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climate brief

Upstream and Downstream Approaches to Carbon Dioxide Regulation

Global Climate Change Research Area
Environment Sector, Technology Group

Greenhouse gas emissions are part of everyday life, originating from a wide range of activities that are entwined throughout our modern economy. Their sources number in the hundreds of millions and vary in scale from large industrial and electricity generating plants to individual automobiles, hot water heaters and furnaces. As a result, cost effective mitigation of greenhouse gas emissions presents a new challenge to policy makers seeking to reduce these emissions.

One aspect of this challenge resides in the fact that the traditional approaches to emissions control targeted emitters (termed "downstream" regulation) and were designed for single, relatively homogeneous sectors whose emitting activities were amenable to control under a given approach and not for much more complex arrays of dissimilar sources as is the case with greenhouse gases. Emission reductions have been accomplished within sectors through either technology standards such as catalytic converters for automobiles or through market mechanisms such as the U.S. SO_2 regulations for the electric sectors. Although these traditional sectoral approaches may appear comforting in their familiarity, they may prove extremely costly if applied to greenhouse gas control. They would likely lead to uneven burdens among different sectors of the economy and could considerably complicate policy evolution as the need for future policy adjustments arise.

Economic modeling indicates that a different approach, one that sends consistent signals to all sectors of the economy, would result in significant cost savings over these traditional approaches. These results suggest that focusing policy on the greenhouse gas content of fuels upstream in the energy chain could significantly enhance economic efficiency and reduce the associated administrative burdens. This shift in policy focus would likely reduce the price society will have to pay to mitigate greenhouse gas emissions and would also provide a policy framework more amenable to revision in the future as required.

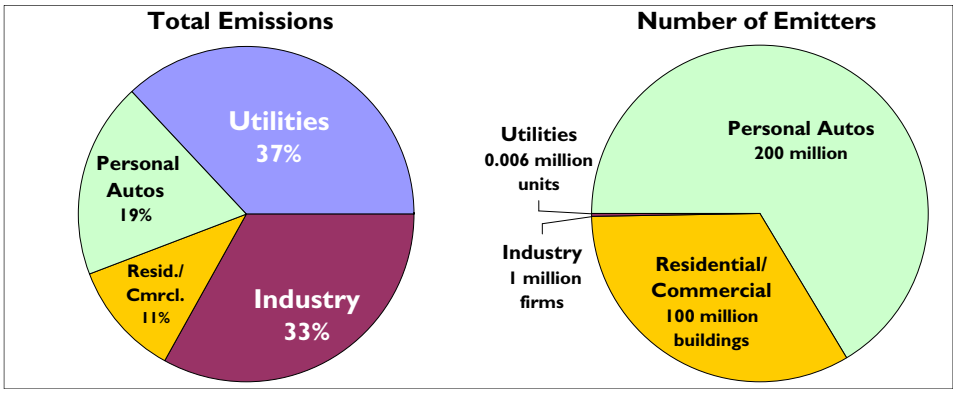

Figure 1. Sources of U.S. carbon emissions in 2000.

This Climate Brief discusses the economic and practical implications of adopting a traditional downstream compliance point for limiting carbon dioxide emissions versus an upstream compliance approach that targets carbon content of fuels. It does not address in detail the issue of allocation of permits since allocation rules may be developed independent of the point of compliance.

Implementation issues

Figure 1 illustrates the diversity of the emitters of carbon in the United States. Although other nations vary in the precise composition of their emissions, this broad range of activities and diversity in scale of emitters holds for all.

An upstream market-based system, one that requires fuel producers to surrender allowances or pay a tax for emissions attributable to their products, could cover 90% or more of these emissions. Exemptions would be provided for non-emitting fuel uses (e.g., some fuel uses as a chemical feedstock or potentially, for cases where carbon is removed from fuel and sequestered). Fuel users (both industries and households) would not be required to hold permits or be taxed, but would see increases in fuel prices commensurate with the increases in costs to fuel suppliers, moderated by their ability to pass increased cost through to customers.

By sending a price signal to all fuel consumers and allowing them to choose the most cost-effective approaches to lowering emissions, an upstream market-based approach would provide incentives to achieve emission reductions at lowest cost.

A downstream system aimed at emitters, in contrast, would require regulation of hundreds of millions companies and individuals. Most policy proposals seen to date have addressed this implementation challenge by differentiating policies by sectors, establishing market mechanisms for some sectors (such as a cap and trade system for electricity generators and large industry) and utilizing technology standards or other

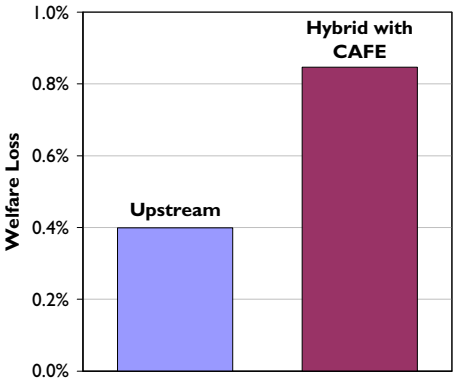

Figure 2. Welfare losses under alternative scenarios for carbon trading systems.

means (including opt-out policies) to address remaining sectors. The European Union emission trading directive, for example, implements a trading system that covers less than 50% of economy-wide emissions. This trading system will be supplemented by other actions such as taxes, efficiency standards, technology standards and incentives in sectors not covered in order to implement Kyoto measures.

The administrative burdens of a downstream "hybrid" system will be greater than that of an upstream market-based system simply due to the number of regulated entities plus the diversity of types of programs that must be put in place. Over time, as the stringency of emissions targets is likely to increase, maintaining consistency across diverse sectoral regulations will create an additional, continual administrative burden.

Economics of upstream versus downstream

A carbon policy's cost will be substantially affected by its coverage of sources, the extent to which market policies are supplanted by "command-and-control" regulation, and the level of consistency in efforts across the economy. Policies that provide only partial coverage of sectors or actions resulting in emissions may be missing opportunities to make inexpensive reductions.

Clearly, if an emitting sector is not regulated, potentially cost-effective reduction opportunities are lost. Less obvious are the opportunities lost when efficiency standards are implemented. For example, a Corporate Average Fuel Economy (CAFE) standard—which controls the average efficiency of new motor vehicles—can be effective in reducing emissions per mile traveled, but will likely not reduce (and provides a small incentive to increase) the number of miles traveled. Finally, there can be substantial losses if some sectors are required to make significantly more expensive reductions than other sectors.

Figure 2 explores the latter two types of losses in efficiency by comparing an economy-wide upstream cap-and-trade system to a case in which roughly 80% of U.S. emissions are covered upstream, but automobile emissions are instead controlled through a 35 miles per gallon (mpg) CAFE standard for new vehicles.*[1]

In this case, the hybrid policy provides the same coverage of emission sources as the upstream policy and provides the same level of emission reductions. It is twice as expensive as the upstream policy because 1) it provides a different mix of automotive reductions (efficiency improvements per mile versus reductions in miles traveled) than an increase in fuel prices would, and 2) it imposes a greater burden on the transport sector than would a policy that equated the marginal cost of reductions across sectors.

Policy implications

Economic analysis suggests that upstream market-based regulation is much more cost-effective than hybrid systems. In addition, it is easier to administer and to update as additional emission reductions may be required over time.

What are the arguments against an upstream approach? First, it is unfamiliar. Second are market imperfections – reality often differs from economic models. Market imperfections have two implications – for an upstream cap and trade system, desired reductions would be attained, but at a higher social cost than projected by models; for an upstream tax, the anticipated reductions may not be realized. Finally, there is the political concern that an upstream cap and trade system looks like a tax to consumers and taxes are not popular.

The argument that a hybrid system is preferable because the upstream alternatives would look like another unpopular tax to consumers raises the critical question of how large of a cost burden are consumers willing to bear to have the true costs of a policy hidden from them. The clear costs imposed by taxes have indeed repeatedly proven unpopular. As a result, it has traditionally been easier to implement more expensive policies that obscure costs rather than more efficient approaches that deliver results at lower, but clearer, costs. Given the high potential costs associated with most recent policy proposals, this is not a trivial issue. Inefficient policies that obscure costs could cost consumers tens of billions of dollars annually.

Other concerns about upstream trading include the burdens that would be placed on fuel suppliers, possibilities of evasion, distrust of the ability of energy markets to pass permit costs through to consumers correctly, and the efficiency with which energy users will respond to price signals. Given the potential stakes, these concerns need to be addressed.

Globally, most policies and policy proposals to date have either focused downstream on emissions sources within a specific sector or group of sectors or have embraced hybrid regimes with some downstream focus and a mix of efficiency and technology standards to cover emitting activities not amenable to regulation at the source. These approaches generally allow some form of emissions trading within those sectors regulated downstream but leave significant activities outside of the trading system. This makes it much more difficult to provide a uniform incentive to pursue all the possible actions that could be undertaken to reduce emissions. As a result, these downstream and hybrid approaches fail to cover some—often significant—sources of emissions, and are unlikely to achieve emission reductions at least cost for the economy as a whole.

References

1. M. Ross and A. Smith, *Upstream versus Downstream Implementations of Carbon Trading Systems with Revenue Recycling and Allowance Allocations*, working paper, Charles River Associates, 2002.
2. L. Bovenberg and L. Goulder, *Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does it Cost?* working paper presented at the FEEM-NBER Conference on Behavioral and Distributional Effects of Environmental Policy, Milan, Italy, 2000.

*While it is unlikely that a hybrid system would actually cover 80% of emissions with a cap and trade system and instead might impose efficiency standards on commercial and residential buildings and energy end uses, these findings provide a basis for understanding the fundamental tradeoffs between market and hybrid policies.

Copies of this *Climate Brief* may be obtained by eligible organizations and individuals by contacting Christopher Gerlach at 650.855.8579 or cgerlach@epri.com.

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