McKinsey Global Institute

The net-zero transition: What it would cost, what it could bring

Governments and companies worldwide are pledging to achieve net-zero emissions of greenhouse gases. What would it take to fulfill that ambition?

In a new report, we look at the economic transformation that a transition to net-zero emissions would entail—a transformation that would affect all countries and all sectors of the economy, either directly or indirectly. We estimate the changes in demand, capital spending, costs, and jobs, to 2050, for sectors that produce about 85 percent of overall emissions and assess economic shifts for 69 countries.

Governments and companies are increasingly committing to climate action. Yet significant challenges stand in the way, not least the scale of economic transformation that a net-zero transition would entail and the difficulty of balancing the substantial short-term risks of poorly prepared or uncoordinated action with the longer-term risks of insufficient or delayed action. In this report, we estimate the transition's economic effects on demand, capital allocation, costs, and jobs to 2050 across sectors that produce about 85 percent of overall emissions and assess economic shifts for 69 countries. Our analysis is not a projection or a prediction and does not claim to be exhaustive; it is the simulation of one hypothetical, orderly path toward 1.5°C using the Net Zero 2050 scenario from the Network for Greening the Financial System (NGFS), to provide an order-of-magnitude estimate of the economic costs and societal adjustments associated with net-zero transition

Six features characterize the shifts in energy and land-use systems, economic sectors, and countries in the net-zero transition, according to our analysis. They are the following:

1. Universal

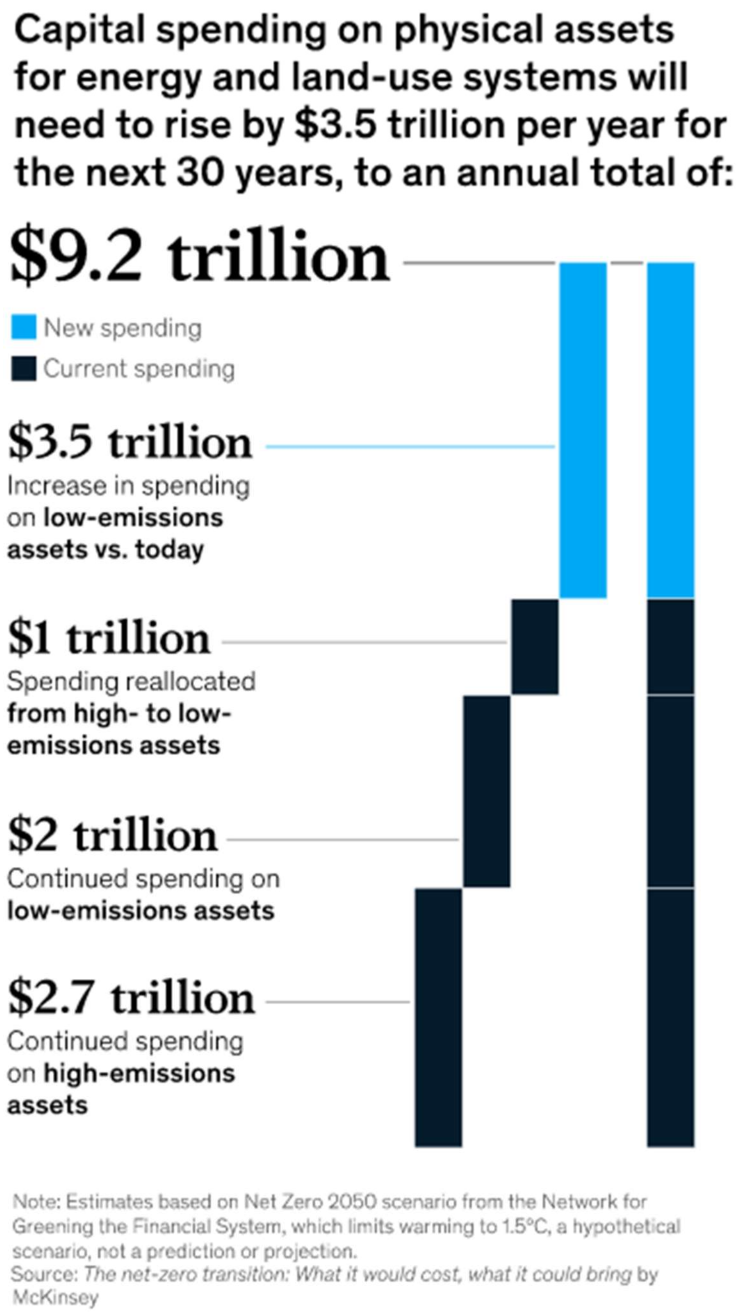
Each of the seven major energy and land-use systems contributes substantially to emissions, and every one of these systems will thus need to undergo transformation if the net-zero goal is to be achieved. Moreover, these systems are highly interdependent. Actions to reduce emissions must therefore take place in concert across the systems. For instance, electric vehicles lead to overall emissions reductions only to the extent that low-emissions electricity production has been achieved. More broadly, all sectors and geographies must play a role. All sectors of the economy participate in these energy and land-use systems across global value chains. Similarly, all countries contribute to emissions, either directly or through their role in value chains (although with significant differences, as we note below). Reaching net-zero emissions will thus require a universal transformation of the global economy.

All carbon dioxide and methane emissions today come from seven energy and land-use systems.

Source: *The net-zero transition: What it would cost, what it could bring* by McKinsey; McKinsey EMIT database

2. Significant

The economic transformation needed to achieve the transition to net zero will be significant. Our analysis focuses on demand, capital allocation, costs, and jobs. Looking just at capital allocation, we find that annual spending on physical assets in the energy and land-use systems through 2050 would need to be about 60 percent greater than it is today, rising by $3.5 trillion annually on average. Accounting for expected increases in spending, as incomes and populations grow, as well as for currently legislated transition policies, the required increase in spending would be lower, but still about $1 trillion. In all, our analysis suggests that the Net Zero 2050 scenario would require spending on physical assets of about $275 trillion between 2021 and 2050 (about 7.5 percent of GDP over the period) in the areas we analyzed. We also see significant shifts in demand for various goods and services in the scenario analyzed here, including steep declines in demand for coal, oil, and gas production and an eventual virtual end to manufacturing of cars with internal combustion engines, as sales of zero-emissions alternatives (for example, battery-electric and fuel cell-electric vehicles) increase from 5 percent of new-vehicle sales in 2020 to virtually 100 percent by 2050.



3. Front-loaded

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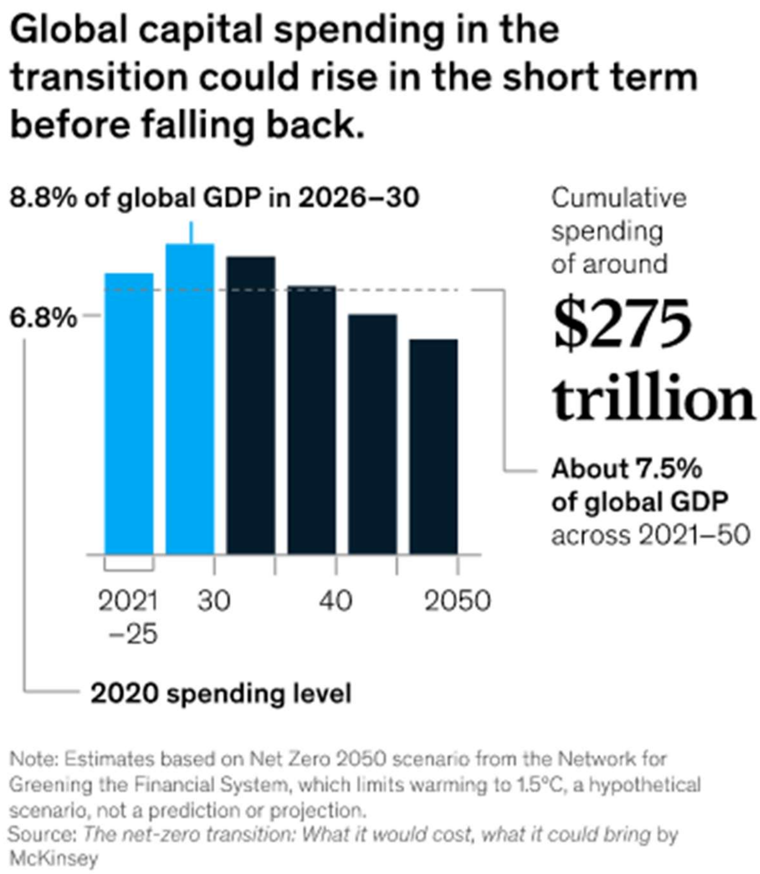
Several aspects of the transition to net zero would be more significant in the early stages of the shift. For example, the capital spending increase noted above would rise from 6.8 percent of GDP today to about 9 percent of GDP between 2026 and 2030 before falling. Delivered cost of electricity could increase in the near term. In our scenario, delivered cost of electricity could rise about 25 percent from 2020 levels until 2040 and still be about 20 percent higher in 2050, to build out renewable power assets and grid infrastructure. In the long run, it is conceivable that the delivered cost of electricity could be on par or potentially less than 2020 levels, because renewables have a lower operating cost—provided that the power system can find ways to overcome the intermittency of renewable power and build flexible, reliable, low-cost grids. The up-front capital spending for the net-zero transition could also lower other operating costs over time for consumers. A key example of that is mobility. More broadly, action is needed over the next decade to reduce the buildup of emissions and prevent rising physical risks that might occur in future decades.

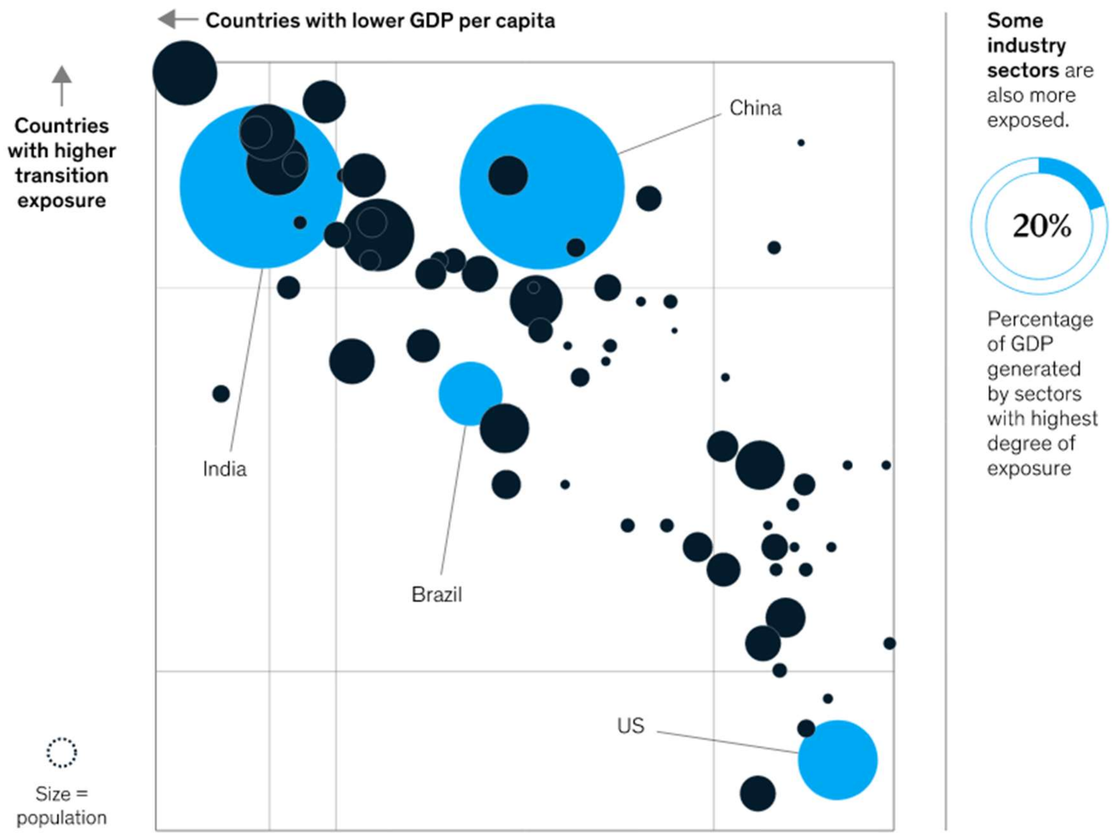


4. Uneven

While universal, the economic exposure to the transition will not be uniform across sectors, geographies, and communities and individuals. First, sectors that account for approximately 20 percent of GDP are most directly exposed to the transition; they have high levels of emissions in their operations (for example, steel and cement), and in the use of their products (for example, automobiles and fossil fuels). Sectors accounting for about another 10 percent of GDP are also exposed because of emissions in their supply chains (for example, construction). Many could see a decline in demand for products in their current form. Many of these sectors would also incur cost increases as they decarbonize. For example, steel and cement production costs would rise by about 30 percent and 45 percent, respectively, by 2050, compared with today, in the scenario we analyze. Second, lower-income countries or those with economies that depend heavily on fossil fuel resource-producing sectors would also be more exposed; for example, sub-Saharan Africa, Latin America, India and some other Asian countries would require capital spending of about 10 percent or more of GDP, approximately one and a half times more than the capital spending in other regions such as Europe, the United States, and Japan, and deploying the capital may be more challenging for these regions; a greater share of their economic activity, employment, and capital stock would also be exposed and may need to transform.

Finally, within countries, certain communities could be more affected than others if their economies rely heavily on industries that have high levels of emissions or whose products are heavy emitters; in the United States, for example, more than 10 percent of employment in 44 counties is in coal, oil, and gas, fossil fuel–based power, and automotive. Workers in such exposed sectors are especially vulnerable; for example, by 2050 in the Net Zero 2050 scenario, demand for fossil fuel–based power jobs could be about 60 percent lower compared to today's direct jobs related to operational activities due to the net-zero transition, while millions of new jobs could be created in the renewables sector. (By "direct" jobs we mean jobs in the specified sector, as opposed to "indirect" jobs, which refers to the upstream jobs that produce inputs for production in the specified sector.) Any increase in costs or prices would affect lower-income households the most.

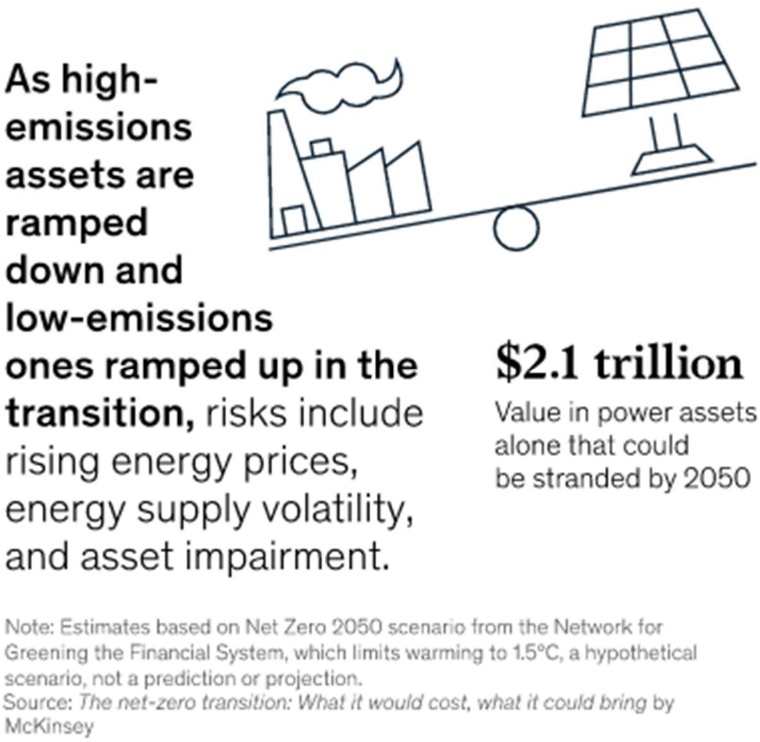
Developing countries and fossil fuel-rich regions are more exposed to the net-zero transition compared with other geographies.



Note: Estimates based on Net Zero 2050 scenario from the Network for Greening the Financial System, which limits warming to 1.5°C, a hypothetical scenario, not a prediction or projection.
Source: *The net-zero transition: What it would cost, what it could bring* by McKinsey

5. Exposed to risks

Management of the transition to net zero will substantially influence outcomes, and any net-zero transition scenario including the Net Zero 2050 one we use in this research will be exposed to risks. These risks range from the potential for increased physical climate risks if any transition is abrupt or delayed, to heightened labor market disruption in the event that the nature of any change is so abrupt that workers have insufficient time to adapt. Large-scale asset-stranding is also a significant risk, if an abrupt transition means that even relatively new high-emissions assets are retired or replaced with low-emissions ones before their normal replacement cycles. Our analysis for stranded assets in the power sector suggests that about $2.1 trillion of assets could be prematurely retired or under-utilized in the net-zero scenario analyzed here between now and 2050. One of the most immediate risks is that of a disorderly energy transition, if the ramp up of low-emissions activities does not take place fast enough to fill gaps left by the ramping down of high-emissions activities. That mismatch could potentially affect energy markets and the economy more broadly if energy supply and prices become volatile. This in turn could potentially create a backlash that delays the transition (see sidebar, "How rising energy prices create risk"). Higher-order effects could include declines in market prices including for financial assets.



6. Rich in opportunity

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The opportunities for countries, sectors, and companies could be considerable if they are able to tap into growing markets as the world transforms to a net-zero economy. Nations that have abundant natural capital, such as more hours of sunshine, or that invest in technological, human, and physical capital could well be positioned to prosper in the net-zero economy. Companies could also gain from three categories of opportunity: first, through decarbonizing processes and products, which can make them more cost-effective in some cases or tap into new markets for relatively lower-emissions products; second, from entirely new low-carbon products and processes that replace established high-carbon options, for example carmakers meeting new demand for electric rather than ICE vehicles; and third, through new offerings to support production in the first two categories. These could take the form of inputs such as lithium and cobalt for battery manufacturing, physical capital such as solar panels, and an array of technical services from forest management to financing to emissions measurement. And the most significant benefit of the net-zero transition is that it will prevent the build-up of physical risks and reduce the odds of initiating the most catastrophic impacts of climate change.

How rising energy prices can create risk

Global energy prices surged in the third quarter of 2021, providing a glimpse of the speed with which market imbalances can feed through to consumers and prompt swift government reactions including subsidies to low-income households.

Natural gas price benchmarks in Europe and Asia were ten times higher in October 2021 than one year prior, while US month-ahead natural gas prices reached their highest level since 2008. International coal prices were also sharply higher, at five times their fall 2020 levels. Rising primary fuel prices sparked large increases in consumer electricity prices in Germany, Spain, and elsewhere in Europe. In the United States, gasoline pump prices of $3.50 per gallon were the highest in seven years. Deteriorating margins for energy providers and electricity-intensive industries such as fertilizer production forced several companies to curtail operations.

Energy prices are already a highly sensitive topic politically everywhere—even under normal circumstances. For example, according to the European Commission, 31 million Europeans live in energy poverty and are unable to adequately heat their homes. To help alleviate price rises, India, Japan, South Korea, the United Kingdom, and the United States announced in November 2021 they would be tapping into their respective strategic oil reserves. Some governments also initiated subsidy programs. These included the US government making available a $4 billion budget for the Low Income Energy Assistance Program, providing aid to more than five million families. Italy and Spain capped home energy bills and redirected utility company profits to subsidize low-income households and small enterprises.

A confluence of factors led to the price fluctuations, including a rebound in consumer activity as lockdowns related to the COVID-19 pandemic eased along with persistent labor and supply chain shortages. In some instances, weather events exacerbated the situation, including low wind speeds in the North Sea, a cold snap in Texas that led to a gas production shut-in, drought in Brazil that depleted hydropower reservoir levels to 25 percent below their five-year average, and flooding of Chinese coal mines that exacerbated shortages driven in part by the recent freeze on coal imports from Australia.

Such events, while not directly attributed to a net-zero transition, nonetheless shine a light on supply chain and grid vulnerabilities. In doing so, they can serve as a cautionary preview of potential future energy market volatility that can be triggered by rapid simultaneous shifts on the supply and demand sides of the global energy and materials landscape. For example, as reliance on renewables grows and investment in fossil fuel-based power generation declines, tight supply for raw material inputs for technologies like solar panels and batteries may compound energy price volatility given long lead times in the capital-intensive mining sector. As the world acts on net-zero pledges, periods of energy price volatility like those in the last months of 2021, among others, thus serve as a reminder of the importance of careful transition management.

Exposure to these risks would also increase with electrification as a key pillar of the transition. Power outages, whether due to the energy mix, weather, or operator error, would have far reaching consequences where households and businesses are depending on a reliable source of electricity for day-to-day needs such as heating, cooling, appliances, vehicles, and industrial applications.

As the mix of the power system shifts to renewables in the net-zero transition we have analyzed here, various factors could influence electricity costs and whether prices are passed through to end users. First, as already noted, the delivered cost of electricity would initially rise in the Net Zero 2050 scenario as power generation assets are replaced and transmission, distribution and storage capacity is built. Increases in these costs could even be higher than calculated here, with more volatility, with implications for prices and for the various reasons discussed previously. Second, storage and transmission costs, which constitute a substantial portion of the cost of electricity, could feed through to consumers in an uneven way, with some paying more while others experience savings. This will depend in part on a range of localized factors including existing transmission and distribution capacity and the need for long duration storage.

Finally, market design could be an important factor: as the power system changes, power markets may need to change with it. Today, power is sold through the spot market, in which prices are set according to production costs of the marginal power producer, and through bilateral purchase agreements between power producers and consumers. Capacity markets have historically accounted for a relatively small share of power sales, but they may play a larger role in the future to fully compensate flexible producers that help balance the grid. New market mechanisms may be needed to encourage some fossil fuel power producers to decommission their plants earlier. Key questions remain about how this would be paid for, and also how cost increases, if any, would affect end consumers.