Carbon Pricing 103: Effects across Sectors

The effects of a carbon price are likely to be felt throughout the economy—but different sectors will respond differently.

Explainer by **Kristin Hayes** and **Marc Hafstead** — 5 minute read — April 27, 2020

Carbon pricing is a climate policy approach that charges emitters of carbon dioxide (CO_2) for each ton they are responsible for emitting, increasing the price of all products that cause CO_2 emissions. The effects of a carbon price are likely to be felt throughout the economy—but different sectors will respond differently, depending on their carbon intensity, how much they are able to substitute non-carbon intensive products for carbon intensive ones, and more. This explainer reviews how carbon pricing affects or may affect the power, industrial, transportation, and building sectors.

Carbon Pricing and the Power Sector

In the United States, power is primarily generated by **burning fossil fuels** (coal, natural gas, and some oil), which generates significant CO_2 emissions, and by **harnessing nuclear and renewable power sources** (including solar and wind energy), which emits little to no CO_2. A carbon price would make carbon-intensive fuels more expensive, making cleaner sources more cost-competitive.

The power sector is **widely expected** to be most responsive to any carbon price signal. Most models predict that even a modest carbon price would lead to substantial reduction in CO_2 emissions in the power sector, as it is both cheaper and more straightforward to reduce emissions there than in some other sectors.

Figure 1 presents results from the Energy Information Administration (EIA)'s 2020 Annual Energy Outlook (AEO), showing how CO_2 emissions in the US power sector would be reduced under a range of carbon prices. The levels of emissions are projected for the year 2030.

A key reason that the power sector is expected to be responsive to carbon pricing policies is that a carbon price changes the relative prices of different electricity generation technologies. The price of coal-fired generation—which produces a comparatively high amount of CO_2 emissions—would rise substantially relative to the price of generation fueled by natural gas, nuclear power, or renewables. These relative price changes would alter the **dispatch order**—the order in which the power system calls on various generating units to meet electricity demand. In the short run, this would result in a shift from coal generation to natural gas generation (as shown in Figure 2). In the longer run, these relative price changes would likely make building new renewable capacity more economic, and these new carbon-free generators would begin to displace the remaining coal and natural gas generators.

Figure 2 shows how various carbon price levels would change the generation mix in the US, shifting away from coal and toward natural gas, nuclear, and renewables.

Figures 1 and 2 show the projected impacts of a federal carbon price on power sector emissions and the generation mix on a national level. But in practice, most of the carbon pricing policies currently in place in the United States are at the regional or state level—including programs like the Regional Greenhouse Gas Initiative (RGGI), which has **successfully decreased emissions** from the Northeast power sector using a cap-and-trade program.

Carbon Pricing and the Transportation Sector

According to the Energy Information Administration, in 2018, petroleum products accounted for about **92 percent** of the US transportation sector's total energy use. **Electric** and other **alternative-fuel vehicles** have been growing in popularity for both **fleets** and the public—particularly in states like California with strong emissions-reduction targets in place. However, they still represent a very small portion of transportation sector energy use.

With this degree of dependence on fossil fuels, it might seem intuitive to think that the transportation sector would be highly responsive to a carbon price. However, modest and even high carbon prices are not anticipated to significantly drive down transportation sector emissions. There are two primary reasons for this:

First, evidence shows that consumers don't significantly change the amount they drive (the number of **vehicle miles traveled**, or VMT) in response to changing fuel prices. Drivers typically have to commute the same distances to work, shopping venues, and leisure activities regardless of the cost of fuel, so opportunities for reducing VMT—at least without broader systemic change—are limited.

Second, the transportation sector **does not offer** the relatively easy opportunities for fuel switching that the power sector does. A typical passenger car internal combustion engine, running on gasoline, cannot be easily converted to run on natural gas or electricity—nor can the engines in planes or shipping fleets. Therefore, even when fuel prices rise, those engines must typically still run on the fuels for which they were originally designed. Of course, as fuel prices rise, through higher oil prices or through carbon prices, consumers will have more incentive to buy electric vehicles to replace gasoline vehicles; researchers are currently working to determine how changes in fuel and electricity prices, both of which would be affected by a carbon price, would affect the adoption of electric vehicles.

Carbon Pricing and the Industrial Sector

The industrial sector is **another major source** of CO_2 emissions: it was responsible for 19 percent of direct global anthropogenic GHG emissions (most of which are CO_2) as of 2014, 90 percent of which come from about a dozen industries (including iron and steel, chemicals and plastics, cement, aluminum, pulp and paper, and ceramics). These industries generate emissions both from on-site fuel combustion (often used to generate high levels of heat needed for industrial processes) and from the manufacturing processes themselves.

Industries pay close attention to fuel input costs and therefore are likely to be responsive to changes in those costs under a carbon price. But the variability in fuel use (and ability to substitute high-carbon fuels for lower-carbon ones), emissions intensity, and other key variables means that certain industries would be more affected than others by a carbon price.

Ho et al. (2008) look at the impacts of carbon pricing on US industry in a highly disaggregated fashion, finding that the effects vary widely from industry to industry. However, the costs would shrink over time as industries adjust their materials, output, and prices; adopt new technologies; and increase process efficiencies. For many industries, in time, their profits would rebound to be nearly the same as they were before the carbon price was in place—although they note that, intuitively, a higher carbon price would lead to higher costs and larger reductions in output and profits.

The industrial sector can also be affected by the carbon pricing policies (or lack thereof) in other countries. When some countries have carbon pricing policies in place and others do not, this can lead to emissions "leakage": companies may reduce costs by shifting operations to regions or countries without a carbon price. Estimates vary significantly as to how much leakage would occur under various carbon prices, but regardless of the magnitude, a number of **policy tools** exist to mitigate this potential emissions leakage.

Carbon Pricing and the Residential and Commercial Buildings Sector

A **2018 report** from the Center for Climate and Energy Solutions notes that "fossil-fuel combustion attributed to residential and commercial buildings accounts for roughly 29 percent of total US greenhouse gas emissions." These include direct emissions from fuel combustion on site (for example, in natural gas-burning furnaces in homes) and indirect emissions from electricity used in buildings (see Figure 3).

Figure 4 shows how energy is used within the residential and commercial building sectors.

As illustrated in Figures 3 and 4, a large majority of energy use and emissions associated with buildings comes from the use of electricity. Therefore, if a carbon price leads to decarbonization of the electricity sector, it will indirectly decrease the overall emissions footprint of the building sector as well.

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Carbon pricing would also incentivize energy efficiency in buildings, as it would increase (to varying degrees) the cost of almost all types of energy. In some cases, energy use will be lower because inhabitants decrease their use of existing appliances, lights, and other devices. In other cases, buildings will become more efficient through a transition to more energy-efficient technologies, such as electric heat pumps as replacements for fossil fuel-burning furnaces.

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