

How Policies to Reduce Greenhouse Gas Emissions Could Affect Employment

Summary and Introduction

Human activities around the world are producing increasingly larger quantities of greenhouse gases, particularly carbon dioxide resulting from the use of fossil fuels and from deforestation. Because of concerns that the accumulation of such gases in the atmosphere will result in a variety of environmental changes over time that would have serious and costly effects, policies to reduce those emissions are being considered. Such policies would impose costs on the U.S. economy and affect patterns of employment throughout the country.

Adopting policies aimed at reducing emissions of greenhouse gases would shift the demand for goods and services away from fossil fuels and products that require substantial amounts of those fuels to make or to use and toward alternative forms of energy and products that require lesser amounts of fossil fuels. Employment patterns would shift to mirror those changes in demand. Changes in employment in specific industries would reflect the amounts of greenhouse gases they emit (through production and use of their output) and the difficulty of reducing their emissions of those gases.

The Congressional Budget Office (CBO) has analyzed the research on the effects that policies to reduce greenhouse gases would have on employment and concluded that total employment during the next few decades would be slightly lower than would be the case in the absence of such policies. In particular, job losses in the industries that shrink would lower employment more than job gains in other industries would increase employment, thereby raising the overall unemployment rate. Eventually, however, most workers who lost jobs would find new ones. In the absence of policies to reduce emissions of greenhouse gases, changes to the climate also might affect employment; however, this brief does not address such changes because that effect would probably arise after the next few decades, and it has not been studied as carefully by researchers.

Various industries would be affected differently by policies to reduce greenhouse gas emissions:

- Coal mining would probably see the largest percentage decline in employment. Among fossil fuels—coal, petroleum, and natural gas—coal, when it is burned, produces more greenhouse gases per unit of energy than do the others. Moreover, coal is widely used to generate electricity, and electric utilities have some ability to substitute other sources of energy for coal. A mitigating factor for the coal mining industry could be the development of technologies to capture and store emissions of coal-fired power plants.
- Employment in oil and gas extraction and natural gas utilities would also be expected to decline as those fuels became more expensive and the demand for them declined. In percentage terms, the decline would be smaller than that in coal mining, though. Because oil is widely traded on international markets, continued demand for it in other countries that did not implement emission-reduction policies would lessen some of the effects of the decline in domestic demand. Because the use of natural gas to generate electricity produces smaller quantities of greenhouse gases than does the use of coal, demand would probably shift from coal to natural gas in some instances, offsetting some or all of the reduction in demand for natural gas that would otherwise occur.
- Mining (for materials other than coal), construction, and the industries that produce metals, nonmetallic mineral products (such as glass), chemicals, and transportation services—all of which use relatively large amounts of energy directly or indirectly—would probably also experience reductions in employment, although the percentage declines would be relatively small.

- Over time, employment would increase in industries and sectors (such as services) whose products are less emission-intensive to produce and result in fewer emissions when used. Employment also would increase in industries that manufacture equipment for the production of energy using low-emission technologies such as nuclear, solar, and wind power.

Effects on Total Employment

By raising the prices of goods and services in proportion to the greenhouse gas emissions associated with their production and consumption, most policies to reduce emissions would affect total employment as well as the number of jobs available in various industries. Although many factors would influence the magnitude of those effects, of particular importance is how quickly and extensively labor markets would respond to sustained increases in energy prices.

If businesses and workers adapted to the changing market conditions quickly—by shifting away from industrial processes that produce greenhouse gases, by adjusting product prices and wages accordingly, and (in the case of workers laid off from shrinking industries) by obtaining any necessary retraining and moving to locations of expanding industries to find employment—then the effect on the aggregate unemployment rate might be relatively small and short-lived. If, alternatively, businesses and workers adapted less rapidly, the effect would be greater and last longer.

A gradually increasing tax on greenhouse gas emissions or a cap-and-trade program like the one that would be authorized by H.R. 2454, the American Clean Energy and Security Act of 2009, would probably have only a small effect on total employment during the next few decades.¹ The experience of the U.S. economy over the past half-century in adjusting to a sustained decline in

manufacturing employment provides evidence that the economy can absorb such long-term changes and maintain high levels of overall employment. From a peak of almost 20 million jobs in 1979, manufacturing employment fell to about 14 million jobs in 2007, but increasing employment in other sectors of the economy offset that decline. For example, from 2000 through 2007, employment in manufacturing fell by 3.5 million jobs, while employment in other sectors increased by 8.2 million jobs.

The increases in prices caused by a tax or a cap-and-trade program would cause workers' real (inflation-adjusted) wages to be lower than they would otherwise be. Nearly all workers would choose to remain in the workforce and accept those wages. However, a small percentage might choose to work fewer hours or not at all, resulting in slightly lower total employment than would be the case in the absence of the policy.

Effects on Workers

While the economy was adjusting to the emission-reduction program, a number of people would lose their job, and some of those people would face prolonged hardship.² The ability of employers to adjust the size of their workforce quickly in response to changes in demand is generally considered a source of strength for the U.S. economy, as resources (both capital and labor) are able to shift to sectors with higher productivity. Each year, millions of people are unemployed—that is, without a job and looking for work—for some time. Many of those workers are employed within a month or so. However, following the introduction of an emission-reduction program, some people who lost their job in a shrinking industry would have a difficult time finding a new job quickly. Some would leave the labor force altogether.

For many of those who lost their job in a shrinking industry, finding a new job would require substantial effort, flexibility, and time. Some would need to learn how to search effectively for a new job. Some would need to acquire new skills more suited to the job opportunities available to them. Some, especially those in communities with limited job opportunities outside of the shrinking

1. A cap-and-trade program would set annual limits, or caps, on total emissions of greenhouse gases and would require entities regulated by the program to hold rights, or allowances, to emit greenhouse gases. After such allowances were initially distributed, entities would be free to buy and sell them (the trade part of the program). For further information, see Congressional Budget Office, *The Economic Effects of Legislation to Reduce Greenhouse-Gas Emissions* (September 2009). The employment effects of any particular legislation could depend on the details of that legislation. This brief does not address such effects for any specific piece of legislation.

2. See Congressional Budget Office, *Long-Term Unemployment* (October 2007) and *Losing a Job During a Recession*, Issue Brief (April 2010).

industries, would need to relocate to new areas with better job prospects.

Even among those who found a new job relatively quickly, many would probably discover that the knowledge they acquired in the old job did not translate perfectly to the new one. Those workers would probably see their earnings decline, even after being reemployed. Moreover, that decline in earnings would probably persist for a long time. For example, for men who lost a job as a result of a mass layoff during the 1982 recession, earnings 15 to 20 years later were still about 20 percent lower on average than they were for similar men who did not lose their job.³

Declines in earnings would not be the only difficulty facing those who lost a job. Some people would lose health insurance coverage associated with their previous employer, though the recently enacted health care legislation will provide new opportunities for individuals to purchase health insurance. Moreover, people who lose their job tend to have more health problems later in life, and losing a job can cause family life to suffer.⁴

In cases in which a shrinking industry was the primary employer in a community, the entire community could suffer. The loss of employment and economic activity could erode the tax base, and homes could decline in value as laid-off workers sold their homes and moved away in search of employment opportunities elsewhere.

Effects on Employment in Different Industries

The effects of an emission-reduction policy would vary substantially from industry to industry. Employment in emission-intensive industries and in industries whose products generate comparatively large amounts of greenhouse gases when used would be lower than what it would be in the absence of the policy—either because

employment in those industries would grow more slowly or because it would decline. Meanwhile, employment in other industries would be higher than what it would be in the absence of the policy.

Conclusions about the magnitude of effects on employment in specific industries during the next two decades are highly uncertain. That uncertainty occurs because such forecasting is inherently difficult and because synthesizing results from existing studies is complicated by differences in the policies that are considered and in the assumptions used about the types and costs of technologies adopted in the future and about the flexibility of the labor market to adapt to change. In addition, the details of the emission-reduction policies could affect employment for particular industries.

Some General Considerations

Under an emission-reduction program, industries that produce carbon-based energy—coal mining, oil and gas extraction, and petroleum refining—would probably lose the most jobs in percentage terms relative to employment without the program. In addition, industries that use those forms of energy intensively, either directly or indirectly through other inputs, would also probably experience declines; an example is the transportation industry, which relies on petroleum products and on equipment made from metals (such as steel and aluminum) that require substantial amounts of energy to produce.

Industries that would be likely to gain employment as a result of the policy include those that produce alternative forms of energy, such as wind, solar, and nuclear energy, or the equipment to produce those forms of energy. In addition, industries and sectors that do not use substantial amounts of carbon-based energy either directly or indirectly—for example, most services—would probably employ more people than they would without the policy.

International competition, which varies significantly from industry to industry, would also affect employment patterns.⁵ If major U.S. trading partners did not implement comparable programs, a U.S. program would put domestic firms in emission-intensive industries at a disad-

3. See Till von Wachter, Jae Song, and Joyce Manchester, “Long-Term Earnings Losses Due to Mass Layoffs During the 1982 Recession: An Analysis Using U.S. Administrative Data from 1974 to 2004” (working paper, April 2009), available at www.columbia.edu/~vw2112/papers/mass_layoffs_1982.pdf.

4. See Sarah A. Burgard, Jennie E. Brand, and James S. House, “Toward a Better Estimation of the Effect of Job Loss on Health,” *Journal of Health and Social Behavior*, vol. 48, no. 4 (December 2007), pp. 369–384.

5. For additional detail, see the statement of Peter R. Orszag, Director, Congressional Budget Office, before the House Committee on Ways and Means, *Issues in Designing a Cap-and-Trade Program for Carbon Dioxide Emissions* (September 18, 2008).

vantage relative to their foreign competitors. The result would be reduced exports, increased imports, and, consequently, a greater decline in employment in those industries.

Estimating the Magnitude of the Employment Effects

CBO has reviewed economic modeling studies that project the effects of emission-reduction programs on employment in various industries. Of particular relevance are three studies—by analysts at Resources for the Future (RFF), the Brookings Institution, and the consulting firm CRA International—that present results for industries spanning the entire economy and that use models designed to analyze economywide policies in long-term equilibrium.⁶ (See Box 1 for additional details about the studies.)

CBO's analysis focused on two years—2015 and 2025. Those two years show, respectively, a short-term and a longer-term response in the economy. In 2015, the policies would have been in place for only a few years and businesses would have had relatively little opportunity to change their capital stocks and make other long-term changes. In contrast, by 2025, businesses would have had more opportunity to make those changes, although significant economic changes might still occur even after that year.

Projections of effects on employment in specific industries are difficult to produce and vary from study to study for two broad reasons. First, the studies differ in the design of the policy that is modeled. In particular, the studies model policies that would reduce emissions by different amounts; and they differ in whether other policies, such as free distribution of allowances (permits to emit greenhouse gases equivalent to a ton of carbon dioxide) to heavily affected industries or transition assistance for workers, are assumed to accompany the

emission-reduction requirements. Second, the studies use different models of the U.S. economy and rely on different assumptions. Some of those assumptions relate to the types and costs of technologies that would be adopted, the development of emission-reducing technologies over time, and the difficulties that different industries would have shifting away from producing greenhouse gases. There is little basis for evaluating the accuracy of those assumptions because they depend on unknown future technologies. Other assumptions relate to the rate at which wages adjust in response to policy changes.

A number of the differences in the studies—especially the differences in the amount by which emissions are reduced and in the cost of alternative energy sources—manifest themselves at least in part through the projected price on emissions that would arise under the policies; that projected price varies substantially from study to study.⁷ To improve comparability among the studies, CBO scaled their projected changes in employment to reflect a common price on emissions. Because two of the three studies examined emission-reduction policies similar to the one envisioned in H.R. 2454, CBO chose to scale the results to its own projections of the prices of allowances under that bill, which are (in 2007 dollars) about \$18 in 2015 and about \$30 in 2025. Thus, if CBO's estimate of the price of emissions in 2015 was 10 percent more than the price projected in one of the studies, CBO increased the employment effects shown by that study for that year by 10 percent. Because of the scaling, none of the projected employment changes presented in this brief are the actual values presented in the studies themselves.

The scaled results should be viewed as rough approximations because the employment effects projected by each study may not be strictly proportional to the price placed on emissions as assumed in the scaling procedure. Moreover, scaling cannot adjust for all of the differences in assumptions among the studies. Scaling also cannot eliminate the sizable uncertainty that surrounds such estimates, and the ranges of estimates reported here may not fully encompass that uncertainty.

Projections of the shifts in employment are highly uncertain because they are sensitive to a number of factors that

6. Mun S. Ho, Richard Morgenstern, and Jhih-Shyang Shih, *Impact of Carbon Price Policies on U.S. Industry*, Discussion Paper 08-37 (Washington, D.C.: Resources for the Future, November 2008); Warwick J. McKibbin and others, *Consequences of Alternative U.S. Cap-and-Trade Policies: Controlling Both Emissions and Costs* (Washington, D.C.: Brookings Institution, July 2009); and David Montgomery and others, *Impact on the Economy of the American Clean Energy and Security Act of 2009 (H.R. 2454)* (prepared by CRA International for the National Black Chamber of Commerce, May 2009). CBO found other studies, but each of them either used an econometric model designed primarily for analyzing short-term macroeconomic fluctuations and policy changes that are narrow in scope or presented estimates only for the short term or for selected industries.

7. Some assumptions can have effects besides those on the projected price of emissions. For example, assumptions concerning when and at what cost coal-fired power plants would be able to capture and store their emissions would manifest themselves partly through the price of emissions but would also affect the relative cost of coal and other forms of carbon-based energy.

Box 1.**Some Details About the Studies Surveyed in This Issue Brief**

The studies surveyed in this issue brief all rely on what are termed general-equilibrium models to project the effects that adopting a policy to reduce greenhouse gas emissions would have on employment in individual industries and groups of industries that collectively span the entire economy. The studies nevertheless differ in a number of important respects, only some of which can be accounted for (or partially accounted for) by the scaling procedure that the Congressional Budget Office (CBO) used to make the studies' results more comparable.

The study by analysts at Resources for the Future (RFF) projects the economic effects of a tax of \$10 per ton of carbon dioxide. The study divides the economy into 21 industries. It assumes that other countries do not impose their own emission-reduction programs and that the United States does not impose a tax on imports in proportion to the greenhouse gases emitted in their production (although it does impose one on imports of coal, oil, and natural gas). Thus, the tax on carbon dioxide puts emission-intensive producers in the United States at a disadvantage relative to their foreign competitors, leading to larger projected negative effects on employment in the United States. The study assumes that wages are sufficiently flexible to restore full employment for its medium-run and long-run projections, which CBO scaled to obtain the projected losses for 2015 and 2025, respectively.

The study by analysts at the Brookings Institution projects the economic effects of reducing carbon dioxide emissions by 2050 to a level 83 percent lower than what occurred in 2005. In the study, caps on emissions apply only to carbon dioxide from fossil fuels, which represented 94 percent of U.S. emissions of carbon dioxide in 2007 and more than 80 percent of U.S. greenhouse gas emissions as measured in carbon dioxide equivalents. The study divides the economy into 12 industries. In the model used for the study, employment adjusts gradually to new policies, and physical capital cannot easily move between industries (which is an assumption similar to the one

underlying the RFF study's medium-run projections). The Brookings study assumes that all other countries act to reduce emissions regardless of whether the United States does or not. Therefore, implementing an emission-reduction program in the United States would eliminate a competitive advantage held by emission-intensive U.S. firms. The study presents estimates for several scenarios; for this brief, CBO uses the estimates from a scenario that reduces emissions by 20 percent by 2020, 40 percent by 2030, and 83 percent by 2050. Those reductions are similar to the targets contained in H.R. 2454, the American Clean Energy and Security Act of 2009.

The CRA International study projects the effects of major provisions of H.R. 2454. Those include the phased reduction of greenhouse gas emissions to 83 percent below 2005 levels by 2050, free allocations of many of the emission allowances to industries, the requirement that specified percentages of a baseline level of electricity be produced from renewable resources, and allocations of allowances to spur investment in technologies to capture and store emissions. In reporting effects, the study divides the economy into nine industries. It assumes that all countries satisfy their obligations under the Kyoto agreements, that other countries do not change their behavior when the United States implements its program, and that no border adjustments (import taxes or export subsidies in proportion to emissions embodied in traded goods) are imposed. The study uses a detailed model of the electricity industry. Rather than assuming that wages adjust gradually to restore full employment, the study assumes that they adjust immediately to any policy change, but by only one-half of the amount required to equate the supply of labor with demand, and that the remaining adjustment does not occur during the forecast period, which extends through 2050. As a result of that assumption, the study projects that, in 2050, total aggregate employment remains 1.1 percent below the baseline amount for that year. That long-term reduction in aggregate employment is reflected in the study's projections of changes in employment by industry.

are difficult to forecast with confidence. For example, industries' abilities to adjust production processes to reduce the use of emission-intensive materials, parts, and other inputs are not well known, so forecasts of such behavior are difficult and uncertain. Moreover, the pace of development and cost of significant new technologies cannot be forecast with confidence. Examples include technologies for making use of alternative sources of energy that are less emission-intensive than those in common use today, for reducing emissions from the use of current sources of energy, and for making production processes more energy efficient. Those uncertainties are compounded by the challenges of estimating the economic effects of a policy that would be implemented over the course of several decades. Furthermore, the pace of adjustment of the economy and employment to the changes in policy and technology is uncertain, and, as some studies indicate, complete adjustment could take many years.

The employment changes resulting from an emission-reduction program would occur in a context of ongoing changes in industries' employment levels that are occurring for other reasons. The projected changes presented here are the changes relative to what employment would otherwise be in the year in question in the absence of the program—not relative to current employment. The two would be different for any industry in which employment is growing or shrinking for other reasons.

Two important characteristics of the employment projections should be noted. First, employment varies substantially from industry to industry. For example, industries that produce fossil fuels, which would probably experience large percentage reductions in employment, are much smaller than other sectors of the economy, such as services, which employ many more people. Consequently, the largest absolute changes in employment might occur in service industries and others that would have relatively small percentage changes in employment, rather than in industries directly involving coal, oil, and natural gas, which would have the largest percentage changes in employment (see Figure 1).

Second, one of the differences among the studies for which scaling cannot adjust is the assumed flexibility of the labor market. The RFF study anticipates that wages will adjust quickly enough that there will be full employment in the medium and long terms. Consequently, its estimates for those time frames (which CBO scaled to

produce the estimates for 2015 and 2025) show increases in employment in the electricity-generating industry and in services other than transportation roughly offsetting the decreases in employment in other industries. Similarly, the Brookings study's expectations about wages produce estimates that show increases in employment in services roughly balancing out decreases in other industries in 2025, although not in 2015. The CRA International study assumes less flexibility, and as a result, it projects that the economy and employment would not fully adjust even by 2025 and that the losses in employment would be larger than the gains.

CBO's views on the flexibility and responsiveness of wages are closer to those that are reflected in the studies by RFF and Brookings than to the views in the study produced by CRA International. Generally, CBO believes that the economy is responsive and flexible over time and would gradually adapt to constraints on emissions. The increases in prices caused by an emission-reduction program would cause workers' real wages to be lower than they would otherwise be, on average, but nearly all workers would choose to remain in the workforce and accept those wages. A small percentage might choose to work fewer hours or not at all, resulting in slightly lower total employment than would be the case in the absence of the program.

Carbon-Based Energy Production

A tax on emissions or a cap-and-trade program would significantly reduce the demand for fossil fuels such as coal and oil, and it would therefore similarly reduce employment in the industries that mine and process those fuels. Such a policy could also affect employment by electric utilities, although the direction of that effect is unclear.

Carbon-Based Fuels. Of the industries that produce fossil fuels, the coal mining industry would probably see the largest percentage decline in employment because burning coal produces more greenhouse gases per unit of energy than burning oil or natural gas does. Moreover, coal is widely used in generating electricity, and electric utilities have some ability to substitute other sources of energy for coal. A potential mitigating factor for the coal mining industry is the possible development of technologies to capture and store emissions of coal-fired power plants.

Currently, under the industry definitions in the RFF study, the coal mining industry employs about

100,000 people. According to the three studies that CBO reviewed, under an emission-reduction program, by 2015 employment in the industry would decline by 10 percent to 18 percent relative to employment without such a program. Over the longer term, employment in the industry would decline even further. By 2025, it would fall by nearly 20 percent according to the Brookings study, by nearly 30 percent according to the RFF study, and by more than 35 percent according to the CRA International study.

Employment in oil and gas extraction and natural gas utilities taken together as a group—currently totaling more than 500,000—would also be expected to decline as oil and natural gas became more expensive and the demand for them declined. As a percentage of the people employed, the likely effects are smaller, however, than the decline in coal mining. Because oil is widely traded on international markets, continued demand for it in other countries that did not implement emission-reduction programs would mitigate some of the effects of the decline in domestic demand. Because natural gas produces smaller quantities of greenhouse gases than do coal and petroleum fuels, demand would probably shift from coal and oil to natural gas in some instances. For example, some electricity producers might switch from coal to natural gas as a fuel, thus offsetting some or all of the reduction in demand for natural gas that would otherwise occur.

By the estimates from the Brookings study, employment in oil and gas extraction would decline by about 8 percent by 2015 and 16 percent by 2025 relative to what it would be otherwise. The estimates from the RFF study indicate that employment in oil extraction alone (that study includes gas extraction with gas utilities rather than with oil extraction) would decline by about 4 percent by 2015 and 8 percent by 2025 relative to what it would be otherwise. In contrast, according to the CRA International estimates, the decline would be only 1 percent for both years.

Employment in natural gas utilities would be essentially unchanged by 2015 or by 2025 in percentage terms, according to the Brookings study. The CRA International study indicates that such employment would increase by 1 percent by 2015 and 2 percent by 2025. In contrast, the RFF study indicates that employment in gas utilities and gas extraction taken together would be lower by

almost 10 percent by 2015 and by more than 25 percent by 2025 than what it otherwise would be—an outcome that differs from what would be expected to occur if demand shifted from coal to natural gas.

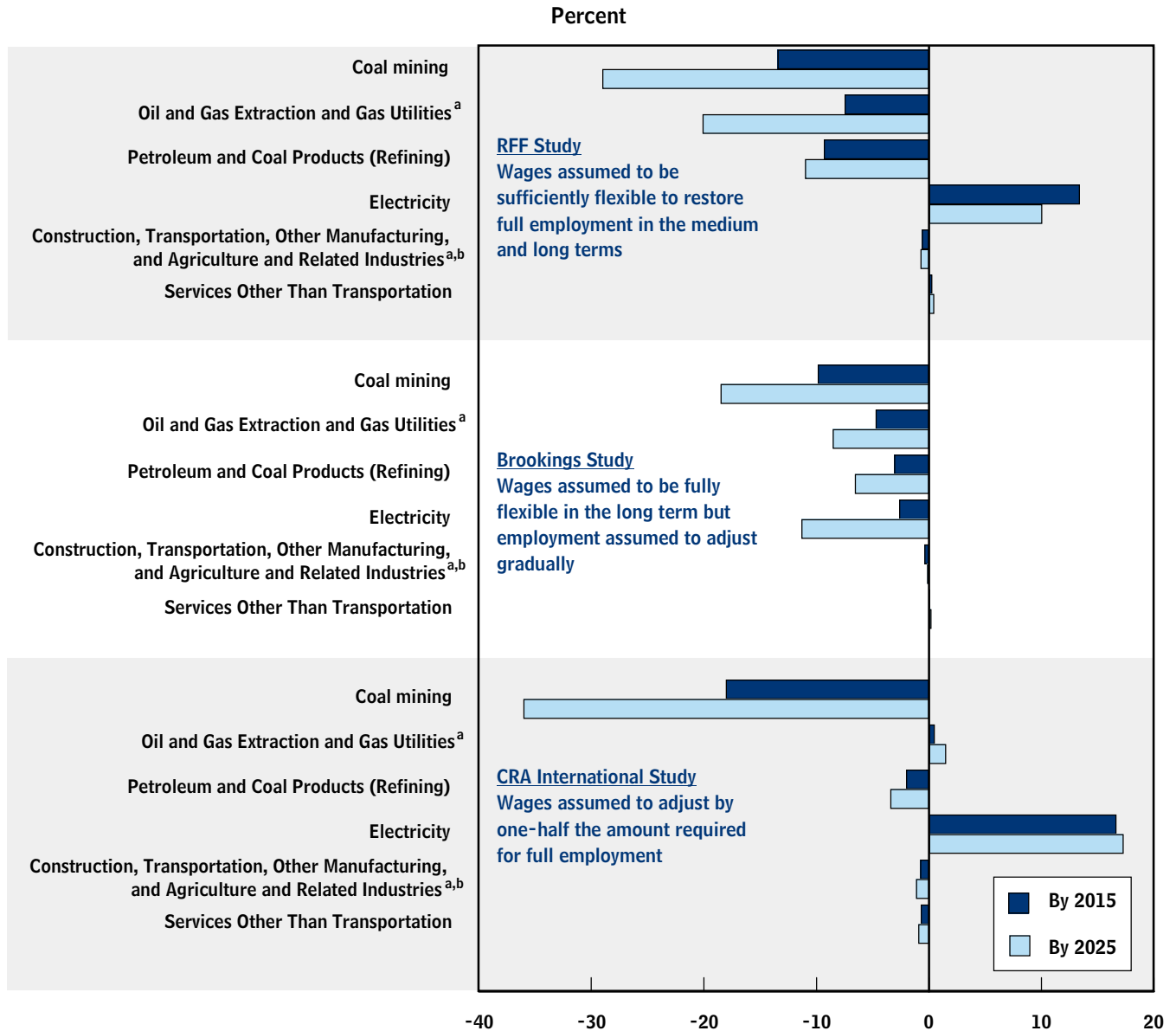
The decline in demand for energy from fossil fuels would also be reflected in the petroleum and coal products (refining) industry, which currently employs roughly 170,000 people. According to the RFF study, employment in that industry would decline by about 9 percent by 2015 and 11 percent by 2025. The Brookings study projects smaller reductions—3 percent by 2015 and 7 percent by 2025. CRA International projects a decline of 2 percent by 2015 and 3 percent by 2025.

Electricity. The effect of an emission-reduction policy on employment in the electricity industry is unclear. Electricity is produced from a variety of fuels that differ in the amount of carbon dioxide they generate. In 2007, about 50 percent of electricity in the United States was generated by coal-fired plants and just over 20 percent by plants fueled by natural gas. Both fuels produce carbon dioxide, although natural gas produces much less than coal. Plants fueled by nuclear or water power or renewable sources that do not produce significant amounts of greenhouse gas emissions accounted for about 25 percent of the electricity generated in 2007. Imposing a price on emissions of greenhouse gases would increase prices for electricity and reduce the total amount consumed.

The RFF study concludes that an emission-reduction policy would cause about a 2 percent decline in electricity production by 2015 and about a 3 percent decline by 2025, compared with what it would be otherwise. Pricing emissions would also cause generators of electricity to switch away from conventional coal-fired plants to those fueled by natural gas and, eventually, toward coal and natural gas plants that capture and store their emissions, nuclear plants, or various renewable options such as wind or solar—technologies that produce low or no emissions. Accordingly, fewer workers would be employed in the conventional plants but more in plants that generate electricity with lower emissions. If more labor hours were necessary to generate electricity using lower-emission technologies, overall employment in generating electricity might increase. Those changes would also affect employment in the portions of the construction industry that build new power plants, transmission lines, and local distribution networks.

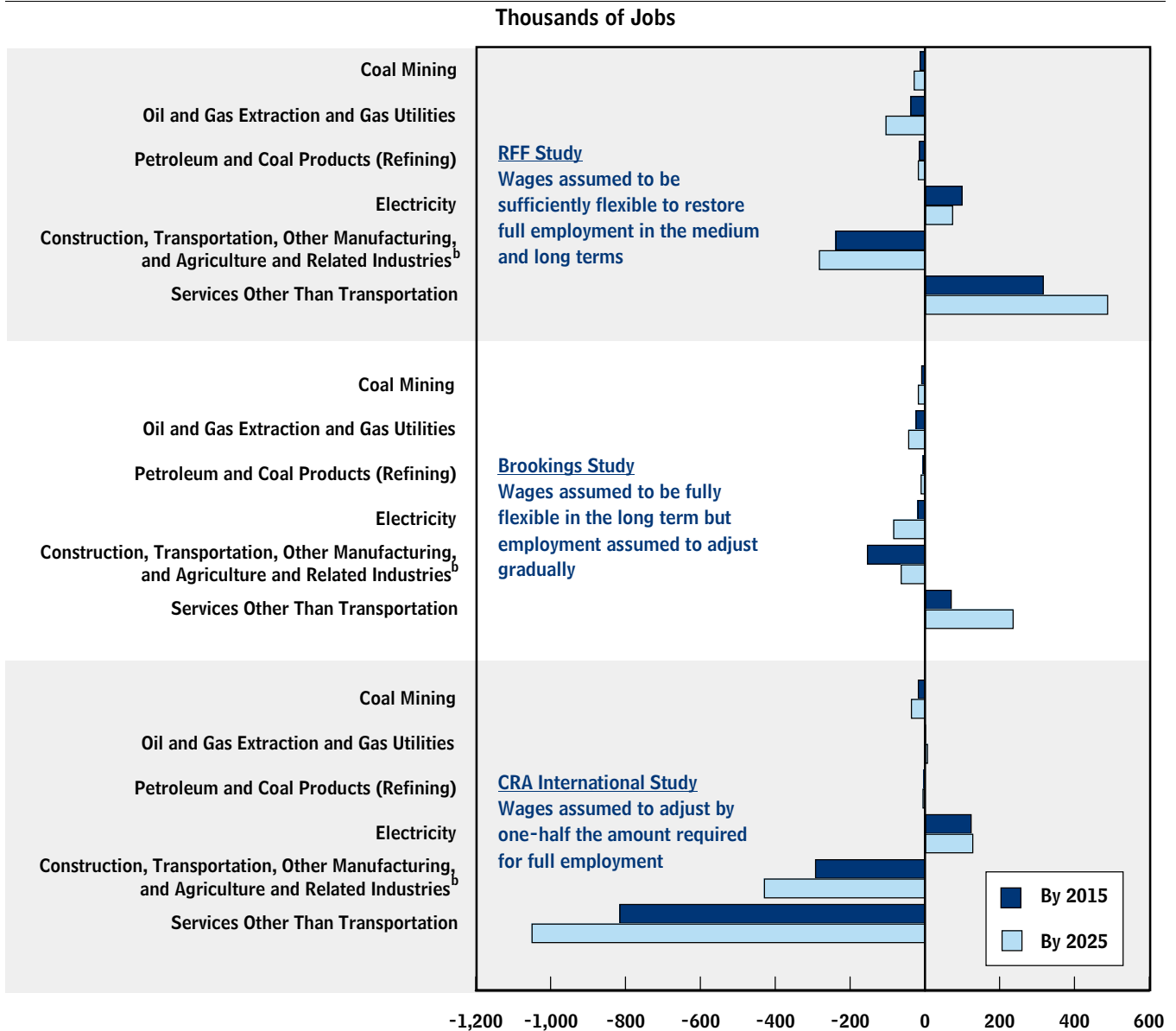
Figure 1.

Projections of Changes in Employment by 2015 and 2025 Resulting from an Emission-Reduction Program



Source: Congressional Budget Office based on projected percentage changes in employment from Mun S. Ho, Richard Morgenstern, and Jhih-Shyang Shih, *Impact of Carbon Price Policies on U.S. Industry*, Discussion Paper 08-37 (Washington, D.C.: Resources for the Future, November 2008); Warwick J. McKibbin and others, *Consequences of Alternative U.S. Cap-and-Trade Policies: Controlling Both Emissions and Costs* (Washington, D.C.: Brookings Institution, July 2009); and David Montgomery and others, *Impact on the Economy of the American Clean Energy and Security Act of 2009 (H.R. 2454)* (prepared by CRA International for the National Black Chamber of Commerce, May 2009) and based on statistics about industry employment from the monthly Current Population Surveys of the Bureau of the Census.

Notes: The estimates are for changes relative to what employment would have been in the absence of the emission-reduction policy. To improve comparability, the projections of all studies are scaled to reflect CBO's projections of the market prices of emission allowances under H.R. 2454, the American Clean Energy and Security Act of 2009. The scaling procedure that CBO used does not adjust for all differences among the studies that might lessen the comparability of the projections. For example, even in instances in which two or more of the studies give projections for industries with the same or similar names, the industry definition in one study may not include precisely the same range of activities as that in another. The industry definitions in the Resources for the Future (RFF) study are based ultimately on the



Notes (Continued):

Standard Industrial Classification (SIC) system; those in the CRA International study are based on the North American Industry Classification System (NAICS). In general, broad industry definitions in the SIC system do not translate directly into broad definitions in NAICS. Moreover, scaling does not adjust for all differences in the studies' assumptions.

- a. The projected change shown is the employment-weighted average of the changes projected by the study for the individual industries contained in the industry group.
- b. This category consists of all industries not listed elsewhere in the table, but the breakdown of industries differs significantly among the studies. The category includes the following industries from the RFF study: agriculture, forestry, fishing, and hunting; other minerals mining; construction; food, beverages, and tobacco; textiles; apparel and leather goods; chemicals, rubber, and plastics; wood and paper products; nonmetallic mineral products; primary metals; fabricated metal products; motor vehicles and other transportation equipment; electronic goods; other machinery, equipment, and manufactures; and transportation. From the Brookings study, it includes mining, durables, nondurables, agriculture, forestry, and transportation. From the CRA International study, it includes energy-intensive sector, motor vehicles, other manufacturing, agriculture, construction, and transportation. That last study also separately breaks out "alternate transport fuel," for which it projects employment to increase by 2 percent by 2015 and 4 percent by 2025. Those projections are not included in the figure.

The studies that CBO reviewed are in conflict concerning the net effect on employment in the electricity industry; two indicate an increase in employment and the other, a decline. The RFF study indicates that employment would increase by about 13 percent by 2015 and 10 percent by 2025 compared with what would be the case without an emission-reduction program. Similarly, the CRA International study projects that employment in the industry would increase by roughly 17 percent by each of those years. In contrast, the Brookings study projects a decline in employment of about 3 percent by 2015 and 11 percent by 2025. That industry currently employs about 740,000 people.

Other Industries Most Likely to Lose Employment

In addition to industries that produce fossil fuels, a wide variety of other industries would also see lower employment under an emission-reduction policy than in its absence. For industries that use relatively large amounts of carbon-based fuels either directly or indirectly through other inputs, the cost of producing their products would increase, and demand for those products would correspondingly decrease. Similarly, industries (such as the automobile industry) whose products use fossil fuels could also see shifts in demand, with corresponding changes in employment. Other than energy producers, industries that would probably have lower employment in 2025 as a result of an emission-reduction program currently employ more than 30 million people, so a small percentage decline in employment would, in total, affect many more people than the larger percentage declines in the energy sector.

Mining, construction, and the industries that produce metals, nonmetallic mineral products (such as glass), chemicals, and transportation services—all of which use relatively large amounts of energy directly or indirectly—would probably experience reductions in employment relative to what would occur in the absence of policies to reduce emissions. Production costs would increase in those industries, and demand for their products would decline as those higher costs were reflected in higher prices. Reduced demand for products would lead to reduced demand for labor. According to the RFF study's estimates, employment in mining (other than coal, oil, and gas) would decline by almost 3 percent by 2025. Employment in industries that produce primary metals (such as steel and aluminum) would decline by 2 percent. Employment in construction and in the industries that produce chemicals, rubber, and plastics; nonmetallic

mineral products; transportation services; other machinery, equipment, and manufactures; textiles; and fabricated metals would in each case decline by about 1 percent.

Of the industries on that list, several stand out because they are so much larger than the others, and, consequently, their likely employment declines would be much larger in absolute terms. For example, the reduction in employment in the construction industry implied by RFF's estimates would be about 67,000 jobs by 2015 and almost 110,000 by 2025. Similarly, the estimated reduction in employment for transportation services would be about 48,000 by 2015 and 62,000 by 2025.

In addition to energy-intensive industries, industries that manufacture products that require significant amounts of energy to use would also be affected. Higher fuel prices would dampen the demand for gasoline. They would also dampen the demand for automobiles that get low gas mileage, so the composition of employment in the automobile industry would shift toward the production of more-fuel-efficient cars.

The industry classifications used in the Brookings and CRA International studies are different enough from those of the RFF study that it is not possible to make comparisons of projections for the industries just discussed. Nevertheless, the conclusions are broadly similar in that emission-reduction policies would decrease employment in energy-intensive industries.

Industries Likely to Gain Employment

For a period of time, job losses from the industries that shrink would lower overall employment in the economy and raise the unemployment rate (if the shrinking was not so slow that reductions in employment occurred through attrition). Eventually, however, most laid-off workers would find employment in other industries whose products are less emission-intensive and produce fewer emissions when used and in industries that manufacture equipment for the production of energy using low-emission technologies (such as nuclear, solar, and wind power). The hiring of those workers would be spurred by a shift in demand toward the products of those industries and away from the products of the more emission-intensive industries. Eventually, the economy would return to full employment. Average wages would be lower than what would otherwise prevail because the higher cost of energy would reduce the productivity of

the economy. As a result, the size of the labor force and total employment would lessen slightly because some workers would choose to leave the labor force, finding other uses of their time (such as engaging in leisure activities or raising a family) to be more valuable to them.

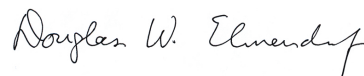
The length of time required for all of the changes to play out would depend on a number of factors. One would be the ability of firms and workers to foresee and act quickly on the changes in prices and to implement the changes that would be required in their output, training, and other activities. Another factor would be the extent to which shrinking industries are concentrated in small communities in which other opportunities for employment are limited, requiring laid-off workers to relocate in order to find new employment. The U.S. economy has adjusted fairly quickly to past changes in the economic environment, including the changes brought about by the rapid development of computer and information technologies, which destroyed many jobs but created many others, and the increase in international trade, which shifted many manufacturing jobs out of the country but probably contributed to the growth of service jobs.

In the three studies CBO analyzed, the increases in employment in industries that are less emission-intensive or whose products produce fewer emissions when used are not as readily observable as are the decreases in employment in industries that are more emission-intensive. One reason is that the industry classifications used in the studies coincide better with industries that would lose employment than with industries that would be expected to gain. All of the studies model separately the various industries involved in the production of fossil fuels—industries likely to lose employment. However, they do not model separately the production of more-fuel-efficient vehicles and the production of less-fuel-efficient vehicles. The increase in employment in the former is offset to a greater or lesser degree by a decline in employment in the latter in the combined aggregate of motor vehicle production that is modeled. Similarly, employment in some parts of the construction industry might be expected to increase as consumers sought to

improve the energy efficiency of their homes or as the producers of electric power built new wind or solar generation facilities, but the RFF and CRA studies model the construction industry as a whole and project that its employment would decline.

The service sector of the U.S. economy (excluding transportation) employs more than 100 million people, or roughly 70 percent of the labor force. As emission-reduction policies increased the price of emission-intensive goods and transportation services, the relative prices of other services (which tend to have low emissions) would fall, leading to a shift in demand toward those services and a consequent expansion of the sector. Because that sector is large, modest percentage increases in it would generate many jobs. The RFF study's results imply that employment in services other than transportation would increase by about 0.3 percent by 2015 and between 0.4 percent and 0.5 percent by 2025. Those very small percentage changes would nevertheless translate to more than 300,000 and almost 500,000 jobs, respectively. The Brookings study projects that employment in the service sector would increase by 0.1 percent by 2015 and by 0.2 percent by 2025. In contrast, the CRA International study projects that employment in that sector would decline. However, that result probably stems from assumptions that lead the study's model to project that, by 2025, significant numbers of workers who lost their job in emission-intensive industries would not yet have found new employment in other industries. CBO's views about the flexibility and responsiveness of wages align more closely with those of the RFF and Brookings studies than with those of the CRA study.

This brief was prepared by Bruce Arnold, with contributions from Molly Dahl. It and other CBO publications are available on the agency's Web site (www.cbo.gov).



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