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Electric Power & Natural Gas and Sustainability Practices

Managing water and climate risk with renewable energy

New analysis shows how companies can target renewable-energy purchases and investments to reduce water risk and carbon emissions in tandem.

This article is a collaborative effort by Alyssa Bryan, Thomas Hundertmark, Kun Lueck, Jason Morrison, Wilson Roen, Giulia Siccardo, and Humayun Tai, representing views from the Electric Power & Natural Gas Practice and McKinsey Sustainability.

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Dwindling supplies of fresh water pose a material business risk: one estimate shows that the lack of clean fresh water threatens some $425 billion of value across more than 500 companies.[1] Companies with water-intensive operations are apt to be attuned to water risk. But all companies can be indirectly exposed to water risk through their purchases of electricity, for water is widely used to generate electricity from steam-powered turbines. By contrast, electricity from renewable sources is generally less water intensive than electricity from fossil fuels.[2] A promising way for businesses to lessen their risk exposure while helping relieve local water stress, therefore, is to make greater use of renewable power, whether by sourcing a larger share of grid power from renewable sources or by installing their own renewable-generation capacity.[3]

It's also well known that switching to renewables can help reduce carbon emissions—something that companies are increasingly seeking to do, given the need to limit the buildup of physical climate risks by achieving net-zero emissions.[4] These dual water and climate benefits of renewable power can be significant and should be considered in tandem. The idea that energy management affects water stewardship and climate stewardship is not new: the so-called energy-water-carbon nexus has long been a focus of academic research related to a wide variety of topics, such as seawater desalination. But it is increasingly relevant to multinational companies' decisions about how to reduce their water footprints in water-scarce regions and lower their carbon emissions.[5]

Assessing the potential water and carbon savings from using more renewable energy requires a granular analysis of site-level factors, ideally guided by a company-level strategy. To ascertain how these factors play out at the industry level, we analyzed data from more than 1,500 companies on the water consumption and carbon emissions associated with their electricity purchases in 2019, and then looked closely at two industries: chemicals, and food-and-beverage processing.[6] (We selected these two industries because both had large data samples with extensive location footprints.)

Two site-level factors stood out in our analysis for both industries. The first factor is the water and carbon intensity of electricity purchased from the power grid; this varies considerably among regions. The second factor is the degree of water stress in the locations where a business operates, which also differs from region to region. For the chemical companies in our data set, 40 percent of energy purchases take place in regions with medium-high or higher levels of water stress, compared with 25 percent for food-and-beverage-processing companies.[7] In this article, we show how considering these factors together can help executives maximize the water and carbon benefits of switching to renewable energy where feasible.

Locating opportunities to reduce water consumption and carbon emissions

Companies' purchases of electricity from the grid affect local water quality and availability because

[1] *Cleaning up their act: Are companies responding to the risks and opportunities posed by water pollution?*, CDP Global Water Report 2019, cdp.net.

[2] While electricity generated from renewables is often less water intensive, other factors might also influence choices about renewables deployment. Since these important factors, which include land-use requirements and environmental impacts on wildlife, are evaluated in permitting processes for renewables deployment across jurisdictions, we have not addressed them in this article.

[3] Power grids, too, can be less or more water intensive. Individual companies and facilities will seldom be able to select an alternative-power grid; however, they can sometimes opt for virtual power-plant agreements that allow them to source all of their purchased electricity from renewable-power sources.

[4] See Kimberly Henderson, Dickon Pinner, Matt Rogers, Bram Smeets, Christer Tryggestad, and Daniela Vargas, "Climate math: What a 1.5-degree pathway would take," *McKinsey Quarterly*, April 30, 2020, McKinsey.com.

[5] Power management is only one of several methods that companies can use to manage their water footprints, down to the site and basin level. Other methods include improving operational efficiency to reduce the amount of water used (for example, to cool machinery or to wash textiles). Companies can apply those methods simultaneously with power management.

[6] Disclosures on water consumption are documented by the CDP (formerly the Carbon Disclosure Project), a global organization focused on promoting corporate disclosure of environmental risks and impacts.

[7] We use the definitions of water stress developed by the World Resources Institute. Countries are designated medium stress to high stress if their ratio of water withdrawals to water supply is in the range of 20 to 40 percent, high stress if the ratio is 40 to 80 percent, and extremely high if the ratio is 80 percent or greater. For more, see Francis Gassert, Tianyi Luo, Andrew Maddocks, and Paul Reig, "Water stress by country," World Resources Institute, December 12, 2013, wri.org.

the fossil-fuel and nuclear power plants that generate most of the world's electricity withdraw considerable fresh water to support their operations. Some power plants discharge some or all of that water back into the local basin, which lessens their impact on water availability. The water that is not discharged is said to be consumed, and water consumption reduces the quantity available locally. Our analysis focuses on water consumption because it tends to increase water stress. By contrast, wind farms and solar arrays consume little to no fresh water; at most, water is used to clean solar panels.[8]

In general, countries that generate less grid power from renewable sources consume water at higher rates per unit of purchased electricity (Exhibit 1). Looking at the sources of grid power for the 119 countries covered by the data set, we found that 47 percent generate less than 1 percent of their grid power using wind or solar. Only 9 percent of countries generate more than 5 percent of their power from wind or solar.[9] To find promising opportunities to reduce water consumption and carbon emissions by switching to renewables—through power-purchase agreements or self-operated renewable installations—companies might prioritize operations in countries with electricity grids that rely less on solar and wind power.

The other factor that bears consideration is water stress. Using information on the water-stress levels of countries, we assessed exposures to water stress for the companies in two sectors within the data set: 111 companies in the chemicals industry and 86 companies in the food-and-beverage-processing industry. In total, the 111 chemical companies reported 209 terawatt-hours (TWh) of purchased energy; our estimates indicate that this energy use resulted in 89 megatons of carbon emissions and 16 billion gallons of water consumed. The 86 food-and-beverage-processing companies reported purchasing 102 TWh of purchased energy, resulting in 39 megatons of carbon emissions and eight billion gallons of water consumed, according to our estimates.

When it comes to managing water impact, companies should know how much of their energy consumption takes place in regions and countries that experience greater water stress. The food-and-beverage-processing companies that we analyzed purchased 20 percent of their grid power in countries with medium to high or higher levels of water stress. The resulting water and carbon impacts were disproportionately large, accounting for 56 percent of the companies' water consumed, and 32 percent of their carbon emissions. Companies in the chemicals sector recorded a higher fraction of their energy purchases in water-stressed countries, 40 percent, which accounted for 44 percent of the sector's water consumption and 49 percent of carbon emissions from purchased energy (Exhibit 2). Across both sectors, energy purchases in water-stressed countries accounted for outsize shares of water consumption and carbon emissions, suggesting an opportunity to reduce both by switching to renewables in those countries.

Estimating the effects of switching to renewables

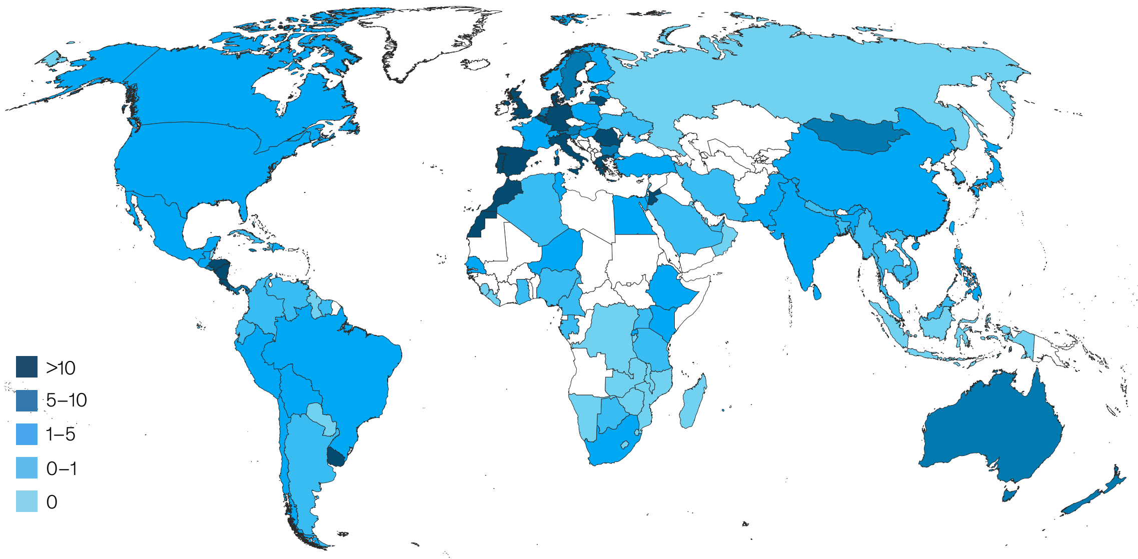
Next, we estimated the potential water and carbon reductions that would result as companies replaced nonrenewable sources of purchased energy (starting with coal power, then oil power, then gas power) with renewables. Adjustments were applied at the country level, to account for variations in the shares of nonrenewable power generated by using different fossil fuels. These variations can make for large differences in the water intensity of nonrenewable electricity: for example, nonrenewable-power generation in Mexico consumes nearly twice as much water, per kilowatt-hour, than in Egypt.

[8]In this analysis, rates of water withdrawal and consumption for wind and solar account only for water withdrawn or consumed during power generation, not for water usage over the life cycle of renewable-generation facilities (including manufacturing of renewable-power equipment).
[9]Hydropower, which provides a large fraction of grid power in many countries, is a renewable source of energy that results in no carbon emissions and, in many cases, little water consumption. However, we have chosen to model only the increased use of solar power and wind power because companies are unable to increase their use of hydropower everywhere they operate. The limitation exists for two reasons. First, not all countries can deploy hydropower; they can do so only if they possess certain natural endowments, such as major rivers. Second, the large scale of hydropower installations makes them impractical for companies to deploy at their own facilities, whereas companies can readily deploy small-scale solar and wind installations.

Exhibit 1

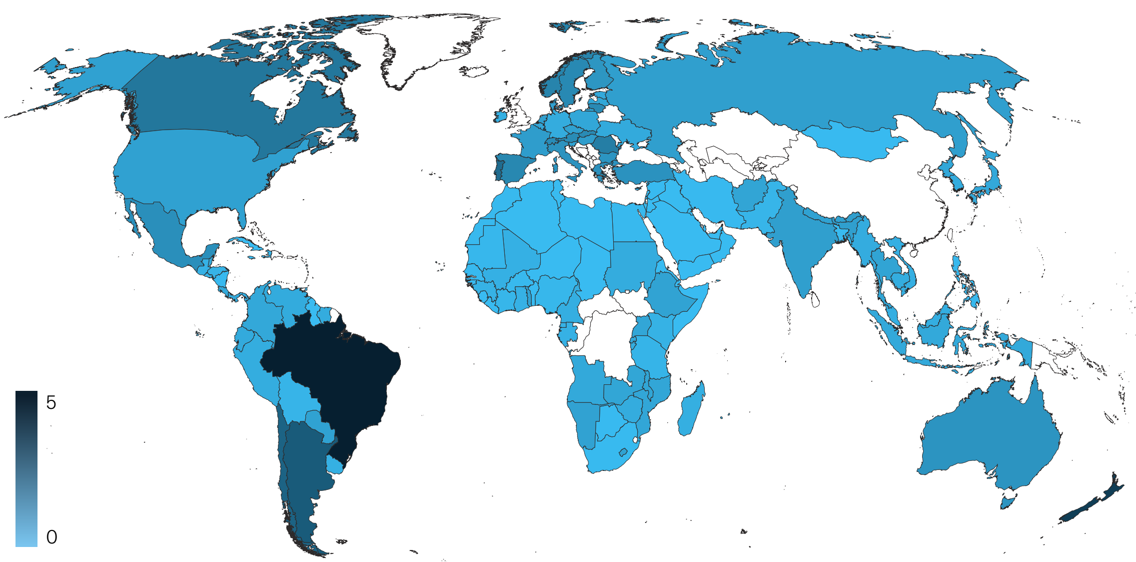
Less than one-tenth of countries generate more than 5 percent of grid power from solar and wind.

Grid power from solar and wind, %



Countries with more solar and wind capacity generally consume less water in power generation.

Water consumption factor for grid power, gallons per kilowatt-hour



Note: The boundaries and names shown on this map do not imply official endorsement or acceptance by McKinsey & Company.
Source: CDP; McKinsey analysis

Substituting renewables for the most carbon-intensive energy sources had a profound impact on emissions, even when the increases in renewables were modest. In the chemicals sector, we estimate that lowering the share of nonrenewable energy by five percentage points and increasing the share of renewable energy by five percentage points would reduce carbon emissions from purchased energy by approximately 40 percent. The same five-percentage-point change in purchased energy had an even greater effect in the food-and-beverage-processing sector: a 58 percent reduction in carbon emissions. Upping the share of renewables by 50 percentage points would prevent 78 percent of carbon emissions for chemical companies and 84 percent of carbon emissions for food-and-beverage processors (Exhibit 3).

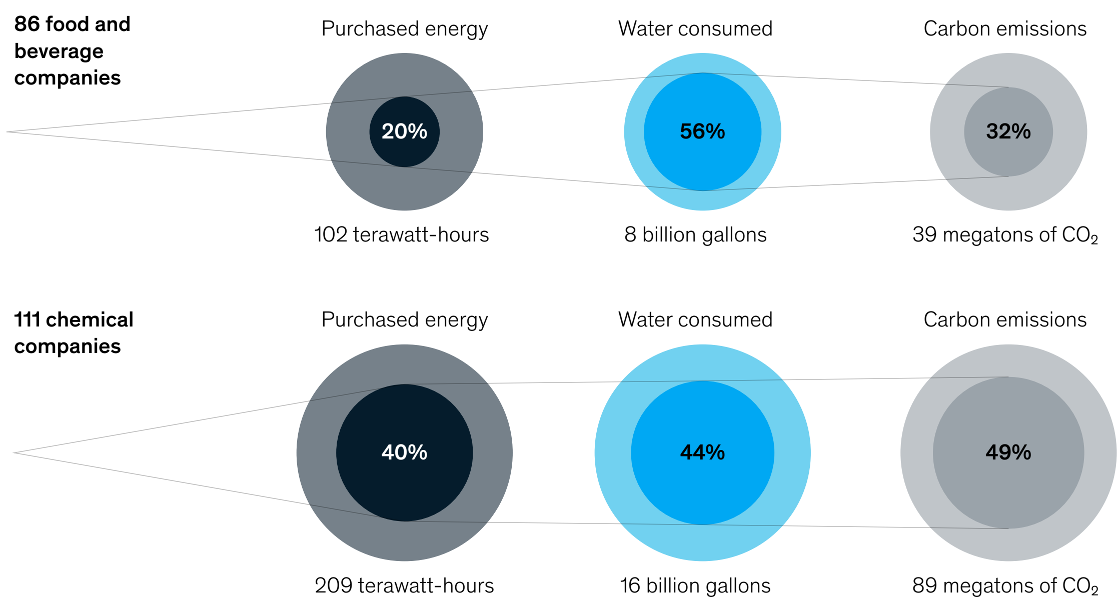
The water savings from switching to renewables were also significant. A 50-percentage-point increase in purchases of renewables results in a nearly 60 percent reduction in water consumption for both the chemical companies and the food-and-beverage-processing companies (Exhibit 4).

Switching to renewables may not be a practical near-term option in every country where a company operates. Utilities might lack the renewable-generation capacity to supply a company with all the renewable energy that it needs. And adding capacity takes time, whether the utility does so or the company sets up its own renewable installations. Companies might therefore take a more gradual approach to increasing their use of renewable energy. Some companies have also made renewable-power purchasing agreements with local utilities. These enable the utilities to accelerate investment in renewable installations by ensuring long-term demand for the electricity that the installations produce.

Exhibit 2

Energy purchased in water-stressed countries accounts for outsize shares of water consumption and carbon emissions.

Share of energy use and resulting environmental impact in water-stressed countries, %

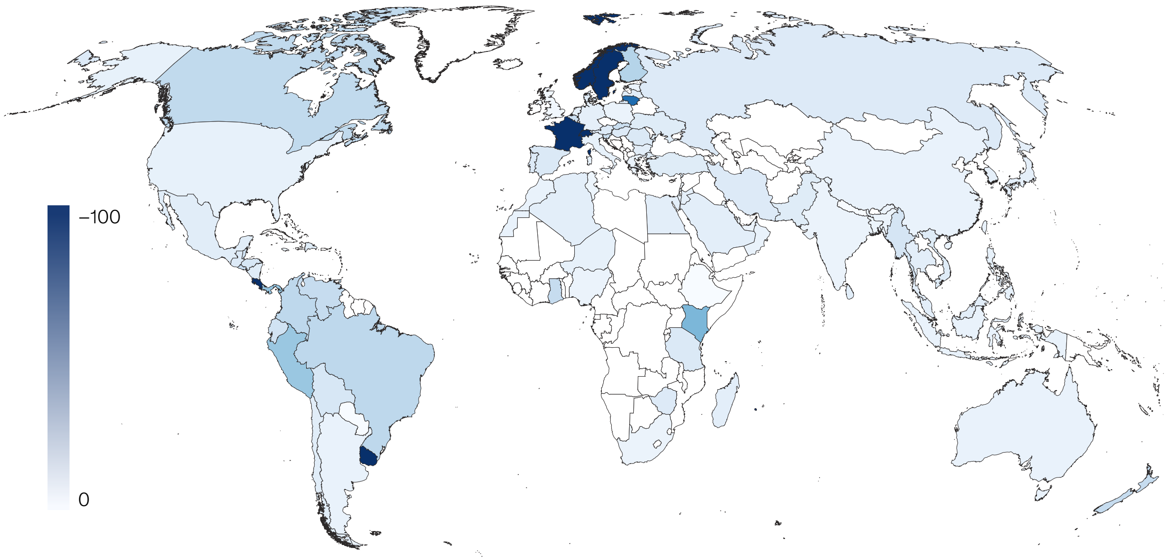


Source: CDP; McKinsey analysis

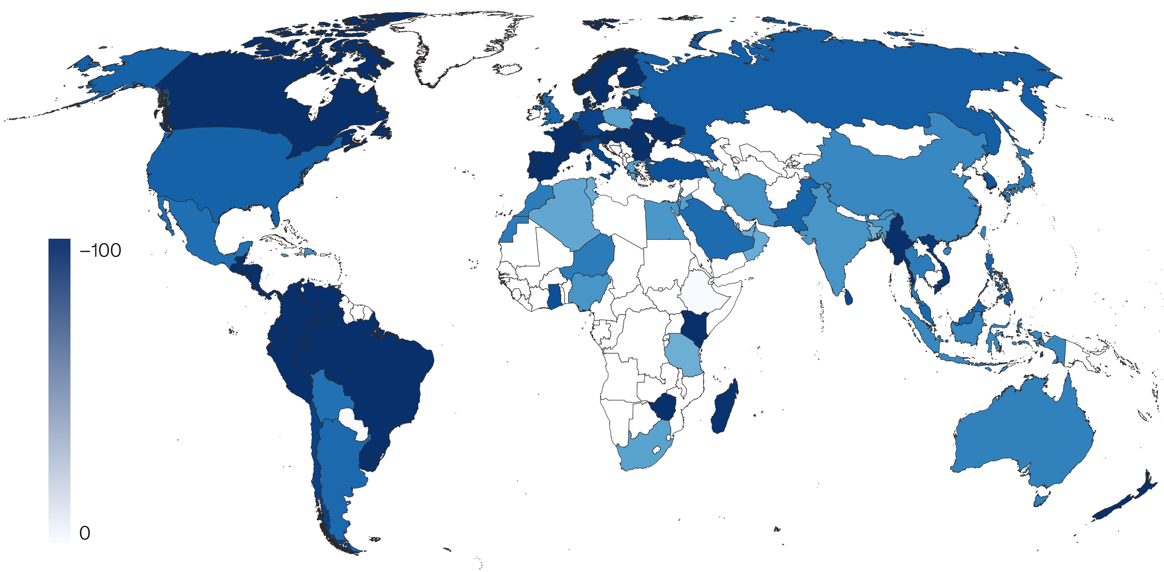
Exhibit 3

Chemical companies that substitute renewables for carbon-intensive energy sources can reduce emissions significantly.

Estimated carbon-emissions reduction by amount of renewable energy replacing nonrenewable energy, % (with +5pp in renewables)



Estimated carbon-emissions reduction by amount of renewable energy replacing nonrenewable energy, % (with +50pp in renewables)

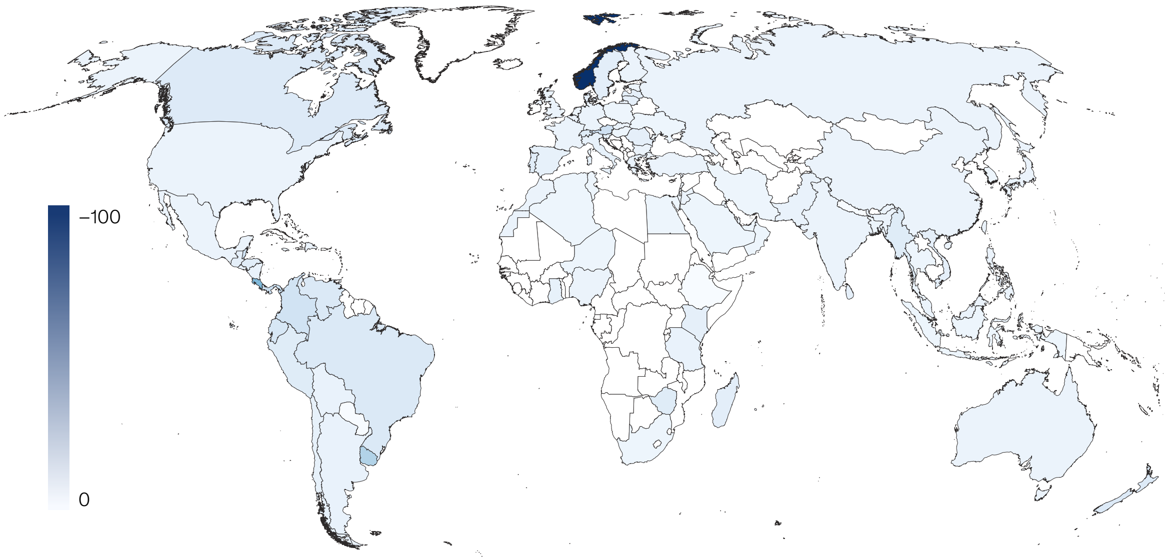


Note: The estimated reductions are based on the potential replacement of purchased energy from carbon-emitting nonrenewable sources (starting with coal power, then oil power, then gas power) with purchased energy from renewable sources (solar power and wind power). Adjustments are applied at the country level, to account for variations in the shares of nonrenewable power generated using different fossil fuels. In countries where the majority of grid power comes from sources other than carbon-emitting nonrenewables, solar, or wind (eg, hydro or nuclear), a small reduction in the share of purchased energy from nonrenewable sources can eliminate all carbon emissions and water consumption associated with the sector's use of grid power. In three countries (Ethiopia, Nepal, Paraguay), the chemical companies in the data set have estimated emissions reductions of zero because their purchased-energy use already results in no carbon emissions. The boundaries and names shown on this map do not imply official endorsement or acceptance by McKinsey & Company. Source: CDP; McKinsey analysis

Exhibit 3 (continued)

Estimates suggest that replacing nonrenewable energy with renewable energy would substantially reduce the water consumption of chemical companies.

Estimated water-consumption reduction by amount of renewable energy replacing nonrenewable energy, % (with +5pp in renewables)



Estimated water-consumption reduction by amount of renewable energy replacing nonrenewable energy, % (with +50pp in renewables)

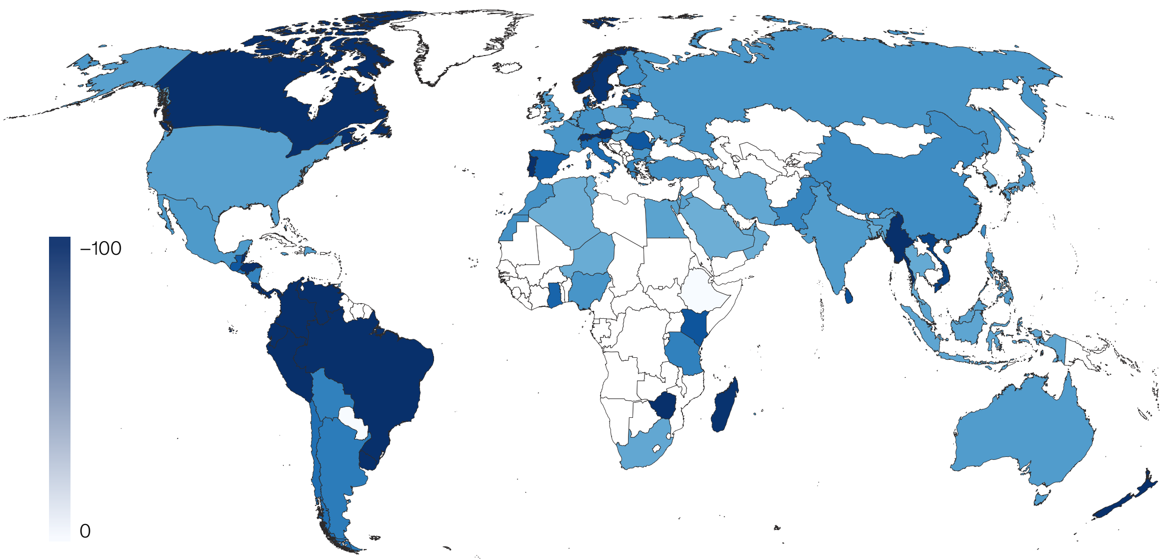


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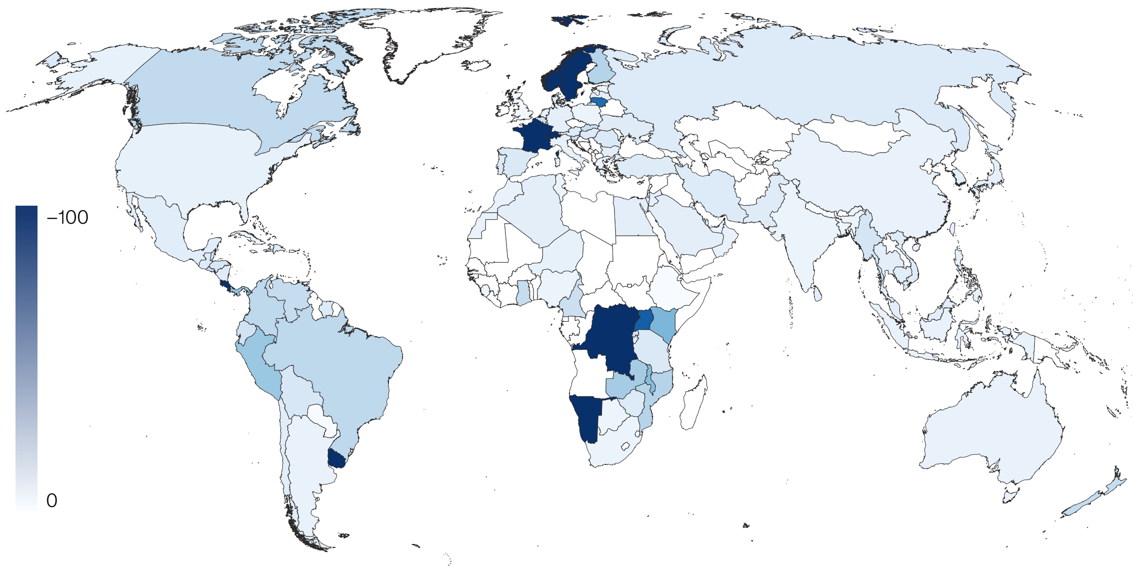
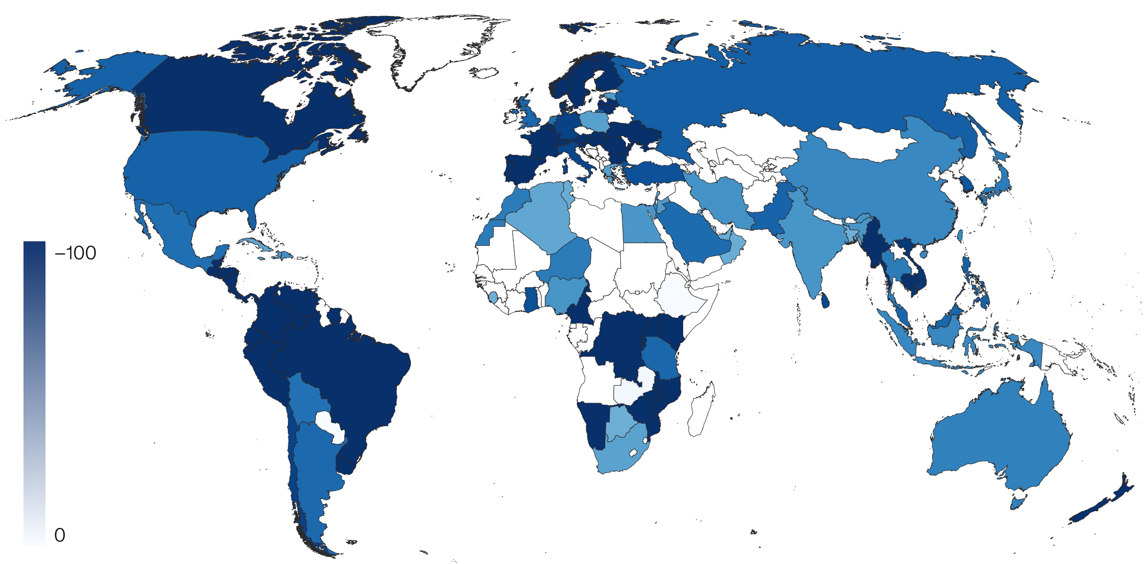
Exhibit 4

Food-and-beverage-processing companies that substitute renewables can produce even greater emissions reductions.

Estimated carbon-emissions reduction by amount of renewable energy replacing nonrenewable energy, % (with +5pp in renewables)



Estimated carbon-emissions reduction by amount of renewable energy replacing nonrenewable energy, % (with +50pp in renewables)

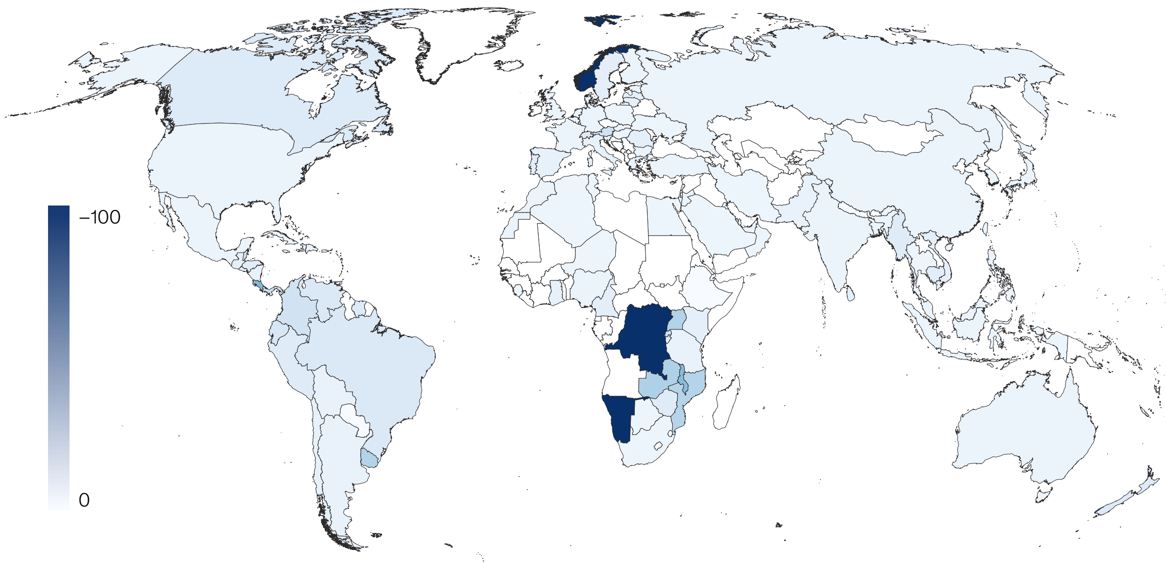


Note: The estimated reductions are based on the potential replacement of purchased energy from carbon-emitting nonrenewable sources (starting with coal power, then oil power, then gas power) with purchased energy from renewable sources (solar power and wind power). Adjustments are applied at the country level, to account for variations in the shares of nonrenewable power generated using different fossil fuels. In countries where the majority of grid power comes from sources other than carbon-emitting nonrenewables, solar, or wind (eg, hydro or nuclear), a small reduction in the share of purchased energy from nonrenewable sources can eliminate all carbon emissions and water consumption associated with the sector's use of grid power. In five countries (Eswatini, Ethiopia, Lesotho, Nepal, Paraguay), the food-and-beverage-processing companies in the data set have estimated emissions reductions of zero because their purchased-energy use already results in no carbon emissions. The boundaries and names shown on this map do not imply official endorsement or acceptance by McKinsey & Company. Source: CDP; McKinsey analysis

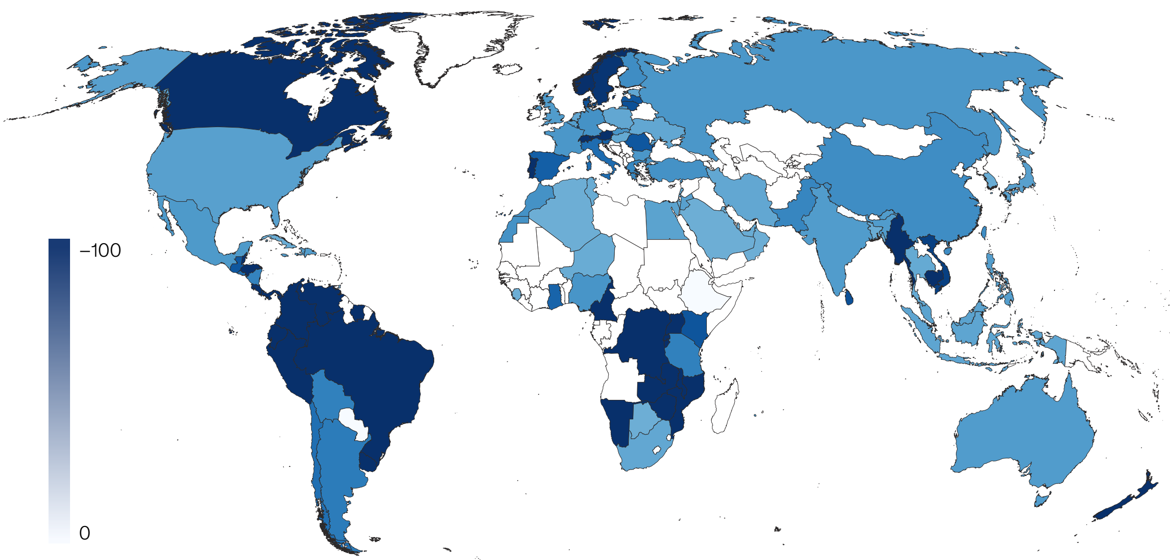
Exhibit 4 (continued)

The estimated reduction in water consumption is also significant for food-and-beverage-processing companies.

Estimated water-consumption reduction by amount of renewable energy replacing nonrenewable energy, % (with +5pp in renewables)



Estimated carbon-emissions reduction by amount of renewable energy replacing nonrenewable energy, % (with +50pp in renewables)



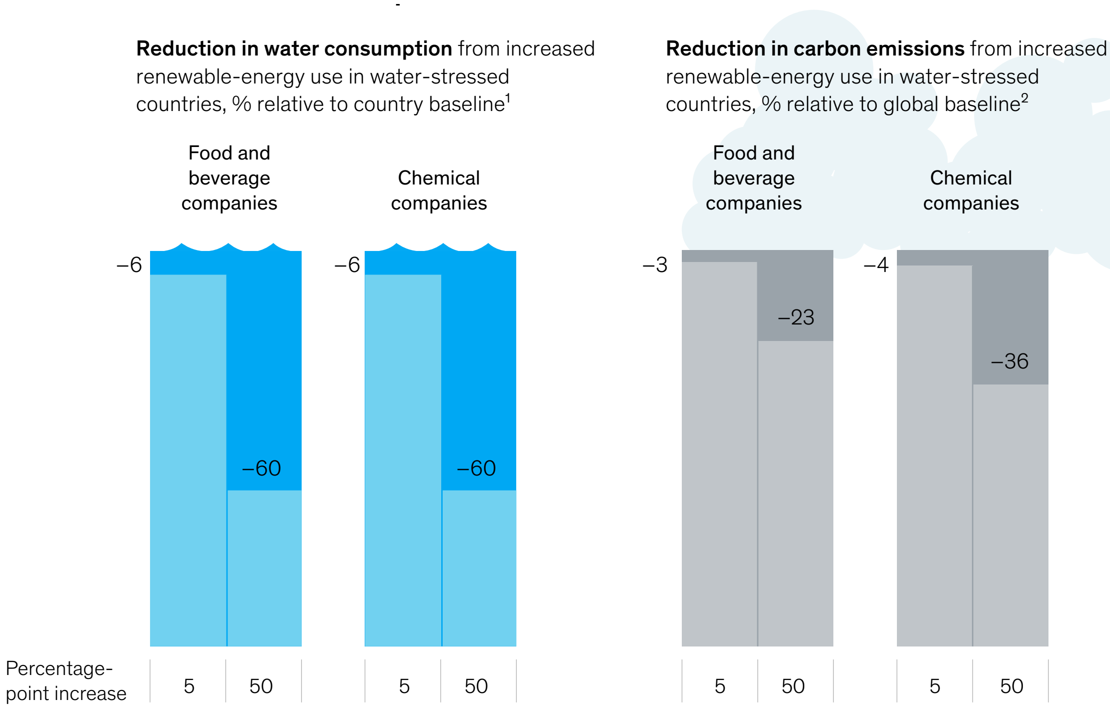
Note: The estimated reductions are based on the potential replacement of purchased energy from carbon-emitting nonrenewable sources (starting with coal power, then oil power, then gas power) with purchased energy from renewable sources (solar power and wind power). Adjustments are applied at the country level, to account for variations in the shares of nonrenewable power generated using different fossil fuels. In countries where the majority of grid power comes from sources other than carbon-emitting nonrenewables, solar, or wind (eg, hydro or nuclear), a small reduction in the share of purchased energy from nonrenewable sources can eliminate all carbon emissions and water consumption associated with the sector's use of grid power. In five countries (Eswatini, Ethiopia, Lesotho, Nepal, Paraguay), the food-and-beverage-processing companies in the data set have estimated water-consumption reductions of zero because their purchased-energy use already results in no water consumption. The boundaries and names shown on this map do not imply official endorsement or acceptance by McKinsey & Company. Source: CDP; McKinsey analysis

To illustrate the effect of a more gradual and targeted ramp-up in renewable-energy purchasing, we modeled the reductions in water consumption and carbon emissions that the two sets of companies would achieve if they increased their use of renewable energy *only* in countries with medium to high or higher levels of water stress. A five-percentage-point increase in renewable-energy use in water-stressed countries would reduce water consumption by around 6 percent for both groups of companies; with a 50-percentage-point increase in renewables, they would lower water consumption by about 60 percent for both groups. In other words, increasing the use of renewables in water-stressed countries results in an appreciable decrease in water consumption—the sort of result that can help guard against water risk.

What's more, switching to renewables in water-stressed countries alone produces significant reductions in carbon emissions. With a five-percentage-point increase in renewables in water-stressed countries alone, we estimate that the chemical companies would lower their global carbon emissions by 13 percent; for food-and-beverage-processing companies, the reduction would be 7 percent. A 50-percentage-point increase in renewables in water-stressed countries would lower chemical companies' global carbon emissions by 36 percent, and food-and-beverage-processing companies' emissions by 23 percent overall (Exhibit 5).

Exhibit 5

Switching to renewables in water-stressed countries produces substantial reductions in water consumption and carbon emissions.



[1]Reductions in water consumption are measured relative to the baseline in water-stressed countries because local reductions primarily relieve local water stress.
[2]Reductions in carbon emissions are measured relative to the global baseline because emissions reductions have the same climate impact no matter where they take place.
Source: CDP; McKinsey analysis

Making the switch to renewables: How to begin

Business leaders in all industries face questions from investors, regulators, and other stakeholders about their companies' impact on the climate and on local water basins and about the actions being taken to manage both types of impact. Increasing the use of renewable energy represents one potential action that companies might take as part of a balanced, comprehensive approach to improving both water efficiency and carbon efficiency, mitigating related risks, and supporting sustainable, inclusive growth for the communities where they operate. Here are five actions that executives can take to support such an approach:

— *Evaluate the company's energy purchases and the resulting water consumption and carbon emissions* in the aggregate as well as at the level of individual sites and for both direct operations as well as purchased electricity. For water, in particular, location-specific assessments matter because levels of water stress differ from place to place.

— *Set integrated targets* rather than separate ones for lessening water consumption and carbon emissions. In doing so, management might benchmark the company's activities against those of its peers.

— *Think cross-functionally about how water and carbon programs can support each other.* This article has focused on how companies can manage electricity sourcing for both water and carbon impact. But many business operations result in both water consumption and carbon emissions. Carbon-management efforts related to other areas, such as manufacturing processes, could be expanded to address water consumption, and vice versa.

— *Collaborate with others in and beyond the direct value chain.* When it comes to managing water and carbon impact by changing the types and sources of energy they use, companies that do business in a given locale may wish to explore joint sourcing of renewables and collaborative stewardship of water resources. Especially in areas with high levels of water stress, companies might consider coordinating their activities and consulting local stakeholders to devise water-management plans that don't put undue strain on shared local resources.

— *Engage local utilities and regional or municipal authorities* to understand their plans for phasing out fossil fuels and for increasing renewable capacity, then seek ways of working together to hasten the transition. If businesses voice interest in or commit to purchasing more renewable energy, they can encourage utilities to make needed capital investments.

Water and carbon priorities don't need to be at odds. An integrated renewable-energy strategy can address these two sets of priorities at once, enhancing the company's performance and improving its standing with stakeholders.

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