

Report examines hidden costs of energy production and use

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A new report from the National Research Council examines and, when possible, estimates "hidden" costs of energy production and use -- such as the damage air pollution imposes on human health -- that are not reflected in market prices of coal, oil, other energy sources, or the electricity and gasoline produced from them. The report estimates dollar values for several major components of these costs. The damages the committee was able to quantify were an estimated \$120 billion in the U.S. in 2005, a number that reflects primarily health damages from air pollution associated with electricity generation and motor vehicle transportation. The figure does not include damages from climate change, harm to ecosystems, effects of some air pollutants such as mercury, and risks to national security, which the report examines but does not monetize.

Requested by Congress, the report assesses what economists call external effects caused by various energy sources over their entire life cycle -- for example, not only the pollution generated when gasoline is used to run a car but also the pollution created by extracting and refining oil and transporting fuel to gas stations. Because these effects are not reflected in energy prices, government, businesses and consumers may not realize the full impact of their choices. When such market failures occur, a case can be made for government interventions -- such as regulations, taxes or tradable permits -- to address these external costs, the report says.

The committee that wrote the report focused on monetizing the damage of major air pollutants -- sulfur dioxide, [nitrogen oxides](#), ozone, and

particulate matter - on human health, grain crops and timber yields, buildings, and recreation. When possible, it estimated both what the damages were in 2005 (the latest year for which data were available) and what they are likely to be in 2030, assuming current policies continue and new policies already slated for implementation are put in place.

The committee also separately derived a range of values for damages from [climate change](#); the wide range of possibilities for these damages made it impossible to develop precise estimates of cost. However, all model results available to the committee indicate that climate-related damages caused by each ton of CO₂ emissions will be far worse in 2030 than now; even if the total amount of annual emissions remains steady, the damages caused by each ton would increase 50 percent to 80 percent.

DAMAGES FROM ELECTRICITY GENERATION

Coal accounts for about half the electricity produced in the U.S. In 2005 the total annual external damages from [sulfur dioxide](#), nitrogen oxides, and particulate matter created by burning coal at 406 coal-fired power plants, which produce 95 percent of the nation's coal-generated electricity, were about \$62 billion; these nonclimate damages average about 3.2 cents for every kilowatt-hour (kwh) of energy produced. A relatively small number of plants -- 10 percent of the total number -- accounted for 43 percent of the damages. By 2030, nonclimate damages are estimated to fall to 1.7 cents per kwh.

Coal-fired power plants are the single largest source of greenhouse gases in the U.S., emitting on average about a ton of CO₂ per megawatt-hour of electricity produced, the report says. Climate-related monetary damages range from 0.1 cents to 10 cents per kilowatt-hour, based on previous modeling studies.

Burning natural gas generated far less damage than coal, both overall and

per kilowatt-hour of electricity generated. A sample of 498 natural gas fueled plants, which accounted for 71 percent of gas-generated electricity, produced \$740 million in total nonclimate damages in 2005, an average of 0.16 cents per kwh. As with coal, there was a vast difference among plants; half the plants account for only 4 percent of the total nonclimate damages from [air pollution](#), while 10 percent produce 65 percent of the damages. By 2030, nonclimate damages are estimated to fall to 0.11 cents per kwh. Estimated climate damages from natural gas were half that of coal, ranging from 0.05 cents to 5 cents per kilowatt-hour.

The life-cycle damages of wind power, which produces just over 1 percent of U.S. electricity but has large growth potential, are small compared with those from coal and natural gas. So are the damages associated with normal operation of the nation's 104 nuclear reactors, which provide almost 20 percent of the country's electricity. But the life cycle of nuclear power does pose some risks; if uranium mining activities contaminate ground or surface water, for example, people could potentially be exposed to radon or other radionuclides; this risk is borne mostly by other nations, the report says, because the U.S. mines only 5 percent of the world's uranium. The potential risks from a proposed long-term facility for storing high-level radioactive waste need further evaluation before they can be quantified. Life-cycle CO₂ emissions from nuclear, wind, biomass, and solar power appear to be negligible when compared with fossil fuels.

DAMAGES FROM HEATING

The production of heat for buildings or industrial processes accounts for about 30 percent of American energy demand. Most of this heat energy comes from natural gas or, to a lesser extent, the use of electricity; the total damages from burning natural gas for heat were about \$1.4 billion in 2005. The median damages in residential and commercial buildings

were about 11 cents per thousand cubic feet, and the proportional harm did not vary much across regions. Damages from heat in 2030 are likely to be about the same, assuming the effects of additional sources to meet demand are offset by lower-emitting sources.

DAMAGES FROM MOTOR VEHICLES AND FUELS

Transportation, which today relies almost exclusively on oil, accounts for nearly 30 percent of U.S. energy demand. In 2005 motor vehicles produced \$56 billion in health and other nonclimate-related damages, says the report. The committee evaluated damages for a variety of types of vehicles and fuels over their full life cycles, from extracting and transporting the fuel to manufacturing and operating the vehicle. In most cases, operating the vehicle accounted for less than one-third of the quantifiable nonclimate damages, the report found.

Damages per vehicle mile traveled were remarkably similar among various combinations of fuels and technologies -- the range was 1.2 cents to about 1.7 cents per mile traveled -- and it is important to be cautious in interpreting small differences, the report says. Nonclimate-related damages for corn grain ethanol were similar to or slightly worse than gasoline, because of the energy needed to produce the corn and convert it to fuel. In contrast, ethanol made from herbaceous plants or corn stover -- which are not yet commercially available -- had lower damages than most other options.

Electric vehicles and grid-dependent (plug-in) hybrid vehicles showed somewhat higher nonclimate damages than many other technologies for both 2005 and 2030. Operating these vehicles produces few or no emissions, but producing the electricity to power them currently relies heavily on fossil fuels; also, energy used in creating the battery and

electric motor adds up to 20 percent to the manufacturing part of life-cycle damages.

Most vehicle and fuel combinations had similar levels of greenhouse gas emissions in 2005. There are not substantial changes estimated for those emissions in 2030; while population and income growth are expected to drive up the damages caused by each ton of emissions, implementation of new fuel efficiency standards of 35.5 miles per gallon will lower emissions and damages for every vehicle mile traveled. Achieving significant reductions in greenhouse gas emissions by 2030 will likely also require breakthrough technologies, such as cost-effective carbon capture and storage or conversion of advanced biofuels, the report says.

Both for 2005 and 2030, vehicles using gasoline made from oil extracted from tar sands and those using diesel derived from the Fischer-Tropsch process -- which converts coal, methane, or biomass to liquid fuel -- had the highest life-cycle greenhouse gas emissions. Vehicles using ethanol made from corn stover or herbaceous feedstock such as switchgrass had some of the lowest greenhouse gas emissions, as did those powered by compressed natural gas.

Fully implementing federal rules on diesel fuel emissions, which require vehicles beginning in the model year 2007 to use low-sulfur diesel, is expected to substantially decrease nonclimate damages from diesel by 2030 -- an indication of how regulatory actions can significantly affect energy-related damages, the committee said. Major initiatives to further lower other emissions, improve energy efficiency, or shift to a cleaner mix of energy sources could reduce other damages as well, such as substantially lowering the damages attributable to electric vehicles.

Source: National Academy of Sciences ([news](#) : [web](#))

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