ESTABLISHING A DOMESTIC GHG REDUCTION TARGET: KEY APPROACHES AND CHALLENGES*

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I. Introduction

Establishing a domestic target (like setting an international target) is essentially a risk-management decision: policy-makers must evaluate which risks and costs are tolerable based on the available information. This paper examines the types of targets that could emerge under a domestic mandatory greenhouse gas (GHG) reduction effort. In setting a target, several features must be determined, including its structure, the emission sources that will be covered; and the level and speed at which target levels will be reached. Whatever the target, given the evolving nature of our understanding, any policy should be designed to incorporate new information. The following paper explores issues relating to target structure, coverage, and stringency, and identifies implementation challenges.

II. Target Structure

Targets can be structured in various ways: they can be expressed in terms of limits on the quantity of emissions, in terms of limits on emission rates (indexes), or in terms of technology-based standards.

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Absolute Quantity Limits

One approach is to limit the number of tons of GHG emissions that may be released to the atmosphere. A mandatory absolute quantity limit traditionally has been called a "cap." Caps can be set for groups of nations, individual countries, economic sectors, companies, or facilities. The advantages of this approach include simplicity, clarity, and proven effectiveness through successful implementation of the U.S. Acid Rain program. As long as a target set in absolute quantities is adhered to, it also has the advantage of environmental certainty: one knows in advance how many tons of GHGs will be emitted to the atmosphere.

Rate-based Limits

Another approach is to set a limit on the number of tons of GHGs that may be emitted per unit of something, i.e., using an indexed approach. As with the absolute quantity approach, rates or indexes can be set for nations, sectors, companies or facilities. At the national level, a rate-based standard can apply to emissions per capita, per unit of energy used, or can be relative to the gross domestic product (GDP). When GDP or energy is used as the unit, the target is often referred to as an "intensity" or "dynamic" target. When rates are set for sectors, companies, or facilities, emission limits can be set per unit of production, per ton of production, or per dollar of sales. For example, emission rates can be in terms of GHG emissions per ton of aluminum or per refrigerator produced.

Rates are not as easy to understand as absolute quantities and do not provide environmental certainty in the short run. That is, one does not know in advance how many tons of GHGs will be emitted. As the level of production, GDP, or energy used climbs, so will total tons of GHG emitted. Rates do have some advantages, however. For example, rates will be the primary focus of company-level compliance efforts regardless of the structure of targets. Companies will focus on improving emission rates even under absolute quantity systems because there are only three ways to lower total emissions: lower the level of production; change what one produces, or lower the emission rate per unit of production. Companies are very unlikely to want to lower levels of production, and while changes in what a company produces will occur, a fair amount of inertia can be expected, with the result that lowering rates will be a prime focus of emission reduction efforts.

Moreover, it is easier to trade between a rate-based system and both product standards and parts of an economy that are not under mandatory limitations.

Rate-based targets also tend to provide more “cost certainty” than absolute quantity approaches because of the way they are set. Technologies—whether currently widely deployed, emerging, or still in early stages of development—are characterized by emission rates. The near-term costs of these technologies are, at least in general, known. So to set a rate (except for per capita rates) is, in effect, to determine which technologies, with known costs, will have to be used. For example, the United Kingdom set emissions rates for industrial sectors as part of its trading system. Both business as usual (BAU) and “all cost-effective measures” rates were estimated for each participating industrial sector. It was recognized that most companies would not implement all cost-effective measures, and that industrial sectors with stagnant or falling production might be less able to adopt new technologies due to lack of investment capital. Rates were thus set between BAU rates and the rates that would result from implementation of all cost-effective measures with less aggressive rates set in sectors with low or stagnant production.

Technology- and Rate-based Product Standards

Product standards can be set either in terms of specific technologies or in terms of rates. Technology-based standards prescribe specific technologies that must be used. Although previously common in environmental regulation, prescribing technologies is often not an economically efficient way to achieve a goal. By prescribing particular technologies, alternative, more cost-effective means to achieve the same outcome are eliminated from consideration, and there is no incentive to develop new technologies. More flexible approaches that allow for innovative and alternative ways to achieve a goal are more desirable. Rate-based product standards allow such flexibility. At present rate-based product standards usually take the form of setting a limit on the amount of energy that can be used to accomplish a task. Examples of rate-based product standards include: miles per gallon (for cars), kWh per cycle (dishwashers), and Watts per lumen (lights). For the purposes of GHG targets, rate-based product standards could be stated in terms of emissions per task (e.g., per mile, per cycle, or per lumen) rather than in terms of energy.

Comparison of Structures

In the short term, emissions and costs under different target structures would vary. In the longer term, based on the aggressiveness of the reduction targets sought, the different approaches could lead to comparable results. Theoretically, an aggressive rate-based approach could yield comparable results to an absolute quantity cap or technology-forcing standards. Under rate-based limits and product standards, GHG emissions levels (i.e., total tons emitted) would be uncertain, at least in the short term. Under absolute quantity approaches, costs would be uncertain, at least in the short term. In both cases, there is inherent uncertainty in predicting future economic growth. If growth is greater than expected, rate-based approaches would yield higher emissions than expected and absolute-quantity approaches would lead to higher costs. As experience is gained, the rate at which limits are tightened could be adjusted so that costs and emission levels would be more in line with desired outcomes.

III. Covered Sources

In 2000, carbon dioxide (CO_2) accounted for 83% of total U.S. GHG emissions, 96% of which resulted from the combustion of fossil fuels. Methane accounted for 9%, nitrous oxide for 6%, and industrially produced gases for 2% of U.S. GHG emissions. The primary sources of methane emissions are landfills, agriculture, natural gas, and coal mining operations. Agriculture is the primary source of nitrous oxide emissions. When considering emissions by sector, emissions from electricity generation can be allocated to end-users or to the electricity generation sector (see figure).

FIGURE 1: GHG EMISSIONS BY SECTOR
(EMISSIONS FROM ELECTRICITY GENERATION STATED SEPARATELY)

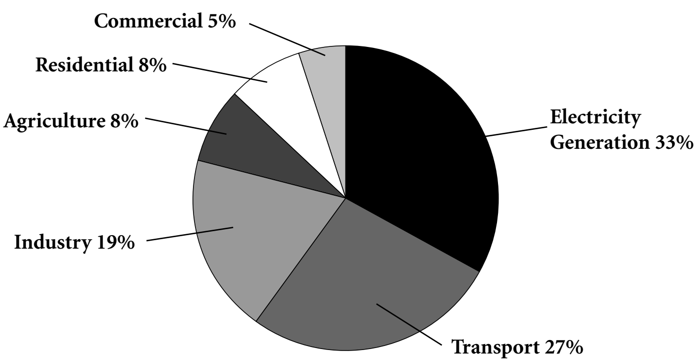
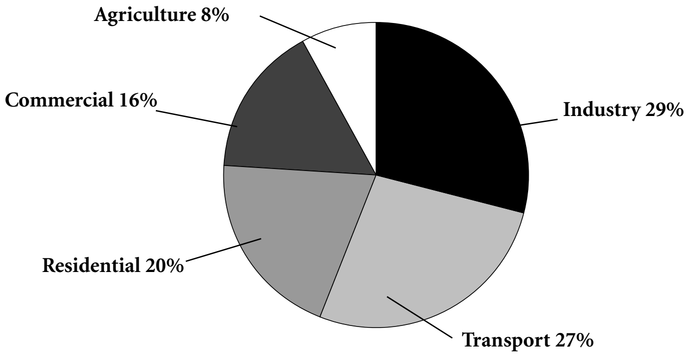


FIGURE 2: GHG EMISSIONS BY SECTOR
(EMISSIONS FROM ELECTRICITY GENERATION ALLOCATED TO END USE)



In order to achieve a national target that reduces GHG emissions, emissions from a number of significant sources must be reduced. As discussed in the Nordhaus and Danish paper, a tax that would affect all sources of carbon dioxide (CO_2) is probably not politically feasible, nor is it administratively feasible to set absolute quantity restrictions on millions of small emission sources. A cap-and-trade program imposing absolute quantity restrictions could more realistically be placed on large point sources, with these restrictions supplemented by product efficiency standards. Moreover, when both rate-based and absolute quantity approaches are considered, a number of other possibilities emerge.

Downstream absolute quantity restrictions may be most suitable for the electric power sector, particularly given the existing reporting requirements under the Acid Rain program. The potential availability of post-combustion capture and storage of waste CO_2 suggests that upstream restrictions on carbon content of fuel for this sector may close off a viable mitigation option. One possible approach would be to begin with caps on emissions from the electric power. Such an approach would vastly simplify issues of ownership of emission reductions. Emissions from buildings and industry are partly from on-site combustion of fuels and other on-site processes and partly due to use of purchased electricity. Reductions in electricity use thus simultaneously reduce building and industry sector emissions and emissions from the electricity sector. (Note: additional policy would still be needed to address important non-CO_2 gases from manufacturing). In concert with these stationary source reductions, transportation emissions could be reduced through a standards-based approach, or through a sector cap.

Certain small sources or sectors (e.g., agriculture) are likely to be exempt under any mandatory limit—whether absolute or rate-based. If the system allows, such exempted sources could sell reductions achieved to sources under restrictions.

IV. Target Stringency and Timing

Target objectives

The objective of a GHG emission reduction program is ultimately to prevent dangerous climate change. To achieve this objective it will be necessary first to stabilize and then to reduce emissions both in the United States and around the world. In the long run, achieving this objective will require the United States and the international community to move to an energy system that is close to emission-free, and to greatly reduce other sources of GHG emissions. The U.S. target should be designed so that the United States is contributing its fair share to the objective. However, the level and timing of U.S. emissions that would satisfy this objective depend on critical assumptions about the connections between atmospheric concentrations and climate impacts, actions taken by other governments, and global population and economic growth. Given the significant uncertainties in assessing what constitutes unacceptably high atmospheric GHG concentrations and the contribution that various countries would make to emissions and emission reductions, defining a domestic target that aims to prevent dangerous climate change would be difficult. Rather than debate what constitutes a "safe" level of concentrations and the necessary U.S. emission reductions, the prudent approach is to get started on a path that would first stabilize and then bend down the emissions path.

Technology and Phasing of Reductions

Given the expected growth in global energy needs, widespread deployment of alternative fuels and technologies with near-zero emissions will be needed over time in the effort to address climate change. Achieving an economy based on very low-emitting energy technologies will require far-reaching, long-term restructuring. Time will be needed for development and deployment of new technologies and for replacement of capital stock. Similarly, the majority of U.S. automobiles rely on an internal combustion engine that runs on gasoline. There are ways to increase the efficiency of these traditional automobiles, and alternatives such as hybrid gas/electric cars are now available. Over time, the ability of the energy production sector to incorporate technologies such as carbon capture and geological sequestration and for automobiles to run on fuel cells or hydrogen will allow for more significant emissions reductions. Interim targets, achievable with existing technologies and at moderate cost, will be useful in defining how quickly reductions can be met. Thus any policy targets would likely involve phased reductions that could be revised over time to achieve the desired reduction trajectory. Such "sequential decision-making under uncertainty" is common for addressing complex and evolving issues (Aldy, Orszag, and Stiglitz, 2001).

In practice, both rates and absolute quantities are used in the process in which GHG emissions limits and timetables are selected. Under a rate-based approach, the absolute quantities (levels) of emissions expected under the selected rates or standards would be calculated—if not by those who set the rates, then certainly by those who wish to evaluate their implications. Emissions levels will be estimated by multiplying rates (i.e., emissions per unit of production, GDP, or energy) by projected production levels, or growth in GDP or energy use. The total emissions that would result from various rates were calculated, and these totals were considered as part of the rate selection process. Under rate-based approaches, if economic growth exceeds expectations of those who have accepted rate limits, emission levels will be higher than expected.

Similarly, absolute quantity targets will be evaluated in terms of the rates they imply. The U.S. Acid Rain (SO_2) program provides an example of how rates are used even in emission limitation systems that use the absolute-quantity approach. The U.S. Acid Rain Program is the "paradigm" absolute quantity approach and allowances to emit were, for the most part, granted for free. To allocate the allowances, the desired emission rate (SO_2 emitted per BTU of input) for each source was multiplied by the average number of BTUs it used in past years (Ellerman at al, 2000).

Costs

The expected cost of achieving targets will be an important consideration. In the short term, as with target levels, costs under different target structures are likely to vary. Over time, costs of reductions will become clearer and new technologies will enter the marketplace, and future targets can be set informed by this experience. Often, estimates of costs prior to regulation are much higher than costs that emerge once regulations are implemented. (Harrington, W. et al 2000).

Projections of economic growth form the basis for setting limits in both absolute quantity and rate-based approaches, but are particularly important for costs under absolute quantity approaches. If economic growth is significantly greater than forecast, achieving the target will be more costly. If costs of compliance are too high, an absolute quantity target may be abandoned or evaded. Conversely, if an absolute quantity limit turns out to have been set too high in relation to the level of economic activity and emissions that actually occur, it will be easy to meet but will fail to restrict emissions and will create "hot air"—emission reductions that can be sold but which do not represent reductions in GHG emissions beyond BAU reductions.

V. Key Implementation Challenges

Measuring, Monitoring, and Compliance

Any mandatory emission reduction system will need a compliance mechanism, which in turn will rely on measurement and monitoring. GHG emissions can be directly measured or can be estimated using formulas based on the amount of fuel or chemicals (inputs) used and the known emission characteristics (i.e., rates of emissions per unit of energy used or per product) of technologies in use. While some large GHG emission sources will use direct measurement, formulas are likely to be used in other cases. Direct measurement does not necessarily provide more accurate results than use of input and technology data, and both absolute quantity and rate-based systems are likely to include sources that will utilize direct monitoring and sources that will use formulas. Technology-based product standards will also rely on formulas, particularly insofar as total annual or lifetime emissions from such products need to be estimated – for example, for trading or to determine compliance with an absolute quantity cap. While self-reporting of measured and formula-derived emissions may be accepted, some system of independent verification would be needed to ensure compliance with any mandatory emission limitation system.

Indirect Emissions, Product Emissions, and Double Counting or "Gratis" Benefits

As long as fossil fuels dominate the energy supply system, any system designed to limit GHG emissions should: (1) encourage large energy users, including electricity users, to become more energy efficient; (2) encourage more energy-efficient products; and (3) avoid double counting or awarding gratis benefits. Meeting these three goals would present difficulties under any system. The Nordhaus and Danish (2003) report explores the difficulty of avoiding double counting when product-use emissions reductions are traded under an absolute quantity target in a sectoral hybrid system. This section goes beyond their analysis to explore, more generally, encouraging emissions reductions while avoiding double counting and gratis awards in both rate-based and absolute-quantity systems.

One issue that will have to be addressed is whether (and if so, how) to include indirect emissions – i.e., the emissions from the building and industrial sectors that result from purchased electricity. As buildings and industries reduce electricity purchases, these indirect emissions will fall, as will direct emissions from electric generators. While these emission reductions are desirable, if an absolute quantity system includes electricity generators as well as the building or industrial sector, ownership or the attribution of credit for such reductions becomes complicated. Determining ownership is critical if trading is to occur. Issues that arise from simultaneous emission reductions can be more easily handled under rate-based targets. Rates could be applied to electric generators, industries, and a full range of products that use energy, including buildings, automobiles, and appliances, without creating ownership issues. Achievement of "better-than-the-rate-limit" can be used to generate tons for trade, analogous to tons available for trading if emissions are below an absolute quantity cap. Consequently, trading can occur under either rate-based or absolute quantity target structures. As in the case of absolute quantity systems, rates can be applied only to selected sectors if desired.

Encouragement of energy-efficient products consists of two components: promoting: (1) products made from materials and components that have lower emission profiles and (2) products that will cause fewer emissions during use. The former are referred to as "embodied" emissions, and the latter as "product-use emissions." It is difficult to define which of the multiple possible claimants should receive credits or incentives for embodied emissions. Product use emissions will also present challenges due to multiple claimants. One possibility not explored in the Nordhaus and Danish (2003) report is granting credit to purchasers of low-emission products. If it was considered administratively infeasible for millions of consumers to buy, sell, and trade credits, the credits could be returned to, or retained by, the retailers or manufacturers – in effect functioning as rebates. This option would stimulate sales of low-emitting products and reward the purchasers. Under a rate-based system, the double counting of product-use emissions described in the Nordhaus-Danish report would not occur because the electricity producer would not receive credits for reductions in energy demand. Finally, the Nordhaus-Danish report mentions that there are no standards for building envelopes. Standards for building envelopes would fit naturally into a rate-based system, thus addressing what has been an elusive goal: reduction of emissions from the building sector.

VI. Conclusions

The choice of a GHG reduction target – how fast and how much to reduce emissions – is largely a political calculation based on the assessment of risks and costs of action and inaction (with all the attendant uncertainties). Beyond this choice of the reduction level itself, the structure of the target will have important implications for administering the domestic system, the timing of imposed economic costs, and achieving compatibility with other trading systems.

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