In describing cost-benefit analysis to students, I've often told them that the "cost" side of the equation is pretty simple. And it does seem simple: just get some engineers to figure out how industry can comply and run some spreadsheets of the costs. But this seemingly simple calculation turns out to be riddled with uncertainties, particularly when you're talking about regulating the energy industry. Those uncertainties need more attention in designing regulations.

EPA confronted some of these issues recently in its reevaluation of a regulation limiting mercury emissions from coal power plants. (You might wonder why EPA was taking this look backwards; the reason was basically that the Supreme Court told them to do so.) In 2011, EPA had estimated that the compliance cost would work out to $9.6 billion per year. EPA now believes, however, that it overestimated the cost by billions of dollars.

You'll note the word "believe" in the last sentence. That's because figuring out what the regulation actually cost is tricky. First, the agency needs to figure out which changes in the power sector were due to new technologies, other regulations, or market shifts. Second, the agency needs information about the costs of facility-by-facility changes, such as shifts in how often facilities are used, their fuel consumption, and how pollution controls were actually operated. This would be especially challenging for the mercury rule, according to EPA, "because the rule regulates hundreds of units within a complex, interdependent, and dynamic economic sector." A lot of coal plants closed after the rule went into effect, but it's very hard to say how much difference the rule made, as opposed to factors like plunging prices for natural gas due to fracking.

Several independent experts have attempted to do such a retroactive analysis. One came up with a $2 billion figure (about a. quarter of EPA original estimate); an estimate by an industry group (the Edison Electric Institute) was only slightly higher. Another expert estimate was about one-eighth the original projected cost. It's quite likely that we'll never know the exact answer.

Part of the problem is that the energy sector is especially volatile and dynamic. The best projections of energy use, sources, and prices comes from the Energy Information Agency (EIA) in DOE, and those projections are often quite wrong. EIA assumes that current trends will continue but there are often major unexpected developments: international crisis impacting oil markets; new state and federal regulatory policies; the invention of fracking; plunging prices for renewables and storage. For example, natural gas production went up by around 50% from 2011-2015, displacing a lot of coal-fired generation.

Another problem is that many coal-fired plants apparently found ways to comply without

relying on the expensive new equipment assumed in EPA's modeling. As EPA now says, "EPA modeling cannot anticipate in advance the full spectrum of compliance strategies that the power sector may innovate to achieve required emissions reductions, and experience has shown that the regulated industry is often able to comply at lower costs through innovation or efficiencies." There are also situations, of course, where compliance costs turn out to be unexpectedly high — for instance, due to unexpected supply chain issues.

There are several important lessons here. First, while we should take estimates of compliance costs seriously, we should also take a close look at uncertainty. Because the energy sector plays an outsize role in environmental regulation, the heightened uncertainty in that sector is particularly important. Thus, compliance cost estimates should be taken with a grain of salt. This also means that benefit estimates can be uncertain since some of the initial benefits of a proposed rule may end up happening anyway.

Second, as EPA itself notes in its reappraisal of the mercury rule, is the importance of designing regulations to give industry flexibility about methods of compliance. This may generally result in lower costs; it also means greater resilience to unexpected developments.

Third, it's not unusual for a regulatory scheme to have escape hatches for situations where compliance costs turn out to be much higher than expected. It may also be a good idea to include an automatic ratchet, toughening regulatory requirements if compliance costs turn out to be unexpectedly low.