do, renewables will be in an improved relative position.

For governments and companies considering the long term, one way to think about it is that the cost of conventional fuels may go down. Or up. More likely, it will do both, as we have seen in 2014–15. Renewables, in contrast, are going in one direction only: down. That's an intriguing proposition with regard to creating a resilient energy portfolio.

The global dynamics of energy are changing. Because renewables have been relatively expensive, historically, most investment has come from developed countries; poorer ones felt they could not afford these energy sources. In addition, oil-rich countries, many of them in places well suited for solar, didn't bother either, because they could burn cheap oil. Both of those assumptions are swiftly changing.

In 2013, China for the first time invested more in renewable energy than Europe, according to the United Nations, and is now the global market leader. That year, new renewable capacity was greater than any other kind. In 2014, China installed 11 gigawatts of solar, and there are plans in the works for just as much this year. (China is also pouring money into cleaner coal—a form of clean tech that many greens disdain but that could be enormously beneficial.) Last year, China was the world's biggest single investor in renewables ($83.3 billion), almost 40 percent more than in 2013; the United States was second ($38.3 billion), and Japan third.

Then there is India. Prime Minister Narendra Modi wants to rely on solar in large part to bring power to the hundreds of millions of Indians who lack it. While the country's chief economic adviser, Arvind Subramanian, acknowledged that "for the foreseeable future, India will be reliant on coal," the country's ambitious goal is to install 170 gigawatts of clean energy by 2022. India's spending on clean energy rose 14 percent in 2014, to $7.4 billion. South Africa ($5.5 billion) is also getting serious about the sector, as are countries in Latin America. In 2012, Mexico's president Felipe Calderón stated a goal of getting 35 percent of electricity from low-carbon sources by 2024. According to a McKinsey analysis, even after taking a hit due to the financial crisis, the region's investments in solar have risen 54 percent a year since 2008; in biomass, by 11 percent; and in wind, by 24 percent. Brazil, Mexico, and Chile are leading the way. McKinsey estimates that of the 40 gigawatts of new power Brazil will add by 2040, at least 15 gigawatts will be renewable, mostly wind; for Mexico, the estimate for renewables is 16 gigawatts by 2020. As a whole, developing countries accounted for just a bit less than half ($131.3 billion) of global investment in clean energy in 2014, and this figure rose much faster (36 percent) than spending in the developed world (up 3 percent).

It's also worth noting that some countries in the Middle East are getting much more thoughtful about the possibilities of solar. A Saudi conglomerate recently purchased a major Spanish solar developer, Fotowatio Renewable Ventures, which has a pipeline of almost 4 gigawatts of capacity. Egypt wants to increase renewables to 20 percent of capacity by 2020 and is nearing approval of a $3.5 billion, 2-gigawatt solar project with Bahrain's Terra Sola. And Dubai's state utility signed a deal late last year with a Saudi solar company for what could be the cheapest solar in the world—less than six cents per kilowatt-hour. McKinsey estimates that even at prices of $35 to $45 per barrel of oil, solar PV pays for itself—and that frees up more oil for Saudi Arabia to sell.

Japan is also becoming a major player. In the wake of the Fukushima nuclear accident in 2011, the government has markedly increased its commitment to renewables. While nuclear accounted for 20 percent of power generation in 2009, it was down to just 1 percent in 2013, according to a McKinsey analysis. In 2011, the country introduced a "feed-in tariff"—essentially, a guaranteed, above-market price—to encourage renewable production. Solar-power installations soared. There have been problems associated with this effort, with utilities saying they cannot economically absorb the surge in capacity, but there seems little doubt that Japan will continue on this course. The country is now the third-largest investor in renewables, and McKinsey has found that the sector is now attractive enough that many non-power players are entering the field.

The science is improving. New solar technologies could allow solar cells to be rolled out via 3-D printer and applied almost anywhere. Japan is managing to make fuel cells work. Techniques to convert manure into methane are getting cheaper. Perhaps most important, storage is getting better and cheaper, and investment in the area is rising.

The biggest barrier to the widespread deployment of nonhydro renewables is that they cannot be stored for a rainy (or cloudy or windless) day. But there is good reason for optimism. The energy density of batteries—that is, how much can be stored by weight—has improved steadily over the past two decades, and the pace appears to be picking up, with the price of storage down 60 percent in the past decade, according to the *Economist*.[3] McKinsey estimates that the cost of producing lithium-ion batteries, now about $400 per kilowatt-hour, could go as low as $150 by 2020. IHS, an energy consultancy, estimates that storage installations will reach 40 gigawatts by 2017; and the market for energy storage could be as much as $70 billion over the next decade, according to Navigant Consulting.

With that kind of potential in play, many smart minds are working hard on this. Major companies in the United States, Europe, and Asia, for example, are pouring resources into storage technologies. In early May, Tesla Motors launched two lithium-ion automated battery systems, adapted from the technology used in its electric cars, which would allow even small businesses and homes to store and release energy on demand. With a base price of $3,000 to $3,500, these 220-pound batteries, known as the Powerwall, could be at work as soon as this summer. At this price, storage becomes economically feasible in a large percentage of buildings, depending on the regulatory environment and cost of power.

The European Union is testing a project in Ireland in which a motorized flywheel can harness surplus energy from the grid, store it in turbines, and then release it on demand. The US Department of Energy's famous innovation lab, the Advanced Research Projects Agency–Energy, is funding a dozen storage-related projects. It is not far-fetched to believe these efforts will discover a variety of cost-effective solutions. The demand for time-shifted energy storage, according to McKinsey, could grow ten times by 2050; that kind of potential attracts innovation. Getting there will require regulatory creativity; however, McKinsey analysts note that at the moment, there are price-signal distortions and a general lack of clarity about how to integrate stored power into the system.

The long game

The world is not running out of fossil fuels in the immediate term. There are enough known oil reserves for the next 53 years, and the rise of shale gas in the United States is an example of how innovation and technology can change the game. Coal is abundant.

So the case for renewables cannot be that they will keep the lights on as hydrocarbons thin out; this isn't even a medium-term concern. The better argument is that renewables are, by and large, cleaner than the alternatives, and they provide a welcome diversity to energy supply and therefore enhance national energy security. Even this would not be enough, however, if renewables were expensive and/or unreliable. But on both these dimensions, the sector is making great strides, and more can be expected.

That said, a sense of proportion is necessary. Trends do not necessarily continue, nor should every bit of good news be expanded, extrapolated, and hastened, as too often happens. Headlines that proclaim the death of the car as we know it or the end of Big Oil are premature. (Reality check: electric vehicles accounted for only 0.5 percent of vehicle sales in 2014; conventional cars and hybrids the other 99.95 percent.) And it's worth remembering that the share of fossil fuels in primary-energy consumption, a category that includes transport, didn't budge a fraction between 2005 and 2013, sticking at 87 percent.

Big, complicated change is not easy, particularly when it comes to something as fundamental as energy. For developed countries, incorporating renewables

into existing electrical systems is proving very difficult indeed. For example, former US energy secretary Steven Chu notes that most of Germany's wind power is in the north; to get it to industry in the south means building transmission capacity—and that runs into "not in my backyard" politics. American utilities are fighting policies that force them to buy off-grid power at retail rates. Emerging markets without an extensive power infrastructure in place will be able to skip these problems but will have to deal with issues of access, finance, stability of supply, and the rising expectations of their citizens.

In short, a world powered by renewables is not around the corner. This will be a long-term transition—a matter of decades, not years. But the resiliency of the sector in the face of much lower oil and gas prices is a sign that it may just be on its way. ■

[1] Pilita Clark, "The big drop: Cheap oil burns green energy," *Financial Times*, December 17, 2014, ft.com.

[2] The term capacity refers to maximum output. Because of lower efficiency, however, a gigawatt of installed capacity of solar or wind produces considerably less power than that of coal, combined-cycle gas plants, nuclear, biomass, or geothermal. One gigawatt of electricity is enough to power about 700,000 American homes.

[3] "Not a toy," *Economist*, April 11, 2015, economist.com.

Scott Nyquist, a director in McKinsey's Houston office, is a leader of both the Sustainability and Resource Productivity Center and the Oil and Gas Practice.

Copyright © 2015 McKinsey & Company.
All rights reserved.

© winhorse/Getty images

Solar power comes of age

How harnessing the sun got cheap and practical.

Dickon Pinner and Matt Rogers

Solar power has been declared a winner before, only to flounder. It's easy to remain skeptical today, given that solar power accounts for less than one percent of the global energy supply. But it is also expanding faster than any other power source, with an average growth rate of 50 percent a year for the past six years. Annual installations of photovoltaic panels increased from a capacity of less than 0.3 gigawatts in 2000 to 45 gigawatts in 2014—enough to power more than 7.4 million American homes. This time really is different: solar power is ready to compete on its own terms.

The momentum behind solar power is a result of innovations in regulation, industry, technology, and financing. In a number of markets, it no longer needs public subsidies to compete on price with conventional power sources, such as coal, natural gas, and nuclear power. The International Energy Agency, which has historically taken a conservative approach to evaluating solar power's prospects, has projected that by 2050, in the best-case scenario, solar energy could be the single biggest source of power, generating as much as 27 percent of electricity worldwide.

If that happens, the consequences will be profound. Electricity will reach places that have never known what it means to get light or heat on demand. The price of electricity could fall, and utilities will have to figure out how to adapt. But the environmental gains, in terms of lower emissions of particulates, sulphur, and greenhouse gases, would be profound.

The power of policy

Four factors lie behind the rise of solar power. The first is regulatory support. Around the world, governments have enacted a range of prosolar policies, including requirements that utilities generate a given fraction of their electricity from solar power, feed-in tariffs (a guaranteed price per kilowatt of solar power), and subsidies to manufacturers of solar

panels and the households that buy them. Policy makers have supported solar power for a number of reasons, including a desire to reduce emissions, diversify their countries' energy supplies, and create jobs. Perhaps most important, they recognized the long-term potential of solar power and wanted to foster a market for it.

Germany, a country with aggressive renewable-energy policies, added 35 gigawatts of solar-panel power in the last ten years, driving the majority of global demand for much of that time. In the United States, a set of mandates requiring utilities to produce a certain amount of electricity from renewable sources and a federal tax credit that allows taxpayers to write off 30 percent of the cost of installing solar power systems have helped the power source take off. From 2000 to 2013, solar-panel capacity in the country increased from 18 megawatts to more than 12,000 megawatts—enough to power almost two million homes.

Not surprisingly, regulatory support has not always been economically efficient, but it has been effective in creating enough demand for a large solar-panel industry to take shape and learn how to compete. Even as the industry has endured painful shakeouts—in the middle years of the last decade, in particular, dozens of solar-panel manufacturing companies went bankrupt—installations have continued to soar, and the industry has become much more competitive. Almost all solar installations in California, for example, took state subsidies in 2007. By the end of 2013, less than 40 percent did. Federal subsidies are still available, of course.

The second factor is industrialization, chiefly in China. Beginning around 2005, manufacturers there entered the solar-panel market to chase growing global demand, and they now account for nearly two-thirds of global production of solar panels. Chinese competition squeezed profit margins and drove many suppliers out of business, but it also led to improved production processes and new economies of scale, cutting costs substantially.

The last decade has seen technological innovations in manufacturing, low interest rates, leaner supply chains, and improved economies of scale; the price of polysilicon, the raw material used to make solar panels, fell by 90 percent over this period. The net result is that the cost of solar panels has fallen by 80 percent since 2005. Prices are still falling, by 5 to 12 percent in the first half of 2014, and there is room for them to fall further. So-called soft costs—meaning the cost of everything but the equipment, such as permits, installation, and maintenance—account for almost two-thirds of the total price tag for US residential solar systems. Soft costs are about one-third of the price tag in Germany, where, among other factors, national standards have simplified installation and streamlined the permitting process.

The third factor behind the rise of solar power is technological innovation. Slowly but steadily, solar panels have become more efficient. Efficiency rates have peaked at about 20 percent—meaning that a panel is able to generate two watts of electricity for every ten watts of sunlight hitting it—but that figure could grow as the industry experiments with a number of new techniques and materials. If it does, the savings could be significant: every percentage-point increase in efficiency can translate into a 5 percent cost reduction on the entire system. There is also room for greater efficiency after the electricity is generated, when power is lost as direct current (produced from the panels) is converted to alternating current (required for distribution by the electrical grid).

The fourth and final factor involves financing. Setting up a solar system entails high up-front costs. It takes about $15,000 to $20,000 to install rooftop panels on a typical house, and even though the investment can pay off over time, many house-

holds and businesses are wary of spending so much cash at once. New financing models are addressing this problem. Under third-party ownership systems, homeowners sign contracts with companies that install and maintain the solar panels. In return, consumers pay either a set monthly rate or a fixed price per unit of power—paying no cash out of pocket but still getting lower electricity bills. In 2012 and 2013, more than two-thirds of the installations in California used this financing approach, one reason the state is leading the country when it comes to solar power.

More for the money

Given these trends, it is not a stretch to assume that in many markets, the costs of solar power will continue to decline by 8 to 12 percent a year. First Solar, an Arizona-based manufacturer, expects its solar-module production costs to fall from 63 cents per watt in 2014 to about 40 cents per watt in 2017. Utilities that rely on coal and natural gas—commodities whose prices are subject to market swings—could never be so confident of continuous year-on-year reductions.

The development of technologies to store electricity—in particular, batteries—will also help solar power's development. Without storage, solar power can be harnessed only when the sun is shining; with storage, it can be used when power costs are highest. The costs of battery storage have declined by about 70 percent over the last five years, and already companies such as SolarCity are packaging solar panels with batteries. The price could fall by another 70 percent in the next decade as the technology and manufacturing methods improve, thanks in part to battery research conducted by consumer-electronics companies such as Panasonic and electric-vehicle companies such as Tesla.

It's not safe to bank on great leaps forward in efficiency and storage. But even without such advances, solar power is making inroads into major markets. In the United States, rooftop solar panels are already competitive in places with lots of sun and high power prices, such as Hawaii and parts of California. As the cost of solar power continues to fall, it could make economic sense for consumers in a dozen US states by 2020 and for specific customer segments—such as those with high electricity consumption and well-positioned rooftops—in more than 25 states by 2030, even without government subsidies. In much of Australia and Central and Southern Europe, solar power is coming close to reaching an economic tipping point. And China, where many cities are so dirty that snow turns gray by the time it hits the ground, is pushing hard, with a goal of installing 70 gigawatts of solar power by 2017.

In parts of the Middle East, solar power is competing against oil-fired electricity generation. Solar power now accounts for less than 100 megawatts of capacity in sunny Saudi Arabia, chiefly because oil-powered generation is so cheap, with providers paying only a little more than the cost of production per barrel (about $5). As Saudi Arabia and—to a lesser extent—other regional oil producers turn away from burning oil domestically in order to sell it for higher prices on the international markets, the case for solar power will get stronger. Heeding that logic, the Saudi government has unveiled plans for 2 gigawatts of solar power by 2015 and 41 gigawatts by 2032. And the Dubai Electricity and Water Authority agreed in 2014 to purchase solar power for less than 6 cents per kilowatt-hour.

Japan is not as sunny, but it is also betting big on solar power as it seeks alternatives to the nuclear plants it closed in the wake of the 2011 Fukushima disaster. It has established generous feed-in tariffs for solar power and other alternative sources. Japan installed more than 8 gigawatts of solar power in 2014 and has set an overall goal of having renewables account for 20 percent of its power by 2030, about double

the figure before the disaster. There is also room for more solar power in Asian countries, such as China and South Korea, that rely heavily on liquefied natural gas, the price of which is linked to oil and can therefore swing up and down.

In places that are not yet electrified, such as much of South Asia and Africa, solar power is usually cheaper and easier to access than conventional energy sources. In India, where about 100,000 villages lack access to electricity, solar power is already less expensive than the likely alternatives, such as coal or diesel, and often more reliable. Solar power also eliminates the need to wait for transmission lines to reach a town. India's new prime minister, Narendra Modi, appears to see the benefits, announcing in January the ambitious goal of building 100 gigawatts of solar power by 2022, which could make India the largest solar-power producer in the world. For villages that aren't connected to the electrical grid, the combination of solar panels, efficient lighting, cellphone plugs, and electric water pumps could improve the quality of hundreds of millions of lives.

The coming disruption

As the rates for solar power begin to match the rates for traditional energy sources in more markets, the capacity of solar power installed each year could increase from about 45 gigawatts today to more than 200 gigawatts by 2025. That would fundamentally disrupt the electric-power sector.

In Europe, the proliferation of solar panels, wind turbines, and other renewable sources is changing the composition of the electricity sector. The market share of renewables there rose from 6 percent of the total in 2006 to 12 percent by the end of 2013, and it has risen much more in some countries. That significant new supply, combined with low growth in demand (or even shrinkage) due to efficiency gains and slow economic growth, has helped push down the wholesale price of power. The price that consumers pay is still high, however, due to the cost of infrastructure plus various taxes. European consumers pay an average of roughly 26 cents per kilowatt-hour, compared with the 12 cents Americans pay.

High prices in Europe have made it easier for renewables to compete, as have requirements that utilities give priority to renewable power on the grid. But European utilities are suffering in part because of this growth in renewables. From a peak of $1.3 trillion in 2008 to the end of 2013, their market value declined by half. In 2014, Germany's biggest utility, E.ON, announced a radical move: in order to focus on renewable power, it will spin off its nuclear and fossil-fuel power plants into a separate company. Japan's utilities, too, have found themselves unprepared for the solar surge and are threatening to hold back on access to the grid.

Utilities in parts of the United States are beginning to face similar problems. Traditionally, US utilities stayed profitable by capturing all new demand for electricity, but solar power is threatening that reliable revenue stream. In the first half of 2014, solar power accounted for a quarter of new capacity, and a house equipped with solar panels doesn't buy as much power from the grid. The resulting drop in demand is shrinking the amount of new capital that utilities can invest, meaning that even if solar power continues to generate a relatively small fraction of electricity in the United States, it could have an outsize effect on the industry's future. In a 2014 survey by the consulting company Accenture, 61 percent of utility executives said that they expected to see noticeable revenue losses as a result of the spread of distributed power sources, including solar power.

Solar power could shake up other sectors, too. In the housing industry, for example, the spread of rooftop solar panels could transform construction and design practices. In manufacturing, factories could relocate to areas with favorable conditions for low-cost solar power. In agriculture, hot countries that lack fresh water could harness solar power for desalinating and pumping water, enabling farmers to work previously infertile land. History suggests that when a commodity gets cheaper, it gets used in new, unforeseen ways.

Risks and resiliency

Amid all the optimism, it's worth considering what might set back solar power. One possibility is that governments might dismantle or weaken their supportive policies. That could hurt, as it did when Spain cut subsidies in the wake of the financial crisis and when Germany lowered its feed-in tariffs. In both markets, the adoption of solar power slowed down, but the industry as a whole kept rolling. Indeed, the solar industry has proved resilient, coming back leaner and stronger from its painful shakeout a decade ago.

The biggest risk in many markets is not that government support will go away but that long-standing regulatory issues will fester. In the United States, for example, utilities are concerned that solar consumers get a nearly free ride, since they rely on the grid on cloudy days and when the sun goes down yet no longer cover the grid's fixed costs. And in some states, when consumers sell electricity back to the grid, they get paid the retail rate for it rather than the lower wholesale rate, a practice known as net metering.

In response, some utilities want to charge households with rooftop panels for access to the grid, imposing fees known as demand or capacity charges. That would change the economics of solar power substantially, depending on how high the fees went. Some utilities in the United States would like to recover the full fixed costs of distribution from solar customers and also end net metering. Regulators may not go that far, however. In 2013, for example, Arizona allowed its largest utility to impose a fixed charge on households with solar power, but the fee was much lower than what it wanted, and the state preserved net metering.

How and when the debate over recovering fixed costs is resolved in country after country will be one of the most important factors determining how fast solar power will scale up and how much of it will be centralized (in the form of large, faraway solar plants) and how much decentralized (on rooftops). Both sides could take their cues from the telecommunications industry. When the monopoly in that industry was broken up in the United States in the 1980s, new market entrants were guaranteed access to the existing infrastructure but had to pay reasonable fees that compensated existing providers for their services, while also leaving room for new competition. And it is worth remembering that an unprofitable utility sector benefits no one; a reliable grid is a national necessity. As SolarCity's CEO, Lyndon Rive, told the *Financial Times*, "It is important that there is a grid."

Compared with the regulatory dispute, other challenges look easy to deal with. One possible risk is the inevitability of higher interest rates (interest rates have nowhere to go but up), which would raise the costs of financing solar power. But there is strong demand among institutional investors for "yield cos"—publicly traded companies that package the cash flow from renewable energy. These low-risk investments should help moderate financing costs. Besides, higher interest rates would also affect other capital-intensive alternatives for generating power.

Another risk is that lower-cost power sources, such as natural gas from shale deposits, could undercut

the economics of solar power. In the short term, that may happen. In the long term, however, natural gas is more friend than foe to solar power. Natural gas tends to be a cheap and reliable source of flexible power that can complement solar-generated electricity by providing 24-hour backup. This reduces the costs of integrating solar power into the grid. Indeed, solar power is going strong in the place with the world's lowest natural-gas prices: North America.

A third possible risk is that nuclear fusion or some other breakthrough will finally take hold. Perhaps, but that is a hypothetical. Better to bet on a proven technology that is seeing its sales booming and its costs falling.

Here comes the sun

Coal, natural gas, and nuclear power, which today supply two-thirds or more of global power, are not about to disappear. But even at its currently low rates of market penetration, solar power has begun to shift the economics of electricity. This is the dawn of the solar age.

If that sounds overly optimistic, consider another technology that went from curiosity to commonplace in a matter of decades: the automobile. When the first car hit the American street in the 1890s, skeptics sneered that the "horseless carriage" had no future. In 1900, there was only one car for every 10,000 Americans. In 1908, however, the Model T hit the market, making cars more affordable for many more people. By 1920, there were almost 900 cars per every 10,000 Americans. The global solar industry is at an analogous stage to where the auto industry was in 1920. Just as it was not yet the norm for Americans to have a car in 1920, it was becoming normal. And norms can change quickly. Between 1920 and 1930, the rate of car ownership shot up to 2,170 cars per every 10,000 Americans. The United States was now a car country.

The next ten years could see something similar with solar power, but on a global scale. It would not be at all surprising, for example, if most new housing developments, particularly in the sunnier parts of Europe and the United States, came with solar power, or if most of those 100,000 Indian villages without power were lit up at night thanks to solar energy. Even without a great leap forward in efficiency and batteries, and even with halting and sometimes contradictory government policies, the momentum behind solar power has become unstoppable. ■

[1] The term capacity refers to maximum output. Because of lower efficiency, however, a gigawatt of installed capacity of solar or wind produces considerably less power than that of coal, combined-cycle gas plants, nuclear, biomass, or geothermal. One gigawatt of electricity is enough to power about 700,000 American homes.

Dickon Pinner and **Matt Rogers** are directors in McKinsey's San Francisco office. Reprinted by permission of *Foreign Affairs* (March/April 2015).

Copyright © 2015 by the Council on Foreign Relations, foreignaffairs.com.

© Jevtic/Getty Images

From liability to opportunity: How to build food security and nourish growth

How can public institutions, development agencies, investors, researchers, and producers work together to build a food sector that propels economic growth, meets demand, and helps to maintain social stability?

Nicolas Denis, David Fiocco, and Jeremy Oppenheim

By 2050, the world will need to feed more than nine billion people, requiring nearly 70 percent more food than we consume today.[1] Moreover, an expanding global middle class will demand more meat and other protein-rich foods, while extreme weather could slash yields in important agricultural regions. At the same time, prices of wheat, rice, and a number of other basic food commodities have been rising for a decade (Exhibit 1). Volatile food prices have repeatedly led to instability—and as the exhibit shows, the volatility continues to increase.

One issue is that many countries devote resources they cannot afford to short-term approaches, such as subsidies, food and cash transfers, and emergency-relief plans. In such cases, food systems come to be seen as fiscal burdens. Reducing these in favor of strategic investments in the food and agriculture sector could turn such liabilities into sources of economic opportunity.

This is not theory. Some places are perpetually in crisis. Other countries and regions have launched effective transformations that improve food security and resilience and enhance economic opportunity. In countries large and small, rich and poor, wet and arid, a resilient food economy—defined as one that can adapt to change and cope with negative shocks—stands on four building blocks:

- efficient agricultural production that takes advantage of innovative technologies and practices

• tailored trade and investment approaches

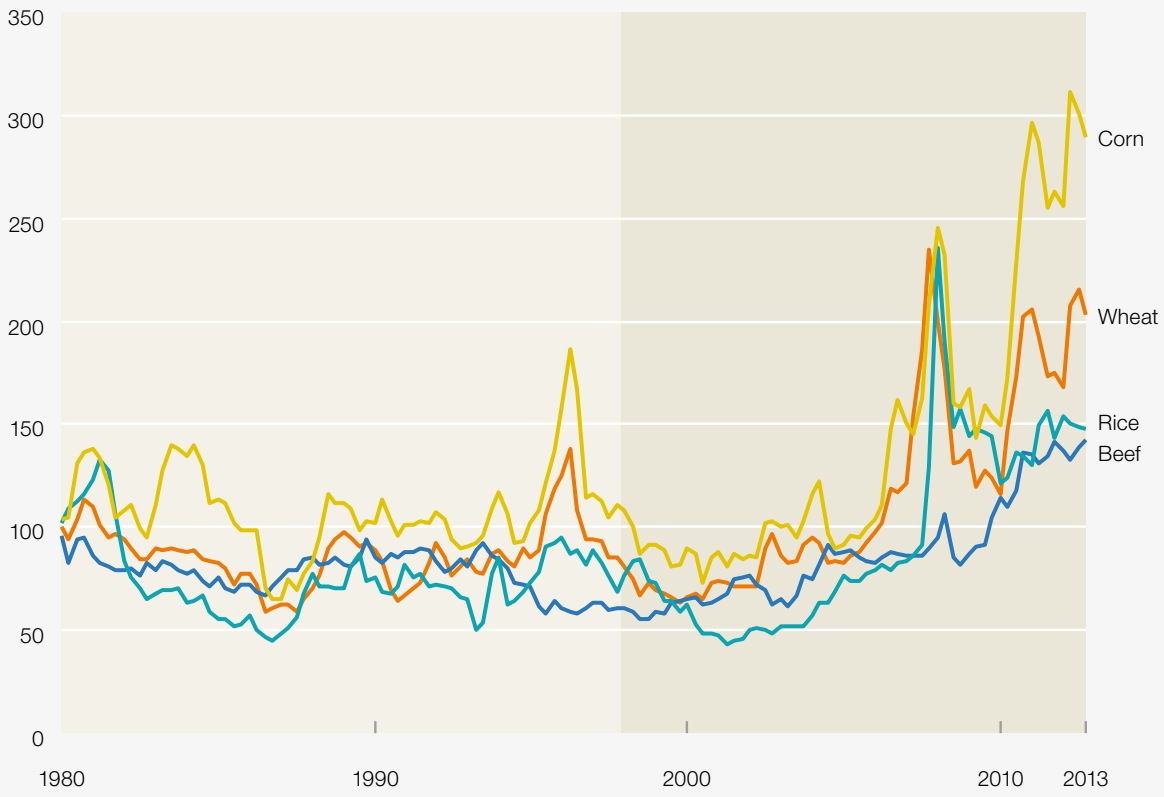
• well-functioning domestic markets

• strategic reserves of food and water

We have reviewed hundreds of indicators to assess a country's overall food availability, affordability, and quality. Our findings underscore the progress that has been made, as well as the enormous potential to do better. For example, the dozen most productive countries deliver corn yields that are ten times that of the dozen least productive ones. Despite advances in seeds, irrigation, crop protection, and other techniques in more than 20 countries, at least a quarter of the population is chronically undernourished. Countries in sub-Saharan Africa have more than four times the global average of arable land, but because of low productivity, some of them have to use their limited foreign reserves to import a high percentage of food requirements. According to the Economist Intelligence Unit, 28 of 109 countries surveyed had insufficient food stocks to withstand a crisis.

Exhibit 1 **The prices of major food commodities are increasingly volatile.**

Food commodities indexes,
nominal price index, 100 = January 1980



Source: International Monetary Fund; UN Comtrade; UN Conference on Trade and Development; World Bank Group; McKinsey Global Institute analysis

What is required is an "integrated food economy approach": a cohesive strategy that strengthens the entire food system. This is a complicated topic, and there is no single right answer to define a nation's ideal food system, but our findings show that many countries do not yet think holistically. Our goal is to present a structured way of thinking about sustainable food systems, including innovative ways to balance scarce natural and financial resources. Certainly some of the innovations will turn out more successful than others, but our main point is that it is worth thinking hard about the food system's design. Every country can move toward a well-functioning food economy if the public and private sectors work together to plan and invest for the long term.

Efficient agricultural production that takes advantage of innovative technologies and practices

A forward-looking national agriculture strategy discourages the production of crops not well suited to the local environment and rather promotes a production strategy that builds on a country's comparative advantages. Countries have a variety of tools at their disposal with which to guide production choices, ranging from producer and consumer subsidies to national agriculture extension services and research (see sidebar "Enabling success: Research and development"). (We acknowledge that cash subsidies are controversial. While they can help a country's producers enter global markets, they too often last beyond initial adjustment periods and are used to maintain irrational production systems that suit short-term political or social objectives.)

The most effective agricultural policies facilitate end-to-end value-chain development, from promoting the right inputs to encouraging creative business models to enabling low-interest financing and risk sharing. For example, Morocco's national agricultural strategy, Plan Maroc Vert, aims to substantially increase the added value of agricultural production

Enabling success: Research and development

Public and private investment in research and development can raise farm yields while creating jobs, expanding GDP, and increasing food security.

More than half of Israel's land area is desert, and agricultural workers make up only 2 percent of the workforce. But Israel has succeeded in producing most of its own food by applying decades of agricultural R&D. It has developed potatoes that can grow in salty soil, improved greenhouse and drip-irrigation techniques, and even genetically modified insects for organic pest control.

The Netherlands, a country of fewer than 17 million people, is one of the world's largest processors of food products. Its universities and research organizations are leaders in related R&D; the public and private sectors continually invest in the renewal of agricultural-production chains.

Israel and the Netherlands are well off, but their successes can still offer lessons to less advanced economies. There are also compelling examples from emerging markets. Brazil invested in soil-conservation technology to turn nonarable grasslands into some of the world's most productive soy-export zones. Kenya has established outposts of leading agricultural-research institutes; these have bred seed varieties tailored to dry-land climates.

by 2020 while mitigating and adapting to climate change and creating more revenue for rural populations. The country is investing in agricultural productivity while improving water-resource management and reducing fossil-fuel consumption in the agricultural sector.[2] Investment in the sector doubled in the last five years, with more than 1,500 specific projects. An important feature is the decision to target crops that are internationally competitive, such as citrus fruits, olives, vegetables, and fish.

Tailored trade and investment approaches

A well-planned international trade and investment strategy can help hedge against volatility and food shortages while spurring economic growth. One place to start is with the basics—getting goods into and out of the country. In 34 countries, it takes more than a month to clear customs and port inspections just to export food, according to McKinsey research. Creating trading and processing hubs can help a country gain access to food supplies even if it has limited production or resources of its own. The United Arab Emirates has created a regional trading hub to diversify supply; it has also reached processing and distribution agreements with distant places such as East Africa and Russia. Meanwhile, it is expanding the cargo capacity of the Dubai airport, regulating retail fresh-food storage to reduce waste, and aiming to meet 40 percent of its own needs for low-water vegetables.

In countries where the government or sovereign-wealth funds direct investment, strategic deals with governments or trading houses can help mitigate risk and improve GDP. For example, Saudi Arabia has invested more than $10 billion in agricultural and livestock projects overseas, including in Argentina, Brazil, Canada, Sudan, and Ukraine. In economies where most investment is private, trade policies can help stimulate deals to close gaps in local production capacity.

Singapore, a dense city-state with a tiny agricultural base, has pursued two strategies to mitigate the risk of supply disruptions and strengthen its food economy. First, it has provided local producers with incentives to explore new technologies to increase production of eggs, leafy vegetables, and fish.[3] Second, it is using its role in international trade and its strategic location to diversify its food sources. Singapore imports less of its fruit from Malaysia, for example, and gets more from Australia, China, and the United States.[4]

Singapore has also become an important hub for importing and processing food products, to which it then adds value and exports. As a result, Singapore is now a leading exporter of some processed foods, while its large warehouses implicitly act as an emergency backup in time of crisis, improving the overall resilience of the food economy.

Well-functioning domestic markets

Efficient domestic markets matter because the route from farm to table is long, complex, and subject to disruption. A single bottleneck can lead to losses for producers and shortages for consumers.

On the other hand, cooperation can produce dramatic advances. For example, after a successful launch in Mozambique in 2011, the international brewer SABMiller extended the production of its popular cassava-based beer to Ghana in 2013. SABMiller sources raw cassava from smallholders; these often lack adequate storage, so crops must be sold immediately and at low value. To overcome this challenge, SABMiller relies on a mobile-processing unit developed by a Dutch social enterprise. By moving processing nearer to the farm, less cassava is wasted, and farmers are able to capture more value. Granted, beer is not an essential, but this example shows that it is possible to solve the processing and perishability problem that affects many critical foodstuffs.

India is using information communication technology to improve value-chain efficiency. The e-Choupal initiative grants four million farmers in 40,000 villages real-time access to market prices, weather conditions, and production techniques through Internet kiosks. These kiosks also act as aggregators through which farmers can buy inputs and sell produce. By connecting buyers and sellers, costs are cut throughout the value chain.[5]

In Ghana, traders are using bar codes and geographic-information-system technologies to monitor pineapples as they work their way through the supply chain from farm to port. This has enabled them to move the crop through the port more rapidly, reduce spoilage, and meet GlobalG.A.P. certification standards.

This kind of innovation has not yet extended to one of the world's biggest sources of food inefficiency—food waste. The UN's Food and Agriculture Organization estimates that the world wastes 1.3 gigatons of edible food every year, or more than a fifth of total agricultural output.[6] Governments can help reduce this waste by investing in infrastructure, adopting best-practice food regulations, and focusing on changes in consumer behavior. It is also important to note that, in many cases, a well-functioning market is not sufficient to ensure that all residents find available, affordable quality food. Even in wealthy countries with high-performing food systems, a portion of the population may be unable to access sufficient food. Inequality is growing in many countries, with market forces leading to unaffordable food for the most vulnerable populations. In the short term, governments may need to intervene directly through input subsidies (for agricultural families) or cash subsidies to rapidly address overall affordability. In the long term, a competitive, efficient food system should lower overall costs for everyone. However, there will always be especially vulnerable members of society who will struggle to grow or buy sufficient food; an important component of a government's obligation to ensure overall food security and resilience is to provide adequate assistance.

Strategic reserves of food and water

Catastrophic events—for instance, civil wars, currency collapses, or extreme weather—reveal the fragility of our global food network. Rich or poor, countries need a backup plan when primary food production or trade routes are disrupted. These stocks can be provided through a combination of public-sector projects, such as strategic grain reserves, and regulation, such as requirements that food distributors or supermarkets maintain stocks at certain levels. A country's plan will hinge on a number of factors: its dependence on international trade flows, its ability to purchase food on the global market, and the capacity of its domestic agricultural sector.

For example, China has a strategic food-reserve system to cope with supply and market disruptions and to keep inflation in check. A national administration manages reserves of rice, wheat, soybeans, maize, vegetable oil, and meat in 31 provinces. Provincial and city governments hold their own reserves.

In the United Arab Emirates, the government has constructed public facilities to store 12 weeks of wheat, rice, and powdered milk. In addition, private retailers are required to stock two to four weeks of perishable reserves, including poultry and fresh vegetables. These supplies ensure availability during short disruptions.

A word of caution: poorly managed storage of food reserves can lead to massive food waste, and poorly timed or unpredictable usage of food reserves can skew prices. To avoid doing more harm than good, food reserves should be managed in a transparent, rule-based manner that does not crowd out the private sector or sow distrust among producers and traders.

Building an integrated food economy strategy

We believe that every country can and should build a sturdy, integrated domestic food system that delivers both nutrition and economic growth. Doing so requires countries to strengthen each of the four building blocks.

The transition can begin with a quantitative, comprehensive assessment of a country's position. In our work with countries, we generally begin by combining analytical benchmarking with a systematic diagnostic and conversations with national leadership to understand the complex issues of a national food system. (See sidebar "A rapid diagnostic: Lessons from Mexico.") In Exhibit 2, we profile four countries that have done this well. Each is taking different steps, but all are moving in the same direction.

In each case, the lesson is the same: success requires taking a broad approach while also making targeted investments. It also calls for collaboration across ministries and between the public and private sectors. It requires considering the well-being of residents of all income levels—not solving for national averages. We know that this is not easy. One approach to consider is to establish a leadership unit—whether by creating a new government agency or working within an existing one—to coordinate the transformation. This agency's task is to keep an eye on the big picture; it recommends adjustments to policies,

Exhibit 2 **Four countries show different ways to improve food economies.**

Netherlands: high income, resource scarce

Used a 2-pronged strategy to transform scarce resources into a leading industry

- Grew high-value crops: developed >10,000 hectares of high-tech greenhouses
- Focused on value addition and trade: 12 of the 40 largest food producers have major hubs in the country, and the Netherlands now boasts €79 billion in agricultural exports, the 2nd-highest total value in the world

Malawi: low income, resource abundant

Sought to move the fertile country from relying on subsistence agriculture to using food as an engine for growth

- Large national input-subsidy program allowed even small, poor farmers to grow food efficiently
- Government and aid programs focused on market and trade reforms to capture sustainable growth in agriculture

Brazil: upper middle income, resource abundant

Invested in untapped resources to become a leading commodity producer

- The Embrapa program transformed unused land through research and investment, helping to more than double exports between 1982 and 1997
- The country is now focusing on roads, trains, storage, and processing to facilitate trade and increase competitiveness

Ethiopia: low income, resource scarce

Nearly halved extreme poverty by building resiliency in a drought-prone environment

- Improved yield in a difficult environment by investing in small farmers—with irrigation, power, agricultural research, and high-quality inputs (such as fertilizers and seeds)—and through local farmer-training networks
- Built roads and grain storage to ease food crises and undertook extensive nutrition outreach to reduce malnutrition

Source: McKinsey analysis

A rapid diagnostic: Lessons from Mexico

The success of a country's overall food economy is contingent on collaboration among public-, private-, and social-sector stakeholders, following a road map that reflects the current situation and prioritizes interventions. An important ingredient is a diagnostic to rapidly understand performance across all four building blocks and set collective priorities for improvement.

Mexico's efforts provide an excellent illustration of what's possible; there, the government, more than 60 private-sector companies, numerous foundations, and research institutions have committed to improving the nation's food economy. A clear and evolving set of priorities guide joint efforts.

Mexico enjoys significant financial resources and abundant, high-quality land, but a diagnostic revealed big challenges:

- Limited affordability. Food accounts for nearly 30 percent of the average consumer-spending basket (compared with 7 percent in Switzerland and 20 percent in Brazil). Uneven production yields, low average value added in domestic food production, and a high dependence on imports partly account for the differences.
- Food is available, but nutritional quality is low. Mexico has the world's highest obesity rate (32.8 percent), caused in part by an average diet that is 45 percent starch, despite the availability of nutrition plans and guidelines.
- The country is vulnerable to emergencies and shocks. Food, already costly, faces 7 percent annual inflation; the country has limited public or private storage reserves; and more than 70 percent of the population is susceptible to extreme weather events, creating a potentially volatile situation.

The diagnostic suggested several interventions for Mexico, many of which are under way as part of a road map to improve food security and economic growth:

- Transform local agricultural productivity. Reducing import dependence and lowering food costs rests in part on closing the gap in productivity between northern and southern Mexico (with as much as an eightfold difference in yields). The country recently launched MasAgro—a ten-year, $138 million collaboration among Mexico's ministry of agriculture, the International Maize and Wheat Improvement Center, donors, and the private sector.
- Create more value from local food production. Mexico's VIDA program (spawned from the World Economic Forum's New Vision for Agriculture) is bringing together more than 60 companies and the government to mobilize more than $740 million in new investment and engage more than 600,000 farmers by 2018—adding to local economies and building a food system more resilient to food inflation and shocks.
- Encourage healthier eating. Efforts include public and private marketing campaigns.

Mexico's food economy is pioneering collaborations among the government, local and international companies, academics, and donors, with careful investments to maximize food security, health and wellness, and economic growth. A rapid diagnostic can help other countries launch similar initiatives by quickly assessing the root causes of food-economy challenges and building consensus to launch joint interventions.

tariffs, and regulations and comes up with ideas to close gaps or build on specific strengths.

To be successful, the agency needs high-level sponsorship, preferably from the president or prime minister. That gives it the political muscle to suggest difficult measures such as altering subsidies or land-use regulations. On a less contentious level, this unit can help to scale up extension services, accelerate licensing and technology approvals, and expand access to financing. One notable example is Ethiopia's Agricultural Transformation Agency, founded by Prime Minister Meles Zenawi in 2010. It put together a plan to raise the productivity of smallholder farmers and pastoralists, strengthen market systems, engage the private sector, expand irrigation, and reduce the number of chronically food-insecure households. Now the agency works with more than 120 public- and private-sector partners, as well as 50,000 public-sector extension workers. Many crops (especially wheat and teff) have seen double-digit yield growth rates.[7]

While governments have an essential role, building a strong food economy is not a massive public-works project. Success requires partnerships across society.

GrowAfrica, for example, builds on public–private partnerships led by the World Economic Forum's New Vision for Agriculture initiative to spur private-sector investment, expand knowledge, and share best practices. The program supports country-level initiatives by mobilizing governments, companies, donor agencies, and farmer organizations to provide technical assistance, financing, best practices, and monitoring and assessment. By the end of 2013, GrowAfrica had helped secure more than $7 billion in private-sector commitments for agricultural investments across ten African countries. These commitments have come from more than 120 companies, which in 2013 alone invested $976 million, reaching nearly three million smallholders through new services, sourcing, contracts, or training and creating 35,000 new jobs.[8]

Safe, affordable food is a necessity. That this does not exist for 800 million people is a tragedy. But it is possible to do better. By rejecting orthodoxies and accepting the value of an integrated, evidence-driven approach, every country can build a food economy that will nourish its future.

1 *Global agriculture towards 2050*, UN Food and Agriculture Organization, 2009, fao.org.
2 "Morocco takes the long view on green growth," World Bank Group, January 2014, worldbank.org.
3 *New Mandala*, "Singapore's food security strategy," blog entry by Guanie Lim, February 7, 2013, asiapacific.anu.edu.au.
4 Ibid.
5 "e-Choupal," ITC, itcportal.com.
6 *Food wastage footprint: Impacts on natural resources—Summary report*, Food and Agriculture Organization of the United Nations, 2013, fao.org.
7 *2013/2014 Annual Report: Transforming Agriculture in Ethiopia*, Ethiopian Agricultural Transformation Agency, 2014, ata.gov.et.
8 *Agricultural partnerships take root across Africa*, GrowAfrica Secretariat, May 2014, weforum.org.

The authors wish to thank the following colleagues for their contributions to this article: Marco Albani, Shane Bryan, Anja Bühner-Blaschke, Lutz Goedde, Alain Goubau, Kartik Jayaram, Jamie Patrick, Vilas Rao, Sunil Sanghvi, Roberto Uchoa de Paula, Viroopa Volla, and Maurits Waardenburg.

Nicolas Denis is a principal in McKinsey's Brussels office, **David Fiocco** is an associate principal in the Minneapolis office, and **Jeremy Oppenheim** is a director in the London office.

Copyright © 2015 McKinsey & Company.
All rights reserved.

© Francesco Ricca Iacomino/Getty images

Rethinking the water cycle

How moving to a circular economy can preserve our most vital resource.

Martin Stuchtey

Three billion people will join the global consumer class over the next two decades, accelerating the degradation of natural resources and escalating competition for them. Nowhere is this growing imbalance playing out more acutely than the water sector. Already, scarcity is so pronounced that we cannot reach many of our desired economic, social, and environmental goals. If we continue business as usual, global demand for water will exceed viable resources by 40 percent by 2030.

Many experts have claimed that wasteful treatment of water results from dysfunctional political or economic systems and ill-defined markets. But the real issue is that water has been pushed into a linear model in which it becomes successively more polluted as it travels through the system, rendering future use impossible. This practice transforms our most valuable and universal resource into a worthless trickle, creating high costs for subsequent users and society at large. Since the linear model is economically and environmentally unsustainable, we must instead view water as part of a circular economy, where it retains full value after each use and eventually returns to the system. And rather than focus solely on purification, we should attempt to prevent contamination or create a system in which water circulates in closed loops, allowing repeated use. These shifts will require radical solutions grounded in a complete mind-set change, but they must happen immediately, given the urgency of the situation.

A new, 'circular' perspective on water management

The global water crisis is real and graphically manifest. It's apparent in rivers that no longer reach the sea, such as the Colorado; exhausted aquifers in the

Arabian Peninsula and elsewhere; and polluted water sources like Lake Tai, one of the largest freshwater reserves in China. The root of this challenge is the violation of the zero-waste imperative—the principle that lies at the heart of any circular economy. It rests on these three basic beliefs:

- All durables, which are products with a long or infinite life span, must retain their value and be reused but never discarded or down cycled (broken down into parts and repurposed into new products of lesser value).

- All consumables, which are products with a short life span, should be used as often as possible before safely returning to the biosphere.

- Natural resources may only be used to the extent that they can be regenerated.

Even countries with advanced water-management systems violate these fundamental rules. They often fail to purify water before discharging it back into the environment because cleanup costs are high or prohibitive, even when energy or valuable chemicals could be extracted. The substances contained in the water then become pollutants. Equally troubling, any volume of water removed from the system is seldom replaced with return flow of the same quality.

When considering a redesign that will create a new, circular water system, we can take three different views:

- the product perspective, which calls for a strict distinction between water as a consumable and water as a durable, since there are different strategies for reducing waste in each category

- the resource perspective, which calls for a balance between withdrawals and return flows

- the utility perspective, which focuses on maximizing the value of our existing water infrastructure by increasing utilization and ensuring better recovery and refurbishment of assets

Water as a product

If we consider water to be a product—something that is processed, enriched, and delivered—we must follow the same strict design rules applied to any other product in a circular economy.

When water is treated as a durable, it should be kept in a closed loop under zero-liquid-discharge conditions and reused as much as possible. The major goal is not to keep water free of contaminants but to manage the integrity of the closed-loop cycle. Situations that favor the durable view include those in which it would be too costly to dispose of the solvents and re-create them—for instance, when water contains highly specific water-born solvents, electroplating baths, acids, and alkaline solutions used in heavy-duty cleaning. The Pearl Gas to Liquids complex in Qatar, for example, requires large volumes of water to convert gas to hydrocarbon liquids, including kerosene and base oil. To help prevent waste in a country plagued by shortages and droughts, the complex has a water-recycling plant—the largest of its kind—that can process 45,000 cubic meters of water per day without discharging any liquids.

When water is treated as a consumable, it must be kept pure and only brought into solution or suspension with matter that is easy or profitable to extract. For instance, consumable water should not be mixed with estrogenic hormones, toxic ink found on poor-quality toilet paper, or textile dyes. All water, including freshwater and gray water (household waste water still fit for agriculture or industrial use), should flow into subsequent cascades, where it may be used for another purpose. Whenever possible, energy and nutrients should be extracted from

consumable water; there are now many revolutionary new techniques to help with this process, as well as other innovations that encourage reuse. Consider the following:

Our ability to extract energy. It is now commercially viable to generate heat and power from sludge and other organic wastes through thermal hydrolysis, which involves boiling them at high pressure followed by rapid decompression. This process sterilizes the sludge and makes it more biodegradable. Facilities at the forefront of this movement include the Billund BioRefinery in Denmark.

Our ability to extract nutrients. We can now recover a wide variety of substances from water, reducing both waste and costs. For instance, the potassium hydroxide that is used to neutralize the hydrofluoric acid in alkylation units can be extracted, decreasing costs for this substance by up to 75 percent. Substances can also be removed from sludge, such as polyhydroxyalkanoates and other biodegradable polyesters. The technology has advanced so much that value can be obtained from substances that were formerly only regarded as contaminants. For instance, ammonia removed from water can be used in the production of ammonium sulfate fertilizer, rather than simply discarded.

Our ability to reuse water. We are witnessing significant improvements in membrane-based treatments that separate water from contaminants, allowing for reuse and commercialization at grand scale. Many types of water benefit from this treatment, from gray water to Singapore's branded NEWater, which is high-grade reclaimed water. In fact, NEWater is so pure that it is mainly used by water-fabrication plants that have more stringent quality standards than those used for drinking water. In addition to innovative membrane-based technologies, experts have developed new source-separation systems that reduce mixing between chemical-carrying industrial and household waste water, making purification easier.

Although we should celebrate these improvements in treating water and safely returning it to the system, the creation of a truly circular economy will eventually require even more radical solutions. Achieving this would require the prevention of impurity and contamination in the first place. In the European Union, for instance, 95 kilograms of nitrate per hectare are washed away from fields into rivers (an amount higher than the 80 kilograms allowed). Discontinuing this process would reduce both waste and contamination.

Water as a resource

Water can come in the form of a finite stock or a renewable flow. As one example, water used for agriculture in Saudi Arabia comes almost exclusively from fossil aquifers that will be depleted in a few decades. Since these stocks are difficult to regenerate, future Saudi agriculture efforts must eventually involve new irrigation sources, such as gray water, and follow more stringent guidelines for reducing waste.

Luckily, most hydrological systems are flow systems—rivers or replenishable aquifers. Water from such systems can be withdrawn or consumed as long as the volume taken does not exceed the minimum "environmental flow" required to keep the ecosystem intact, or the natural replenishment rates. You cannot be more circular than managing the water balance of a river basin in a rigorous and integrated fashion. Investing in strategies that promote the vitality of a watershed are also circular, including those that involve better forest management (protection, reforestation, and forest-fuel-reduction programs that help control or eliminate wildfires), improved agricultural practices (such as no-tillage farming), and restoration of wetlands. The list of highly successful watershed-protection programs is long, ranging in location from New York's

Although we should celebrate improvements in treating water and safely returning it to the system, the creation of a truly circular economy will eventually require even more radical solutions.

Catskill Mountains to Bogotá, and many additional opportunities exist.

Technologies that help balance supply and demand can also help water (both stock and flow) become part of a circular model. These include drip-irrigation systems that promote conservation by directly delivering water to root zones, irrigation scheduling, new technologies for steel dedusting that use air instead of water, and the application of Leadership in Energy & Environmental Design principles, which mandate inclusion of water-saving devices.

Water as an infrastructure system

Our global water networks and treatment plants, which are worth approximately $140 billion, consume about 10 to 15 percent of national power production. Following the principles of a circular economy, we must maximize the benefits over these deployed assets. These approaches may help:

Using existing assets for more services. Utilities have many options here. For instance, they could allow telecommunication companies to install fiber cables through their trenches for a fee and then charge for their maintenance, or they could use their sewage systems and wastewater-treatment facilities to collect and treat preprocessed food waste with sewage sludge. Using the latter technique, New York State has begun a program that has the potential to process 500 tons of food waste daily, generating heat for 5,200 homes. Utilities could also provide their data to governments or other interested parties for use in various initiatives, such as those related to healthcare or flood management.

Selling performance, not water. Instead of selling water and charging by the cubic meter, utilities could pay consumers for curbing use and then sell the conserved volume—termed "nega water"—back to the system. Such an effort, and similar initiatives, would also require a major overhaul of rate-setting mechanisms. Utilities should also promote conservation by selling double-flush toilets and similar devices, or by offering different levels of service, pricing, and convenience, with the goal of encouraging consumers to reduce use. As such, there should also be rate-setting mechanisms in place to encourage utilities to undertake water-conservation efforts.

Driving asset recovery. Utilities should establish asset-recovery centers and create procedures that promote reuse of equipment. This would include standardizing their pipes and meters to ensure they can be easily recovered and refurbished. Utilities should also begin tracking assets, which will allow easier reuse of equipment.

Optimizing resource efficiency. Finally, utilities should invest in ever more efficient operations and

use green power, ideally generated in-house, whenever possible. They should be given incentives for doing so—something that does not typically happen today. There are many examples where anaerobic digestion of sludge alone produces biogas that covers more than 60 percent of energy consumed at wastewater-treatment plants.

Next-generation moves for water-system management

Innovators, responsible operators, and committed system developers are spearheading the creation of new technological solutions, pilot cases, and initiatives to improve water management. Many of the technologies are already generating profits or will be soon. These include the bespoke polymers that are created during the biological digestion of wastewater, as well as vapor-transfer irrigation systems that use low-cost plastic tubes that allow water vapor to pass but not water or solutes, making saltwater irrigation possible.

Equally important, leaders are also rethinking their institutional approach to water management. Many of their solutions are only being applied at small scale, however, and this must change over the next ten years to meet the water-resource challenge. So how can the water sector drive the much-needed system-level transition from today's linear model to tomorrow's circular design? What are the attractive, integrated plays? Five ideas stand out:

Product-design partnerships. Even in 2015, there is no dialogue between producers—say, of atrazine herbicides, antimicrobial disinfectants, or detergent metabolites—and wastewater operators. Their relationship resembles that between a distant water source and a sink, with diluted accountabilities. As the cost of treatment mounts, pressure will increase on producers to reduce contamination, especially as new technologies make it easier to identify their source. Shouldn't wastewater operators help by offering their expertise to producers and initiating product-design partnerships to ensure that water stays pure after use?

Resource-positive utilities. Wastewater utilities are ubiquitous, visible, and largely similar. They could soon become energy positive thanks to technical advances related to sludge methanization, waste-heat recovery, potassium hydroxide reduction, or on-site distributed power generation. Who will champion further advances, including those that aim to convert wastewater to energy, integrate grids, and recover nutrients?

Management for yield. Water is a powerful driver of yield in almost any industrial process and the extraction of raw materials. Improved site-level water management can increase beverage yields by 5 percent and oil-well productivity by 20 percent, largely benefitting the bottom line. It can also convey many other advantages, such as reduced heat or nutrient loss during processing. Taken together, these advantages can turn water into a major value driver. For instance, one pulp-and-paper producer discovered that it could improve margins by seven percentage points through better water management, leaving a much more circular operation behind. Who will help other companies find such value?

Basin management. From Évian-les-Bains to Quito, floodplain protection is a viable method for reducing the risk of flooding and preventing freshwater contamination. But attempts to improve basin management often fail because they require sophisticated multiparty contracts and a deep knowledge of hydrology and engineering. Who will help connect interested parties and minimize the bureaucracy associated with basin-management agreements?

Local organic nutrient cycles. Most communities are struggling to handle low-quality sludge and fragmented, contaminated streams of organic

waste coming from households and businesses. Simultaneously, agriculture experts are exploring new sources for nutrients, since mineral fertilizer will soon be in short supply. If we aggregate local organic waste flows, we could help communities deal with their problem while also creating vibrant local markets for fertilizer components. Who will create and manage the local organic-nutrient cycle of the future?

Each of these plays represents a new way of looking at water and represents a huge business opportunity. They provide the industry with a chance to reposition itself and develop a new generation of designers, power engineers, yield managers, ecosystem-services marketers, or synthesis-gas tycoons.

■ ■ ■

The shift to a circular water economy holds much promise. It would replace scarcity with abundance and greatly reduce the resources needed to run our global water infrastructure. At some point, a circular water economy might even eliminate rapidly growing cleanup costs because no harmful substances would ever be added to the water supply. Since water is the single most important shared resource across all supply chains, and wastewater is the largest untapped waste category—as big as all solid-waste categories taken together—it is the natural starting point for the circular revolution. The water sector's advanced technologies and proven record of multi-stakeholder agreements also lend themselves to circular solutions. We must capture this unique opportunity now, before localized droughts and shortages become a global crisis. ■

The author wishes to thank Ellen MacArthur for her contributions to this paper. The Ellen MacArthur Foundation promotes educational and business initiatives that further the development of the circular economy. He would also like to thank Laurent Auguste, the senior executive vice president of innovation and markets at Veolia.

Martin Stuchtey is a director in McKinsey's Munich office and leads the McKinsey Center for Business and Environment.

Copyright © 2015 McKinsey & Company.
All rights reserved.

© Prasit photo/Getty images

Manufacturing growth through resource productivity

Resource productivity should be a top priority for manufacturers. This excerpt from a new book presents five core beliefs to drive growth by becoming leaner and greener.

Markus Hammer and Ken Somers

A decade or so ago, companies in industrial manufacturing and other process industries did not need to focus on resource productivity. If they gave any attention to the topic, it was to undertake small, incremental measures with the hope of generating marginal improvements. That period is over. Today, there is no debate: resource productivity must be among the top priorities—if not the top priority—of industrial manufacturers around the world.

Recent shifts in both supply and demand are squeezing these companies from both sides. On the supply side, raw materials are increasingly scarce, making them more difficult and more expensive to procure. At the same time, demographic changes—primarily in emerging markets—are increasing the demand for finished goods. These trends have been building over the past several years, and they will continue to gain momentum. As a result, industrial manufacturers will need to do more with less.

Compounding this problem is the fact that the easy gains have already been captured. Most organizations have already taken the obvious steps—for example, upgrading their lighting and automating their heating, ventilation, and air-conditioning controls. Yet they are now bumping up against the limits of what they can accomplish using a traditional approach. Why? The fundamental premise of that approach—in which resource productivity is subordinate to other operational priorities—is no longer valid.

For example, many managers still assume that these measures will only serve as a hindrance to plant operations—that they will be an opposing force that makes their daily work more difficult. Others assume that they simply don't need these measures. (This is a line we hear frequently when meeting with companies: "Our plant is already as efficient as it can be.") Yet there are always opportunities to transform a process or facility, improving efficiency and yield and also generating clear financial benefits, often with little or no capital expenditure.

To capture these gains, however, organizations need a better approach to resource productivity. They need to embed new ways of thinking—core beliefs—in their management teams, workforces, and organizational cultures. We use the word "belief" deliberately, because it underscores the way that change comes from thinking about productivity in a whole new way. Specifically, our approach for enhancing resource productivity centers on five core beliefs:

1. *Think lean.* In the original application of lean, companies analyzed the value stream of a particular manufacturing process and ruthlessly cut away anything that did not clearly add value. This methodology is highly synergistic with resource productivity, which applies similar rigor and looks at all steps of a process, seeking to eliminate anything that leads to wasted resources, in both energy and materials. Lean is an extremely useful way of thinking about resource productivity because it uses well-known principles—like standardization and continuous improvement—that a broad base of managers and leaders already know and likely use. Similarly, it relies on best practices such as performance meetings and integrated key performance indicators, which are likely to be in place already and translate easily to resource-productivity initiatives. Perhaps most important, lean is extremely comprehensive and bottom up. The best ideas often come from line walks with workers, who feel empowered to make suggestions and drive improvements, fostering a more inclusive process and leading to better results.

2. *Think limits.* In the traditional approach to resource productivity, companies typically start with their existing process as a baseline, and then seek to make incremental improvements from there. The second of our core beliefs—think

The best ideas often come from line walks with workers, who feel empowered to make suggestions and drive improvements, fostering a more inclusive process and leading to better results.

limits—flips this concept on its head. Instead of using the current process as a baseline, it calculates the theoretical limit of that process—meaning the output from an ideal version, with no mechanical or chemical losses and perfect energy utilization—and establishes that as the baseline. Such a goal is clearly unattainable in the real world, but this approach leads to a more comprehensive means of identifying and reducing losses. It creates an ambitious "stretch" target that companies then seek to achieve. (Often, the calculation alone identifies categories of loss and waste that the facility managers were not previously aware of.)

3. *Think profit per hour.* Our third core belief—thinking in profit per hour—helps align objectives for the organization. This is critical, because different productivity initiatives often have different goals, which can conflict with one another. Production managers, for example, strive for improvements in output, while energy managers focus on reducing energy consumption. Which one takes precedence? More often than not, the managers themselves don't know. Reconciling these issues requires a powerful new metric: profit per hour. At the highest level, profit per hour calculates an operation's gross profit for any given period of time by subtracting overall costs, including energy and resources, from revenue. It is a real-time, operational metric that helps organizations break down silos, giving managers clear visibility into the relationships among different productivity measures. More important, it generates a quantitative—and thus definitive—answer to the question of which measures should be organizational priorities.

4. *Think holistic.* Despite the best intentions, many companies fall short of their resource-productivity goals. Why? Success requires a thorough change-management effort. Managers must set meaningful and achievable goals, and persuade often reluctant organizations to embrace and pursue them. They must secure the buy-in of their employees as well as equip them with the skills and deploy the new management systems needed to improve the way the organization functions. McKinsey spent three years surveying some 600,000 managers, 7,000 senior executives, and leading academics to explore why some transformations fail and others succeed. The results showed that successful transformations are based on three core elements that drive one another like interlocking gears. First are technical systems, meaning the assets and equipment a company owns and the processes people perform with those assets to create value. Second is management infrastructure—the formal structures, processes, and systems that companies use to manage people and the technical systems. Third are mind-sets and behaviors, or the attitudes that drive behavior individually and collectively. Successful companies apply a comprehensive approach that encompasses all three, making them better able to implement and sustain changes to improve resource productivity.

5. *Think circular.* At a basic level, the global economy relies on taking raw materials out of the ground and making them into finished products, which ultimately get thrown away. It's a very linear logic—"take, make, dispose"—yet it's not sustainable in the long run. Instead, the fifth and final core belief is that organizations need to move beyond this linear approach and "think circular." That is, they should treat supply chains as circles, where they can create new value by looping products, components, and materials back into the production process after they have fulfilled

their utility over the product life cycle. This is a complex endeavor—it requires designing products in a new way, adopting business models that go beyond a mere one-time sale, and revamping supplier relationships.

■ ■ ■

We have been studying resource productivity for almost a decade and helping companies transform their operations for greater efficiency in both energy use and yield. The business imperative today is clearer than ever. Company leaders—from the executive team down to the managers and shift supervisors of individual plants—have the power to give their organizations a true competitive edge. Increasingly, winning companies will seize this opportunity and adapt their core beliefs, starting now. ■

This is an edited excerpt from *Resource-Productive Operations: Five Core Beliefs to Increase Profits Through Leaner and Greener Manufacturing Operations*. For more details about the book, including the ability to download the first chapter, visit mckinsey.com.

Markus Hammer is a senior expert in McKinsey's Vienna office, and **Ken Somers** is a master expert in the Antwerp office.

Copyright © 2015 McKinsey & Company.
All rights reserved.

© Adam Bennie/Getty images

Building the cities of the future with green districts

Better design can make sense aesthetically, environmentally—and economically.

Shannon Bouton, David Newsome, and Jonathan Woetzel

At the current pace of urbanization, the world's cities will add 65 million inhabitants a year between now and 2025.[1] The resulting demand for infrastructure will mean that each year, India alone will need to add as much floor space as exists in all of Chicago, and China more than twice that. The way the world builds now will determine urban sustainability—in emissions, waste production, and water use—for decades.

In this article, we examine what could become the building blocks for the sustainable cities of the future: "green districts." The term is new and still imprecise. Our definition of a green district is a densely populated and geographically cohesive area that is located within a city and employs technologies and design elements to reduce resource use and pollution.

In general, green districts deploy design principles that lead to dense, transit-oriented, mixed-use developments; they also consider using renewable energy sources. EcoDistricts, a Portland, Oregon–based nonprofit that specializes in helping governments and others to develop sustainable cities, notes that green districts are interesting because they are "small enough to innovate quickly, and big enough to have a meaningful impact."[2]

Interest is growing. The US Green Building Council has started a program, based on its successful Leadership in Energy and Environmental Design (LEED) rating system for individual buildings, to evaluate the concept of sustainable neighborhoods. Known as LEED for Neighborhood Development (LEED-ND), it is the first system of its kind; according to the council, the idea is to integrate the principles

of smart growth, new urbanism, and green building. So far, more than 300 projects have earned the LEED-ND rating. Estidama, a program in the Middle East, launched a similar rating system in 2010.

Several organizations are supporting the development and promotion of green districts worldwide. In June 2014, the Clinton Global Initiative and EcoDistricts began the Target Cities program. The idea is to revitalize neighborhoods in eight North American cities (Atlanta; Austin; Boston; Cambridge, MA; Denver; Los Angeles; Ottawa; and Washington, DC) and in the process to create models from which other communities can learn.

There are three reasons to believe that green districts will continue to grow.

Green districts are economically viable

To date, the self-defined green districts that have been built, including the Upton development in Northampton, England, and the 1,145-acre Civano project in Tucson, Arizona, have concentrated on offering environmental benefits. There has been less attention to the question of whether they are economically sustainable. For example, one estimate is that Civano, which is slated to have 2,600 families with sharply lower waste, energy, and car use, cost $20 million more to develop than a "similarly sized, conventional master-planned community."[3]

But that does not take into account return on capital and long-term payback. To evaluate this question, we created a model that compares the cost of building a green district versus that of a conventional one. We looked at 15 well-developed green-district technologies, covering buildings, waste, water, transport, and utilities. We also considered ten design elements, such as permeable pavements, green space, bike lanes, and building orientation (Exhibit 1). We then applied this analysis to three geographic areas that have different needs but share an interest in the subject: northern North America, the Yangtze River Delta in China, and the Persian Gulf region.

In North America, cities such as New York; Portland, Oregon; and Toronto are building or planning to build green districts. In China, the government has made ecocities part of its newest five-year plan. In the Persian Gulf, entire new cities such as Masdar, United Arab Emirates, and Energy City Qatar are being built with explicit sustainability goals.

In each market, we used the model to assess a greenfield location—that is, a new district built from scratch. (The model can, however, be adapted to brownfield or infill developments.) The model calculated how much the various technologies and design choices affect the cost of building and maintaining a green district versus a traditional one. It considered such variables as baseline energy demand, density, population, and per capita floor space; then it estimated how much these affect annual operating costs and rate of return. Looking at a one-square-kilometer district with a mix of 70 percent residential and 30 percent commercial use, we assumed application of all relevant technologies. We took into account that the mix of technologies deployed will vary. A green district in Canada will not look or operate like one in Saudi Arabia.

To illustrate, when we ran the model for a hypothetical city in the coastal provinces of the Yangtze River Delta in central China, we found that optimizing building orientation and installing permeable pavements that reduce the flow of water to treatment systems delivered the greatest return on investment. In addition, the former delivered sizable savings on energy, and the latter on water that can be collected and reused. Other technologies, such as enhanced building insulation, which delivered the greatest return in a midwestern North American city,

Exhibit 1 **Twenty-five technologies and design elements move beyond green buildings to green districts.**

▸ Design elements
◆ Technologies

Resources	Systems: Green buildings	Moving beyond green buildings to district scale		
	Buildings	Transport	Open space	Utility infrastructure
Energy[1]	◆ Solar water heating ▸ Building envelope[2] ▸ Efficient windows ▸ Building design[3] ◆ Rooftop photovoltaic systems ◆ Energy-efficient lighting ◆ Power-use submetering	▸ Dedicated bus/ car-pool lanes ▸ Bike infrastructure ▸ Pedestrian-only streets ▸ Pedestrian-friendly streetscapes[4]	◆ Energy-efficient street lighting ▸ Trees/urban forestry	◆ Pneumatic waste-transport system ◆ Combined heat and power ◆ Liquid-desiccant air conditioning
Waste	N/A	N/A	◆ "Smart" waste bins (eg, solar-powered compactors)	◆ Composting ◆ Anaerobic digestion
Water	▸ Green roofs ◆ Water-use submetering ◆ Water-efficient faucets and appliances ◆ Rainwater collection	▸ Permeable pavement and green alleys	N/A[5]	◆ Gray-water system

[1] All forms of energy, including electricity, fuel for vehicles, and natural gas.
[2] Combination of best practices for insulation, roofing, wall materials, and so on.
[3] Optimal building configuration, layout, and orientation.
[4] Wider sidewalks, less surface parking, and distributed mix of uses, including street-level retail, less surface parking, and wider sidewalks.
[5] Solutions to reduce runoff in open spaces are highly dependent on specific configuration and terrain, so costs and benefits are highly variable.

Source: McKinsey analysis

dropped down the scale for return on investment in the Yangtze River Delta due to its more moderate heating and cooling needs.

In contrast, there are things like water submetering that can work anywhere. In this practice, individual households or businesses pay for the water they use, which is a great incentive to take shorter showers. That requires installing more meters (one per apartment, for example, rather than one for an entire building) so the short-term economics are almost neutral; but the savings in water use is substantial, on the order of 30 percent compared with conventional technologies. In short, we believe that in any city, there is a list of green-district technologies that makes sense, but the specifics will vary.

Across all three case studies, we found that while not every green solution costs more than the conventional alternative, green districts overall do

have higher construction costs (by about 10 percent). That comes out to $35 million to $70 million per square kilometer, or $1,000 to $4,000 per resident. However, annual owner operating costs are lower, with savings of $250 to $1,200 per resident. The internal rates of return range from 18 percent to 30 percent. All this translates into a breakeven rate of three to five years, depending on the region and technologies deployed. And this does not take into account the substantial benefits of improved environmental quality.

Our conclusion, then, is that green districts are economically viable, as long as planners take care to match the right technologies to the location, taking into consideration climate, resource costs, regulation, and technology costs, including subsidies. In many cases, making the economics work is not so much a matter of cost as of timing. For example, installing a combined-heat-and-power system costs about twice as much as a conventional natural-gas system. But the operating costs are less than half, and the payback on the higher incurred costs is about five years. And that does not even take into account the associated environmental benefits, such as 30 to 50 percent lower emissions.

Green districts are environmentally beneficial

Compared with standard building and construction practices, and depending on the region, the total impact of the technologies considered in our model are substantial: 20 to 40 percent lower energy consumption; 60 to 65 percent less freshwater consumption and wastewater production; 25 percent less solid waste going to the landfill. Private-vehicle kilometers traveled were 50 to 80 percent less.

The savings associated with green districts result from how the different technologies work together. While buildings represent the single most important element in energy and water savings, for example, the benefits are not just about what happens within the four walls. Other factors include where these buildings are located and how people move between them.

Green districts have the greatest potential to produce economic savings in areas with high resource demands and costs. For example, technologies for reducing water use have a much faster payback period in the desert nations of the Middle East than in regions with more water. Similarly, a temperate city will likely have a significantly longer payback period for district-heating technologies than one in a

Green districts are economically viable, as long as planners take care to match the right technologies to the location, taking into consideration climate, resource costs, regulation, and technology costs.

cold climate. Logically, if local districts are resource intensive or resources are costly, the district has a greater potential to produce savings than if resources are cheap or already are consumed efficiently.

Green districts can improve the quality of life

Green districts are not only gentler to the natural environment but may also be kinder to the humans who inhabit them. As cities grow, they often become more congested; that can raise the costs of living and doing business. It also can mean more air pollution and thus more respiratory illnesses. For example, the World Health Organization estimates that of the 1,600 cities for which it has information, the air quality in most of them does not meet its standards. Traffic congestion is not only an annoyance but also an expense: according to recent research, congestion's cost, partly from wasting the time and patience of commuters, equals 1.5 to 4.0 percent of GDP.[4] Through better transit design and energy planning, green districts can set a course toward cleaner, less congested, more livable cities.

Most self-defined green districts, such as Malmo in Sweden, the Shipyard District in San Francisco, and South Korea's Songdo International Business District, are attractive and livable spaces. Some are also designed for social diversity. The Kronsberg development just outside Hannover, Germany, for example, provides housing of various sizes and types, including condominiums, semidetached, and single-family homes, as well as multiple forms of housing finance and ownership. The goal is to attract a wide range of residents, including the disadvantaged.

Green districts can also be part of urban revitalization, transforming vacant or changing areas in existing cities. Hammarby-Sjostad in Stockholm, formerly a run-down, underused industrial district, is now a thriving "eco-village." Its 25,000 residents benefit from a transportation system that generates 30 to 40 percent less carbon dioxide per household than a comparable nearby district, primarily because of 40 percent fewer trips by private car. It also has a wastewater-treatment system, the hot water from which is used in the local district's heating system, and substantially lower energy costs (by 32 to 39 percent).

The way ahead

Given these advantages, why haven't green districts already become the norm? The case for them is

strong, but real life can get in the way. One issue is that developers pay the bulk of the extra costs for green districts up front, but they are often unable to charge more when they sell, because owners see only the higher sticker price and not the long-term benefits of lower spending on water, energy, and sanitation. If developers cannot recoup their costs, they are not going to bother.

The simplest way to overcome this difficulty is for the developer and the operator to be the same—for example, in new districts built by universities, government complexes, and medical centers (Exhibit 2). These may therefore be the most logical places to start the movement, because they are well positioned to test the value of green-district technologies and design features.

However, if green districts are to scale up, new business models are required. One possibility is for developers to own and operate the districts they build until they recover the additional costs, after which, they sell. This is a change from the traditional business model of developers selling properties as quickly as possible, often even before they are complete. Another option is for owner-operators to step into the gap to take advantage of this opportunity. This is a role cities might consider assuming, given that many utilities are municipally owned, and this is where a lot of the operating savings are.

Exhibit 2 **There are different ways to encourage creation of green districts.**

Potential incentive scenarios	Campus development	Municipal effort	Comprehensive service-provider arrangement
Description	A single entity is simultaneously developer, operator, owner, and user[1]	Municipality (with public utilities) owns and operates green districts	Private-sector entity owns and operates green districts[4]
Distribution of benefits	Campus-scale institution recoups higher initial costs through resource savings	Developers get incentives to cover higher capital costs[2] Developers pass building-specific costs to occupants City benefits by having other providers besides public utilities[3]	Developer sells green district to operator, which charges users to recoup costs

[1] Applicable entities are campus-scale institutions, such as corporate headquarters, government centers, medical centers, military bases, and universities.
[2] Incentives could include subsidies and zoning easements.
[3] City benefits from usage fees as well as from avoided utility subsidies and costs to build or expand utility infrastructure.
[4] A developer could play this role if it were able to maintain involvement in the district for an extended period of time.

Source: McKinsey analysis

Given their environmental and commercial potential, green districts can become increasingly important in an urbanizing and resource-limited world. Green development will not make a bad deal a good deal; like any other project, it requires the right location, marketing, and design. But green development can make a good deal a great one by maximizing a district's economic, social, and environmental potential. On that basis, green districts have a future—and possibly a big one. ■

[1] *How to make a city great*, McKinsey Global Institute, September 2013, mckinsey.com.
[2] *The EcoDistricts™ Framework: Building Blocks of Sustainable Cities*, EcoDistricts, May 2013, wsdot.wa.gov.
[3] Simmons B. Buntin, "Unsprawl case study: Community of Civano, Arizona," *Terrain.org*, Autumn 1999, terrain.org.
[4] Susanne Dirks, Constantin Gurdgiev, and Mary Keeling, *Smarter Cities for Smarter Growth*, IBM Institute for Business Value, 2010; Li-Ren Duan, Li-Zeng Mao, and Hong-Ge Zhu, "The social cost of traffic congestion and countermeasures in Beijing," *Sustainable Transportation Systems*, 2012, pp. 68–76.

The authors would like to thank the working team that developed the model: Nikita Agarwal, Vasudha Gupta, Clayton Hunter, Andy Kuziemko, Ana Lagos, Jennifer Sternberg, and Lukas Streiff.

We also wish to acknowledge the assistance of our external advisory board: John Bachmann (AECOM), Uwe Brandes (Urban Land Institute), Jeb Brugmann (ICLEI), Stephen Fong (Rose Rock Group), Stephen Hammer (Massachusetts Institute of Technology), Dan Hoornweg (World Bank Group), James Lee (iContinuum Group), Michel Morvan (Veolia), Jeffrey Raven (New York Institute of Technology–Manhattan), Rick Robinson (IBM), Seth Schultz (C40 Cities), and Zachary Tofias (C40 Cities).

Shannon Bouton is the global manager of the McKinsey Center for Business and Environment and is based in McKinsey's Detroit office, **David Newsome** is an alumnus of McKinsey's Atlanta and Miami offices, and **Jonathan Woetzel** is a director in the Shanghai office.

Copyright © 2015 McKinsey & Company.
All rights reserved.

Tools for sustainability

How and why to work with supply chains on energy efficiency

Four steps can help create sustainability programs that work for both buyers and suppliers.

Nick Bennette, Markus Hammer, and Steven Swartz

Everyone loves energy efficiency. After all, companies can save money while improving their environmental footprint. What's not to like?

Many companies are already trying to improve how they obtain and use energy. Driven by the high costs for oil and power, heavy energy users in particular have made efficiency a priority. Many have developed useful on-site diagnostic systems.

Often, however, organizations are part of complex networks in which energy use at any single site is too low to merit much attention, or beyond their control. Among consumer-goods companies, for example, upstream supply chains can account for most of the energy used to create their products. Of course, these suppliers could invest in efficiency themselves, and many do. But in cases where they lack the will or expertise, it can make sense for buyers to get involved—for both business and environmental reasons.

Why bother?

Companies that collaborate with their suppliers can gain shrewd insight into supply-chain performance—for example, by getting a sense of how able and willing their suppliers are to adapt. In the longer term, as suppliers spend less on energy, the lower cost of production can translate into lower prices. To give a sense of the scale of the opportunity, consider that purchased goods can account for up to half of a company's cost structure, and energy costs for suppliers typically exceed 10 percent of that. A 10 percent energy-efficiency improvement in such a supply chain would improve net margins by up to 50 basis points.

There is the additional matter of demonstrating improved energy performance to meet international energy-management standards, which may soon become a prerequisite for certain customers—particularly governments and institutions. Few companies have the rigorous documentation, reviews, metrics, and processes in place to reach ISO 50001[1] compliance; this requires an organization to develop and implement an energy-management system that includes the planning and execution of improvements. Many also lack the skills required to capture

energy-savings opportunities, even though investment in these capabilities can pay back quickly. Buyers, by working with suppliers, can help move them a long way toward ISO certification.

Even given these advantages, such cooperation doesn't happen all that often. In a recent McKinsey survey of executives from 340 companies, half agreed they should work more with their supply-chain partners on sustainability, but only a third believe such efforts so far have been effective.

The most common approach to tackle sustainability in the supply chain has been the scorecard. Buyers or nongovernmental organizations (NGOs) ask suppliers to report on a range of qualitative and quantitative metrics and to undergo sustainability-related inspections and audits. Suppliers are then graded on their responses. For example, the supply-chain program of the CDP (previously known as the Carbon Disclosure Project) includes a comprehensive supplier questionnaire. More than 60 member companies and nearly 3,000 of their suppliers report emissions data and sustainability practices, including those that relate to energy management. The Sustainability Consortium (TSC), comprising more than 100 companies, universities, and NGOs, is developing a rigorous scorecard to measure and report sustainability-related metrics for specific consumer-product categories. Its working groups have already created sustainability-measurement and reporting systems for electronics, agriculture, packaging, and other sectors, and they've developed metrics and practices for their members to follow.

Scorecards, however, are inherently limited because the information tends to go only in one direction: the suppliers fill the scorecards out and send them to buyers but often do not receive much in return. For example, suppliers might learn how they compare with their peers in different categories but not how to improve their performance.

TSC is addressing this shortcoming with the use of tool kits associated with its category sustainability profiles, showing suppliers improvement opportunities associated with hot spots in a supplier's performance. Given the differences in production processes across even suppliers of the same products, however, standardized evaluation can be difficult, and suppliers may be reluctant to share performance or cost data. Finally, and perhaps most important, such assessments tend to fall short on providing suppliers with specific, actionable information on what improvements they can and should pursue.

Doing better

For these reasons, many companies have begun to think about how to develop an approach that offers benefits for both sides. One global retailer, for example, knows that its supply-chain footprint accounts for many times more greenhouse-gas emissions than actual company operations do. Since 2010, the retailer has worked with an environmental NGO to cut supply-chain emissions, in large part by capturing energy-efficiency opportunities. In addition to working

with the CDP and TSC and developing its own product-sustainability index, the company has rolled out an internal supplier-energy-efficiency program. In-house experts audit supplier sites and then suggest efficiency improvements, such as lighting retrofits and automated building-control systems—the same kinds of projects that have proved effective in the company's own facilities.

This effort and others like it have certainly helped some suppliers improve their operations, but it would be difficult to scale up to a supplier network that includes thousands of individual facilities. So innovative companies are combining the scalability and reach of scorecards with specific, factory-level guidance and support (see sidebar, "The RedE approach").

Once buyers decide to take the initiative and go this route, there are four important steps to create a sustainability program that works for both buyers and suppliers.

1. Identify promising elements of the supply chain. Determine which product categories are the most energy intensive, either by analyzing public data or by working with suppliers directly, and then estimate which suppliers have the lowest rates of active energy management. On the basis of this information, it is possible to make a good estimate of the opportunity for savings for each product category. Once high-potential categories—those that are high in energy intensity but low in active energy management—are identified, assess which category managers are interested in addressing energy efficiency and developing a collaborative supplier approach. Rank order the categories, based on cost-saving potential and internal support in the high-potential companies.

2. Develop a two-way engagement model. Once the buyer has determined which product categories are most promising, the next step is to identify high-potential activities that can help category managers improve their performance. In the scorecard approach, there's an unstated theme: "Do this, and do it this way, because it's important to us." The thinking behind a two-way model is to present a set of practices and ideas that can be both financially valuable and energy saving, such as installing energy-efficient lighting or improving compressor efficiency. The premise is to provide suppliers with the information and tools they need to make their own decisions (see sidebar). The model might also present advanced methodologies, such as emissions estimations, that can help both parties assess the financial and environmental benefits. The information goes both ways. It could take the form of something as simple as the buyer producing a spreadsheet with a list of projects and essential variables, and the supplier entering its own data in addition to projects that may not have been included on the original list.

   Buyers also need some way to monitor their suppliers, for example, by requiring them to submit regular progress reports. A feedback mechanism illuminates what isn't working. As participants go through the process—completing one project after another—they track savings and expenditures. Over time, the result is a database, grounded in real-life experiences, that informs and refines the model.

The RedE approach

Building a two-way engagement model is no simple task. To do so, companies need to know two things: how to improve energy efficiency and how to build an interactive platform that works for both suppliers and buyers. Enter the Resource Efficiency Deployment Engine, or RedE.

RedE is a simple but comprehensive web-based platform that McKinsey developed to identify, rank, implement, and track energy-efficiency projects. Securely based in the cloud and easily scalable, RedE is an open ecosystem of buyers and suppliers, benefiting from the data and contributions of multiple supply chains. RedE suggests a targeted list of what can be done, provides an estimate of costs and savings, describes each improvement project, and offers a tracking platform.

RedE operates from a database of nearly 100 levers—approaches that have worked in practice to deliver cost and energy savings to business. There are three main types of levers: settings (for example, optimizing oven parameters), refurbishment (for instance, resurfacing the interior of a pump), and replacement or redesign (say, installing new energy-efficient equipment or reconfiguring a pumping network). Suppliers can plug in their equipment and process information and get a clear sense of which levers might be worth pulling to target costs and savings.

Suppliers can use RedE to build a detailed business case for each project, manage implementation, and track savings. Buyers, in turn, can use RedE to measure suppliers' efforts, both at the individual and aggregate level. They can see who is most active, nudging those who are not and learning from those who are. Sensitive and proprietary data from individual suppliers are not shared—a crucial element in building confidence. In short, buyers can develop insights about their suppliers on an individual basis while also getting a sense of benefits in the aggregate. Both suppliers and buyers can see and measure relative performance. In effect, the two sides collaborate with each other to improve energy efficiency and compete with each other on results.

Following a commitment to reduce supplier emissions by 20 million metric tons by 2018, one global retailer is using RedE to accelerate improvements in its supply chain, starting with successful pilot projects in the plastic-toy and electronics categories. First, the retailer defined the most promising projects based on prior work with suppliers and ensured that these were included in the web-based tool. Then, it built support with merchants, communicating the idea that participation was one of the retailer's priorities.

About half the invited suppliers chose to use the voluntary platform. Specifically, they input information about their facilities, loaded and reviewed the relevant levers, and then selected a set of projects to pursue in their plants. Suppliers refined the savings estimates with their own data and ultimately implemented many of the chosen initiatives. The retailer assessed the feedback, improved the tool, recalibrated the cost and energy-savings estimates, and added new levers.

This improved RedE's functionality and supplier value proposition, which in turn improved adoption and savings rates. Based on these results, the retailer is rolling out RedE in more categories and aiming to have it play a significant role in meeting its target of reducing emissions in its supply chain by 20 million metric tons.

The evidence is strong that value is being lost due to wasted energy in product manufacturing. RedE provides suppliers with the knowledge and tools to lower their production costs and buyers with the insight to understand what is achievable.

3. Get started. Don't wait for everyone to get on board; pilot the approach with suppliers in each category that are willing to test the two-way model and experiment with the tools. Avoid the buckshot approach, particularly at first. It's better for buyers to focus on one category at a time, figure out what works, get and apply supplier feedback, and then move on to another category. This should be a deliberate, step-by-step, cumulative process. As the buyer refines the content, in the form of projects that have proved to work, more suppliers will see it is relevant and worthwhile. As more companies get involved, the quality of the data and projects improves. A virtuous circle forms: more iterations bring better information, which brings in more participants.

4. Involve other actors. Companies can use peer pressure to encourage other buyers to engage their supply chains, too, particularly when these overlap. The CDP has found that when a single buyer requests information, most suppliers don't bother to answer. When two or more companies ask, the response rate is more than 75 percent. In addition, building a coalition of peer companies can help to address concerns that scorecards and sustainability tools are just another way to squeeze suppliers on pricing.

Improving resource efficiency in the supply chain is not easy—but it is possible. What matters is being systematic, collaborative, and data driven. By developing such an approach, buyers and suppliers can build a lasting, trust-based model for improving resource efficiency, rather than treating it as a typical corporate initiative with clear start and end dates. The most important thing of all, however, is to begin. ■

[1] International Organization for Standardization's requirements for establishing, implementing, maintaining, and improving energy-management systems.

Nick Bennette is a consultant in McKinsey's Seattle office, **Markus Hammer** is a senior expert in the Vienna office, and **Steven Swartz** is a principal in the Southern California office.

Copyright © 2015 McKinsey & Company. All rights reserved.

June 2015
Designed by Global Editorial Services
Copyright © McKinsey & Company

McKinsey Practice Publications meet the Forest Stewardship Council™ (FSC ®) chain-of-custody standards. The paper used in this publication is certified as being produced in an environmentally responsible, socially beneficial, and economically viable way.

Printed in the United States of America.