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Cutting carbon, not economic growth: Germany's path

The country can go on cutting its greenhouse gas emissions substantially, but difficult trade-offs loom.

Anja Hartmann, Jens Riese, and Thomas Vahlenkamp

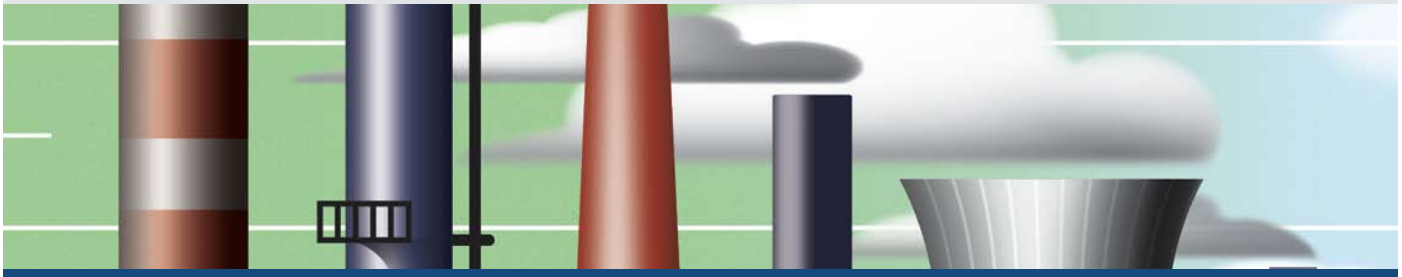
Article at a glance

By 2020, Germany could eliminate 30 percent of its 1990 level of greenhouse gas emissions, without curbing economic growth.

The country has already eliminated 17 percent of its 1990 level of emissions, largely by restructuring and modernizing the high-emissions power and industrial sectors of the former East Germany.

A study found that Germany could achieve most of the remaining cuts needed for a 30 percent reduction by increasing the use of renewable energy and implementing measures (such as better insulation in buildings) that would not only improve energy efficiency but also pay off for investors.

Cuts of more than 30 percent, however, could involve difficult trade-offs on issues such as nuclear power and the international competitiveness of Germany's energy-intensive industries.



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The government of Germany, one of the world's largest economies, has set an ambitious goal for reducing greenhouse gas emissions: as of 2020, it wants to cut them by up to 40 percent of their level in 1990, the base year under the Kyoto Protocol.[1] Our study[2] of the technological opportunities to abate the country's carbon emissions suggests that achieving a 30 percent target, while challenging, would neither curb economic growth nor require lifestyle changes or lower levels of comfort. But hitting targets higher than that could be very costly and politically contentious.

To many people inside and outside Germany, a 40 percent target may appear to be less of a stretch than it actually is. After all, the country has already reduced its emissions by 17 percent from the 1990 level, almost entirely by restructuring and modernizing the high-emission power and industrial sectors of the former East Germany. Emissions typically rise along with economic growth, and although the economy is growing, they are rising slowly overall because consumers and businesses are adopting energy-saving measures across the economy. But the country aims to reduce its emissions significantly while also phasing out its nuclear power—a zero-emission technology that generates more than a quarter of its electricity today. And to achieve major cuts, Germany can't rely solely on energy-saving measures (such as insulating buildings) that are profitable in the long term; it will also need to adopt costly approaches, like generating power through wind.

In other words, while the country has made significant strides in reducing its emissions, the next 13 percent of the reductions—to achieve a 30 percent decrease from the 1990 level—will be more challenging than the gains already realized. Reducing emissions substantially beyond 30 percent will be even more challenging and costly.

Still, German politicians, business executives, and private citizens widely agree that the country should set a positive example for any concerted international effort to reduce the flow of carbon dioxide and other greenhouse gases into the atmosphere. The German debate has been lively, but until now there has been no detailed effort to inform it about the technical and economic feasibility of various emission targets by assessing the various abatement levers.

Our evaluation (see sidebar "A uniform methodology") of the significance and cost of some 300 technological levers revealed a wide range of opportunities to reduce emissions across the energy, industrial, buildings, transportation, and agricultural sectors, without restraining economic growth. We studied what it would take to reduce emissions by 30 percent or more from the 1990 level, assuming ambitious but realistic penetration rates for each technical solution. Our study found that Germany could gain about two-thirds of the remaining cuts needed for a 30 percent reduction—even accounting for economic growth and the phaseout of nuclear power—through measures that would pay off in the long run for the decision makers who invested in these solutions, such as better insulation in buildings and greater efficiency in industrial plants. Increased use of renewable energy sources, such as wind power and biomass, account for most of the remaining third of the cuts required for a 30 percent reduction but will come at a relatively high cost.

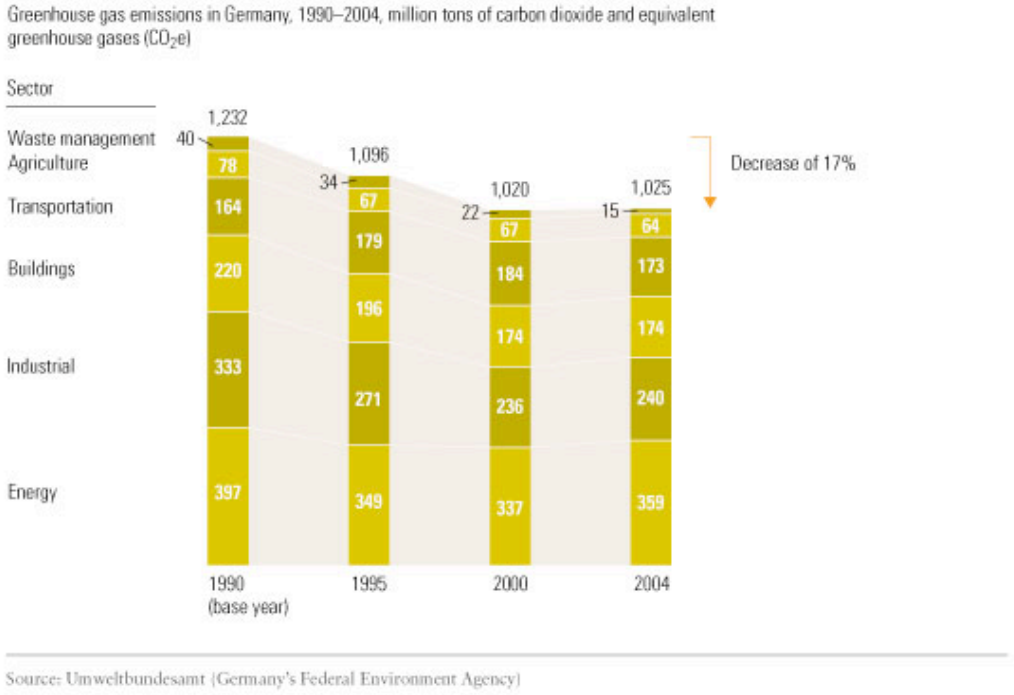
Capturing all of these opportunities—a challenging task, since they are fragmented across sectors—will require deftly designed political implementation measures, frameworks, and tools. The cost of achieving reductions beyond 30 percent would rise exponentially. The large expense of these higher aspirations may spark a public debate about the trade-offs involved in nuclear power, the global competitiveness of Germany's energy-intensive industries, and the freedom of consumers to choose the products they want, such as cars with powerful engines.

A big one-time effect

Germany's reunification and the ensuing structural transformation of East Germany's energy, industrial, buildings, and waste-management sectors contributed very strongly to the 17 percent decrease in greenhouse gas emissions already achieved. Since 2000, overall emissions have remained fairly constant, despite economic growth, as Germany adopted more energy-efficient and less greenhouse gas–intensive technologies in both the eastern and western parts of the country (Exhibit 1).

EXHIBIT 1

Holding steady since 2000



Source: Umweltbundesamt (Germany's Federal Environment Agency)

The energy sector's emissions declined after reunification as a result of lower demand for power when factories were shut down in the east and some of its power plants were renovated or replaced with cleaner technology. Since 2000, the sector's emissions have risen somewhat as a growing economy increased usage of power.

German reunification also significantly lowered industrial emissions from 1990 to 1995 as plants in the east were closed; further reductions after 1995 came largely from higher energy efficiency in German industry, in east and west alike. Many industries reduced their emissions of greenhouse gases from production processes as well.

Reunification also promoted a significant decline in the buildings sector's emissions from 1990 to 2004. Buildings in eastern Germany, especially, were extensively renovated and insulated, and low-temperature gas and oil boilers replaced high-emitting coal-fired residential heating systems. In the transport sector, however, emissions initially rose after German reunification because cross-border traffic increased. Since 2000, they have declined somewhat as more fuel-efficient passenger cars and trucks (and greater energy efficiency in rail transportation) offset higher traffic volumes.

Finally, emissions from waste management decreased across Germany by more than half from 1990 to 2004. This reduction was achieved mostly at disposal sites, by capturing methane emissions and either feeding them into the gas grid or burning them. Emissions also declined somewhat in agriculture, primarily thanks to a drop in the amount of livestock and to declining use of certain fertilizers.

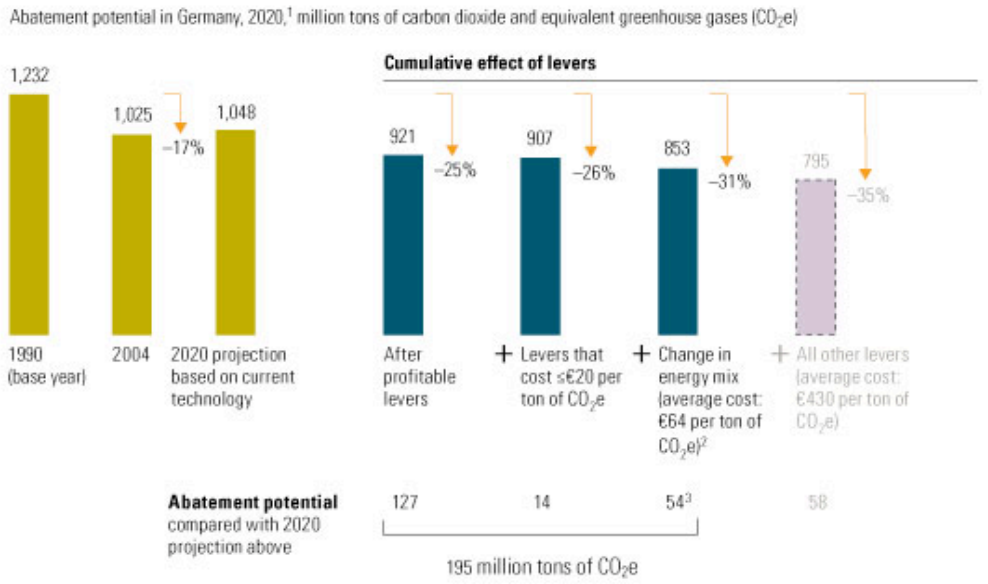
Getting to 30 percent

To determine how Germany can get from the 17 percent reduction of emissions achieved by 2004 to any 2020 target it chooses, we applied our analysis of the extent and cost of the available abatement opportunities to a baseline projection of how emissions would develop in the remaining time period. We made certain key assumptions. One is that the German economy will continue to grow by around 1.6 percent a year. Another is that when goods and facilities reach the end of their useful lifetime, residential customers, businesses, and governments will replace them with technologies that have the average energy efficiency and greenhouse gas intensity of those sold today. As average technologies replace subaverage ones, the quality of the stock as a whole gradually improves. This "current technology" projection does not assume any future technological improvements in energy efficiency and greenhouse gas intensity.

Our study estimates that greenhouse gas emissions in Germany would rise slightly from today's level, to reach 1,048 million tons of greenhouse gases in 2020, if nothing more were done to reduce them. Against this baseline, we found that the country could cut an additional 195 million tons of greenhouse gases annually by 2020 at a total cost that would neither curb economic growth nor require changes in consumer lifestyles. In this way, emissions of greenhouse gases would fall by 31 percent from the 1990 level. Cutting these 195 million tons of emissions would require the use of levers at each of three different cost levels (Exhibit 2).

EXHIBIT 2

Assessing potential targets



[1] Assumes that Germany proceeds with phaseout of nuclear power.

[2] Assumes cost of €32 per ton of CO_2e for power generation and cost of €175 per ton of CO_2e for biofuels, taking into consideration applicable subsidy rates in each case, plus taxes and customs.

[3] Includes elimination of 6 million tons of CO_2e through pilot carbon-capture-and-storage (CCS) projects in power generation.

Source: McKinsey, *Costs and Potentials of Greenhouse Gas Abatement in Germany*, for Federation of German Industries' (BDI) Business for Climate Protection initiative

1. We identified a total of 127 million tons that could be eliminated by 2020 through the use of levers generating a positive payoff for the companies or consumers that adopted them. The costs of abatement would be recouped within the amortization period. This degree of potential abatement assumes that investments would be made in the most energy-efficient technologies available today and that some of them will be enhanced in the foreseeable future, improving the stock beyond the level assumed in the current-technology projection. These levers include heating systems, insulation for buildings, electrical drives in industrial plants, and power trains in cars.

2. An additional 14 million tons of greenhouse gases could be eliminated at a cost of up to €20 a ton by implementing a number of industry-specific measures in certain production areas. These include the capture and decomposition of the greenhouse gas nitrous oxide in the manufacture of adipic acid, higher efficiency in new lignite power plants, and the increased use of combined heat and power (CHP) plants.

3. Changing the energy mix in Germany toward the use of less emission-intensive sources of power—primarily wind power and biomass in the energy sector and biofuels in the transportation sector—could eliminate an additional 54 million tons of greenhouse gases. The cost of these abatement levers is relatively high: an average of €32 a ton and €175 a ton in the energy and transportation sectors, respectively. (As a point of reference, since trading under the EU's Emission Trading Scheme began, the price of emission certificates has ranged from €6 to €31 a ton.) These measures will probably be implemented, as they currently enjoy broad political support and are already partially subsidized under Germany's Renewable Energy Sources Act (EEG).[3]

The energy, industrial, buildings, transportation, and agricultural sectors can each contribute substantially to achieving this level of abatement—195 million tons—by reducing emission volumes roughly equal to their current share of total emissions (see sidebar "Abatement by sector").

Painful trade-offs

Germany would face difficult trade-offs if it decided to aim for emission cuts substantially beyond 30 percent by 2020. Such a target could be achieved if the government accelerated cycles of investment in abatement technology by way of incentives or other public-policy measures or restricted economic growth or the quality of life. Neither of these possibilities entered into our calculations, however. Otherwise, we found only two ways to reach higher targets, and both are painful.

One is to use a number of levers that could abate an additional 58 million tons of greenhouse gases annually, which along with the measures already described would provide for a 35 percent cut in emissions. But these technologies generally have abatement costs far higher than €20 a ton—and in some cases, such as hybrid cars, up to several thousand euros. In fact, each percentage point of abatement beyond 31 percent would exponentially increase costs, both for the companies directly affected and for the overall economy. Just reducing emissions by 32 percent (instead of 31) as of 2020 would add over €450 million a year to the cost of abatement.

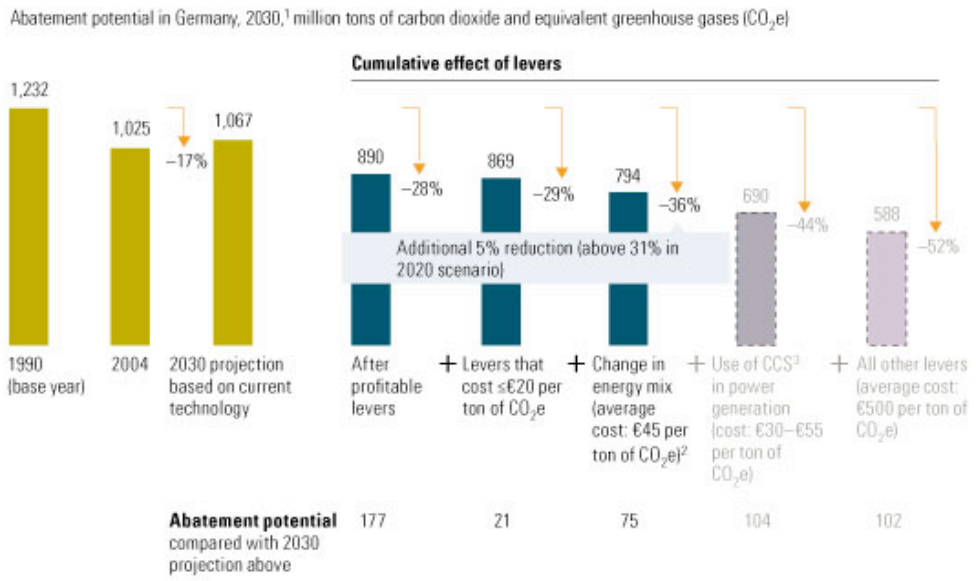
The other possibility involves nuclear power, which Germany has decided to phase out by 2025. There is a strong popular consensus to stand by that decision. Our analysis shows that if the German people and their leaders decided to delay the phaseout, an additional 90 million tons of greenhouse gases[4] could be abated by 2020, without extra costs. Combined with the 195 million tons achieved in the 31 percent scenario, delaying the phaseout of nuclear power could reduce emissions by 38 percent from the 1990 level. The cost would be about €4.5 billion a year lower than that of the basic scenario described in this article.

Beyond 2020—betting on carbon storage

If Germany cuts 31 percent of its greenhouse gas emissions by 2020, we estimate that it could reduce them by an additional 5 percent—to 36 percent, compared with the 1990 level—by 2030 if it merely continued to implement the abatement measures in the 31 percent scenario (Exhibit 3). We assume that these technologies would penetrate further (mainly in the automotive and industrial sectors and as buildings were renovated) and that more power would be generated from renewable energy sources, particularly offshore wind parks.

EXHIBIT 3

Further reductions possible



[1] Assumes that Germany proceeds with phaseout of nuclear power.

[2] Assumes cost of €32 per ton of CO_2e for power generation and cost of €175 per ton of CO_2e for biofuels, taking into consideration applicable subsidy rates in each case, plus taxes and customs.

[3] Carbon capture and storage.

Source: McKinsey, *Costs and Potentials of Greenhouse Gas Abatement in Germany*, for Federation of German Industries' (BDI) Business for Climate Protection initiative

The potential for cuts beyond 36 percent is more uncertain. Innovative technologies in all areas could abate emissions further but will be promising only if Germany and the world community can resolve broader regulatory issues. A case in point is carbon capture and storage (CCS), a technology for separating the greenhouse gases emitted by coal and natural gas–fired power plants and energy-intensive industries (especially steel and cement) and then storing those gases in natural underground cavities. This technology, which appears to be Germany's single biggest opportunity to go on reducing emissions substantially from 2020 to 2030, faces major obstacles.

Carbon capture and storage could reduce emissions by an additional 104 million tons of greenhouse gases a year. Combined with the cuts described above, it would reduce emissions by 44 percent compared with the 1990 level by 2030. We estimate that this technology will cost €30 to €50 a ton in the energy sector and €45 to €55 a ton in the industrial sector.

Yet the hurdles for introducing carbon capture and storage are high. The safety regulations and processes for granting permits must be implemented soon if over 100 million tons of greenhouse gases a year are to be transported and stored in suitable underground cavities by 2030. The pilot projects already initiated must move at a fast pace to reach technical maturity as soon as possible. Moreover, it isn't clear that the German public would accept the required infrastructure—for instance, above-ground pipelines to transport the greenhouse gases and underground storage cavities to contain them.

Finally, an important point: unless the technology is regulated through an international framework, its implementation in Germany would make the country's energy-intensive industries, such as steel and cement, less competitive in world markets. The effects on power generation alone would raise the cost of electricity by €15 to €25 per megawatt hour, which would especially affect industries with high electricity consumption, such as producers of nonferrous metals.

Germany is well positioned to reduce its carbon footprint significantly. The challenge is to do so without putting the economy's wealth and competitiveness at risk. But if the country succeeds, it would create opportunities for many German businesses, which are already among the leaders in developing ways to abate greenhouse gas emissions. If Germany can develop an international market for these solutions, its businesses could strengthen their global position—for example, in power plant engineering, electronics, chemicals, and alternative energy.

A uniform methodology

We used a standardized methodology across industries to evaluate all key technical levers—a total of more than 300—for reducing greenhouse gas emissions in Germany through 2020 and 2030. For each lever, we quantified the possible abatement in million tons of greenhouse gases and the abatement costs in euros per ton.

Our evaluations reflect ambitious but realistic penetration rates for each technical solution. We based all calculations on the regular investment cycle, determined by the standard lifetime of factories, equipment, or goods.[5] The abatement costs quantified are the costs or savings that would result for decision makers (companies and consumers) investing in a more energy-efficient or less emission-intensive solution. The study did not consider levers that would diminish the quality of life or require economic activity to move abroad.

For the most part, the technologies we evaluated are available today or have reached an advanced stage of development. We assumed that Germany would maintain the current quality and scope of its existing infrastructure (for instance, power grids and the traffic infrastructure) and phase out nuclear power as planned.

This study did not assess the political implementation measures, frameworks, and tools needed to achieve the abatement targets.

Abatement by sector

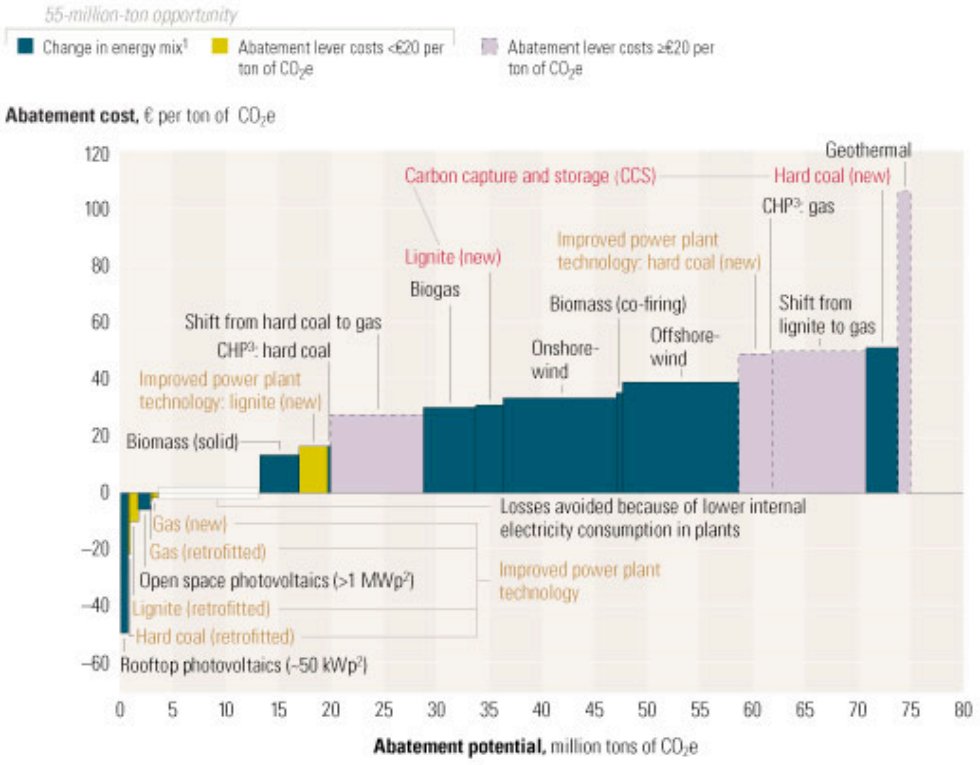
All economic sectors in Germany can contribute significantly to a 31 percent reduction of the country's greenhouse gas emissions by 2020. The required 195 million tons of abatement would call for the use of levers at each of three cost levels: measures that improve energy efficiency and are profitable in the long term, technology that costs up to €20 a ton, and less emission-intensive sources of power generation at a higher cost. The types of measures and the corresponding expense vary considerably across sectors.

Energy

The energy sector could reduce its greenhouse gas emissions by 55 million tons. Renewable energy sources now account for a good 10 percent of the power generated in Germany. Increasing their share to about a quarter would cut the sector's greenhouse gas emissions by 34 million tons as of 2020. (Of this total, onshore and offshore wind power would cut emissions by 11 million tons each, biomass by 9 million tons, and solar power and other technologies by 3 million tons.) Pilot projects to capture and store carbon dioxide from power plants would reduce emissions by 6 million tons.

Reduced demand for electricity as a result of energy-efficiency improvements in the industrial and the buildings sectors and in rail transportation would decrease emissions in the energy sector too—by 10 million tons—because of lower internal electricity consumption at power plants and reduced grid losses. Finally, 5 million tons of emissions would be eliminated by retrofitting older power plants with more efficient technology or by optimizing the efficiency of newly built plants.

Costs or savings that would result for decision makers (companies and consumers who invest in these solutions) in Germany's energy sector, 2020,[1] measured in tons of carbon dioxide and equivalent greenhouse gases (CO_2e).



[1] Assumes Germany proceeds phaseout of nuclear power.
[2] MWp = megawatt peak; kWp = kilowatt peak.
[3] CHP = combined heat and power.

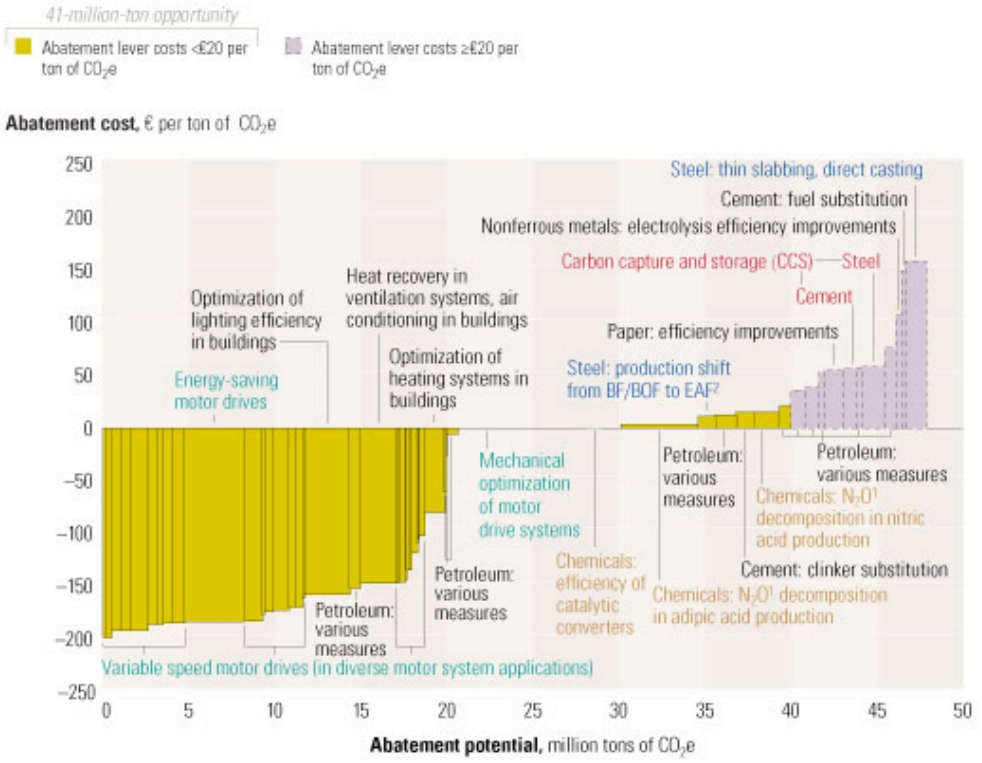
Source: McKinsey, *Costs and Potentials of Greenhouse Gas Abatement in Germany*, for Federation of German Industries' (BDI) Business for Climate Protection initiative

Industrial

The industrial sector could cut 41 million tons of emissions, partly by improving its energy efficiency (for example, through the use of variable-speed drives in motor systems) and partly by capturing greenhouse gases (in the production of chemicals, among other things). Investors would gain from efficiency-enhancing measures eliminating 30 million tons of greenhouse gases; measures to eliminate the remaining 11 million tons would cost up to €20 a ton.

Energy efficiency in production processes would increase on average by 1.6 percent a year up to 2020 if these measures were implemented. Greenhouse gas emissions from industry would be 25 percent lower in 2020 than they were in 1990.

Costs or savings that would result for decision makers (companies and consumers who invest in these solutions) in Germany's industrial sector, 2020,[1] measured in tons of carbon dioxide and equivalent greenhouse gases (CO_2e)



[1] N_2O = nitrous oxide.
[2] BF = blast furnace; BOF = basic oxygen furnace; EAF = electric arc furnace.

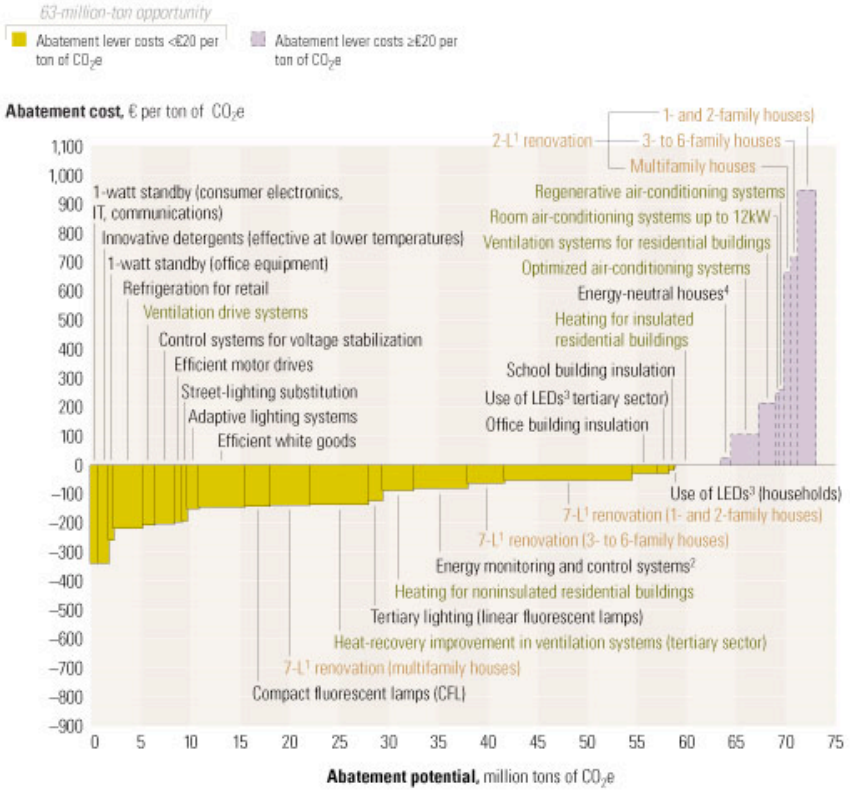
Source: McKinsey, *Costs and Potentials of Greenhouse Gas Abatement in Germany*, for Federation of German Industries' (BDI) Business for Climate Protection initiative

Buildings

The buildings sector can eliminate 63 million tons of greenhouse gases by implementing measures to reduce energy consumption and increase energy efficiency—for instance, better insulation, the replacement of heating systems, and the installation of energy-efficient electrical devices and lighting. All of these measures pay off for the decision makers.

Yet implementing such improvements often requires overcoming substantial obstacles, including the huge investments needed, relatively long amortization periods of more than ten years, and the unequal distribution of costs and benefits (for example, property owners pay for more efficient heating systems and tenants reap the benefits in the form of lower heating bills). If the buildings sector can fully achieve its realistic potential for abatements, it could reduce emissions by nearly 30 percent as of 2020 compared with the 1990 level.

Costs or savings that would result for decision makers (companies and consumers who invest in these solutions) in Germany's building sector, 2020,[1] measured in tons of carbon dioxide and equivalent greenhouse gases (CO_2e)



[1]Targeted annual energy consumption of heating oil: 7 liters (7-L) and 2 liters (2-L) of heating oil per square meter of space.
[2]For example, as used in energy performance contracting: cost savings from reduced energy consumption help repay cost of installing energy conservation measures.
[3]Light-emitting diodes.

Source: McKinsey, *Costs and Potentials of Greenhouse Gas Abatement in Germany*, for Federation of German Industries' (BDI) Business for Climate Protection initiative

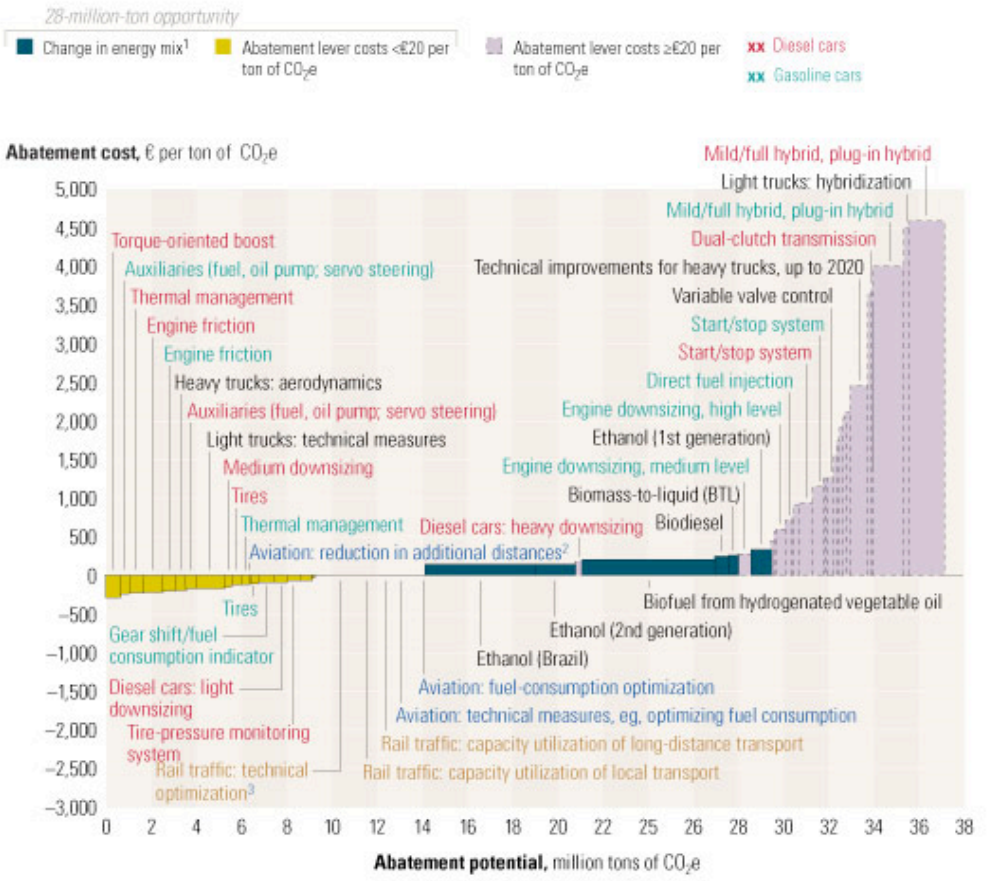
Transportation

Emissions of greenhouse gases could fall by 28 million tons in the transportation sector. Half of the opportunity comes mainly from technology to improve fuel efficiency, which often gives end users an economic benefit. In road traffic, the most important lever for cars and light trucks is the further improvement of gasoline and diesel engines.

Biofuels, which account for some 5 percent of total fuel consumption, represent the other half of the opportunity. If their share of the fuel mix increased to the target level of 17 percent, emissions of greenhouse gases would fall by 14 million tons, at an average cost of €175 a ton.

If all these measures were implemented, the transportation sector's greenhouse gas emissions could fall by 7 percent compared with their 1990 level.

Costs or savings that would result for decision makers (companies and consumers who invest in these solutions) in Germany's transportation sector, 2020,[1] measured in tons of carbon dioxide and equivalent greenhouse gases (CO_2e)



[1] Assumes Germany proceeds with phaseout of nuclear power.
[2] For example, reducing holding patterns over airports, opening up no-fly zones.
[3] For example, increase capacity utilization by adjusting timetables and train lengths.

Source: McKinsey, *Costs and Potentials of Greenhouse Gas Abatement in Germany*, for Federation of German Industries' (BDI) Business for Climate Protection initiative

Anja Hartmann is a principal in McKinsey's Hamburg office, **Jens Riese** is a principal in the Munich office, and **Thomas Vahlenkamp** is a director in the Düsseldorf office.

Agriculture
An additional 9 million tons of greenhouse gases could be eliminated if farms shifted toward organic practices and if the livestock industry took steps to reduce methane emissions from cattle.

Notes

[1]The German government has said it will target a 40 percent cut if the European Union lifts its abatement goal to 30 percent, from the current 20 percent. The European Union has announced that it intends to aim for the 30 percent target if high-emitting countries in other regions pledge comparable reductions within the framework of an international climate agreement.

[2]McKinsey conducted the study, from May to September 2007, on behalf of the Federation of German Industries' (BDI) Business for Climate Protection initiative. More than 70 companies and associations participated in assessing some 300 levers for abating greenhouse gas emissions in Germany. The study analyzed and evaluated the latest research on technological trends, and all results were discussed in numerous interviews with leading experts.

[3]Our estimate of the abatement costs considers all benefits for investors—for instance, EEG payments, which in 2006 amounted to €3.2 billion. By 2020, the volume of payments is expected to increase to some €4 billion a year. For biofuels, we assumed that the current benefits will expire by 2020. We assumed that existing ethanol import tariffs, which contribute significantly to the high abatement cost of biofuels, will remain in place up to 2020.

[4]After the nuclear phaseout, about 150 terawatt hours of gross electricity production from nuclear power stations would have to be replaced, primarily by generation from high-emission coal- and gas-fired power plants.

[5]Implementing abatement levers outside the normal investment cycle would generally raise their cost—in some cases, quite considerably.

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