CHAPTER 6

Reducing Vehicle Emissions Through Cap-and-Trade Schemes

John German

Global warming is a worldwide problem that is growing in importance. Carbon released during fossil fuel burning is the primary contributor to greenhouse gas (GHG) emissions, and cap-and-trade programs are actively being developed worldwide to provide a sound economic framework for reducing carbon emissions. Cap-and-trade programs have been used successfully in several emissions-related undertakings, such as the U.S. effort to control acid rain by limiting sulfur dioxide emissions and the transition from leaded to unleaded gasoline. Today, carbon trading programs are already being implemented for selected sectors, such as electric utilities.

Encouraged by the past success of emissions trading programs, many energy and environmental specialists are looking to implement carbon trading across all carbon sectors. Most of these plans implicitly assume that motor vehicles can easily be incorporated into global cap-and-trade programs that already exist for other energy sectors. However, there has been remarkably little analysis of the mechanisms needed to incorporate vehicles into cross-sector trading programs. This chapter examines whether or not this assumption is realistic and suggests an alternative method for vehicles that will likely work better. The focus here is on light-duty vehicles (LDVs), while recognizing that transportation includes other vehicles and systems that are likely to require their own focused analyses.

Previous Studies

Two recent studies have already examined the creation of GHG cap-and-trade programs to reduce GHG emissions from motor vehicles. Robert R.

Nordhaus and Kyle W. Danish published the most recent study in May 2003 for the Pew Center (Nordhaus and Danish, 2003). Called "Designing a Mandatory Greenhouse Gas Reduction Program for the U.S," this was a comprehensive study covering all carbon sectors and included a detailed assessment of different ways to incorporate transportation into a trading program. The Pew study examined four cap-and-trade structures:

- An upstream program applying, for example, to fuel producers
- A fully downstream program applying, for example, to vehicle owners or manufacturers
- A hybrid sectoral program with tradable standards. This program combines a downstream cap-and-trade program for large sources in the electricity and industrial sectors with enhanced product efficiency standards for energy end users, such as carbon dioxide (CO_2) per mile standards for vehicles. Vehicle manufacturers could trade between their own product lines, with each other, and with firms subject to the downstream cap-and-trade program.
- A hybrid sectoral program with capped tradable standards. This is similar to the hybrid sectoral program with tradable standards, except that a cap would be set on the total emissions from vehicles. Thus, manufacturers would have to account for the total projected emissions associated with each product they sold, not just for vehicle efficiency.

Each of these structures was evaluated for environmental effectiveness, cost-effectiveness, administrative feasibility, distributional equity, and political acceptability. Table 6-1 presents a summary of the findings in the Pew study.

The authors of the Pew study concluded the following:

> *The analysis would argue against an economy-wide downstream cap-and-trade program (as difficult to administer), a stand-alone large source cap-and-trade program (as incomplete), and a GHG tax that is not part of a larger tax reform initiative (as unviable politically). The analysis does suggest that the comprehensive, upstream cap-and-trade approach and the sectoral hybrid approach are the most viable alternatives for a domestic GHG reduction program.*

The study goes on to state that if the sectoral hybrid approach is taken, "then careful attention will have to be given to minimizing economic costs and administrative complexity, and assuring that the program can be effectively enforced." The authors simply assumed these concerns could be dealt with, however. No attempt was made to address specific design issues.

The second, earlier, report by Steve Winkelman, Tim Hargrave, and Christine Vanderlan, of the Center for Clean Air Policy (CCAP), in April 2000 focused on ways to incorporate transportation into GHG trading (Winkelman et al., 2000). The policies examined were similar to the later

TABLE 6-1. Summary of Pew 2003 Study Results with Respect to Vehicles

	Environmental Effectiveness—Coverage, Certainty, Enforceable	*Cost-Effectiveness—Flexibility, Predictability, Long-Term Incentives*	*Administrative Feasibility—Administrative Cost, Adaptability*	*Distribution Equity*	*Political Acceptability*
Cap & Trade—upstream	Good	Hypothetically least cost if includes flexibility measures	Good	Depends on allocation and auctioning provisions	Works by limiting fuel availability and raising fuel cost
Cap & Trade—downstream			Prohibitive administrative cost		
Sectoral Hybrids—tradable standards	Must expand coverage (vessels, locomotives, HD, aircraft, buses) Emission reductions uncertain	No incentive to reduce end-use Vehicle fuel sales must be exempted from upstream cap & trade Likely considerably more costly than upstream cap & trade	Must translate mpg into annual CO2 (annual VMT assumptions, timing) Requires continuously promulgating adjustments Double-counting risks Evasion if upstream trading allowed	Possible concern	Avoids gasoline price increases
Sectoral Hybrids—capped tradable standards	Emission reductions more certain, although still rely heavily on estimates		Raises issues with allowance allocation, shutdowns, new market entrants, mfr. market share shifts, overall sales		

TABLE 6-2. Direct and Indirect Influences on Transportation GHG Emissions (from the CCAP Study)

Entity/Factor	*Vehicle Miles Traveled*	*Vehicle Efficiency*	*Fuel Carbon Content*
Consumers	Travel Decisions	Consumer Preferences Vehicle Maintenance	Consumer Preferences
Vehicle Manufacturers	(Indirect influence: vehicle efficiency impact on driving costs)	Vehicle Technology	Vehicle Technology
Fuel Producers	Fuel Price	NA	Product Mix
Land Use & Transportation Infrastructure	Available Travel Options	NA	NA

Pew 2003 study; upstream, downstream, and hybrid approaches. The CCAP analysis also investigated the influences of fuel producers, vehicle manufacturers, customers, and land-use policies on the three aspects of carbon emissions: vehicle miles traveled (VMT), vehicle efficiency, and fuel carbon content.

Table 6-2 summarizes the direct and indirect influences of these different factors, illustrating how downstream, upstream, and hybrid programs affect carbon emissions. For example, vehicle manufacturers are the primary influences on vehicle technology, while fuel producers have more leverage on VMT.

The authors found that "the hybrid approach is aimed at combining the benefits of the upstream and downstream systems in a synergistic way. It appears to fall short of this goal, however, because additional complexities are introduced without any clear environmental benefit." The study recommended combining land use policies and an upstream trading system with carbon efficiency standards similar to the current Corporate Average Fuel Economy (CAFE) standard, although inclusion of carbon efficiency standards was based primarily upon arguments that there were other reasons for improving vehicle efficiency than just carbon emissions.

While both of these studies explore the relative merits of the various GHG cap-and-trade systems for transportation, they fall short in addressing the major implementation challenges associated with each alternative. The following sections explore in detail the major policy options in order to highlight obstacles that must be addressed in cap-and-trade systems. Based on an understanding of these issues, an alternative regulatory framework is suggested that has the potential to achieve the same environmental goals while avoiding much of the administrative complexity of current cap-and-trade systems.

Upstream Trading

Upstream trading refers to trading between producers of carbon-based fuels or products. For the transportation sector this would be fuel refiners and importers of refined petroleum fuel. In a pure upstream emissions trading system, fuel producers would be required to hold GHG emission allowances for each ton of CO_2 equivalent emissions produced each year. In addition, fuel producers would be required to hold allowances for each ton of emissions produced due to consumption of the fuels they sell.

Such a system reduces emissions via two mechanisms. First, emissions can be reduced as a direct result of the allocation of emission allowances. Each fuel producer can reduce emissions by reducing fuel output, manufacturing process emissions, or average fuel GHG intensity measured by fuel carbon content, or by purchasing additional allowances from the allowance market. In all of these cases, the total quantity of GHGs emitted to the atmosphere is reduced, although reductions may come from a nontransportation sector in the last case. Second, direct activities to reduce emissions on the part of fuel producers can reduce fuel demand by increasing the cost of fuel production. Demand will decrease as a result of the price elasticity of fuel, although the effect may be small.

The advantage of upstream trading systems is that administration is simplified due to the relatively small number of regulated firms in the upstream industry. There are approximately 175 petroleum refiners, 200 oil importers, and 900 gasoline pipelines in the United States. Data about their operations are readily available. This makes upstream trading schemes reasonably simple to administer at low cost, while providing comprehensive coverage. However, while fuel producers can affect the GHG emissions from their own operations, they have no direct control over fuel consumption in an upstream system. The only consumption control fuel producers have is on price. An upstream trading program has the effect of raising fuel prices. This increased fuel price signal creates incentives to produce and use low carbon fuels, reduce vehicle use and maintain vehicles in good condition, and purchase carbon-efficient vehicles.

The increased price will be limited by the cost of reducing carbon in other sectors. For example, if it costs $50 to reduce a ton of carbon in the electric sector, this translates to just $0.13 per gallon of gasoline. Thus, if the fuel price needed to meet the carbon cap on fuel producers exceeds $0.13 per gallon, fuel producers will simply buy credits from the electricity sector.

Even at $2.50 per gallon, gasoline costs are relatively low compared to fuel prices outside the United States and to historical trends in the United States. Gasoline costs are still a relatively minor economic factor in vehicle ownership. A $0.13 per gallon increase will only have a small impact on VMT and vehicle purchase decisions, and virtually none on low carbon fuels or vehicle technology.

The problem with vehicle technology is that the fuel savings are largely offset by the cost of the technology. The net benefit over a wide range of vehicle technology is less than $200. In addition, the average customer only values the fuel savings for his or her ownership period, which is roughly 50,000 miles, so the net benefit valued by the customer is frequently less than zero. When compared with the multitude of important tradeoffs facing customers in their purchase decision and the emotional factors involved, most customers treat fuel economy technology as a very low priority.

The dynamics of an upstream cap-and-trade system for transportation can be illustrated with a simple example. If we assume that regulated fuel producers will not reduce fuel production, each firm is then faced with three compliance strategies: reduce emissions associated with fuel production, produce and sell cleaner fuels, or purchase emissions allowances from other sectors. If the marginal cost of reducing fuel-related emissions exceeds $0.13 per gallon, a fuel producer minimizing marginal abatement cost will simply buy credits from the electricity sector. Even if one assumes that the entire increase in marginal cost is passed on to consumers, a $0.13 per gallon increase will be unlikely to change driver behavior. Because fuel cost represents only a relatively minor economic factor in vehicle ownership, it is unlikely to have a large impact on VMT and vehicle purchase decisions, and virtually none on low carbon fuels or vehicle technology.

Overall, upstream trading schemes have low administrative costs, but they promise little direct reduction of motor vehicle fuel consumption. Emissions reductions, especially in the near term, are likely to come from other sectors where the marginal cost of GHG abatement is lower. Of course, from a global climate change perspective, this is fine because the atmosphere doesn't care if CO_2 reductions come from vehicles or somewhere else. Due to the oil intensive nature of transportation, however, this may not be the best solution for energy security and trade deficits. Moreover, upstream trading programs are likely to be hampered by political barriers to increasing fuel price. While upstream trading has important benefits and should not be discarded, a supplemental program targeting motor vehicle fuel consumption is likely to be desirable.

Downstream Trading

Downstream trading schemes shift the responsibility for carbon emissions from fuel producers to vehicle owners or operators. The narrowest downstream trading scheme would be similar to the rationing coupons issued in World War II, except that the coupons could be freely traded. The problems with this approach are obvious. There are over 200 million vehicles on U.S. roads, with allocations and trading provisions needed for all. This is a huge administrative burden, and there is no low-cost technology for monitoring vehicle emissions. There are also privacy concerns with mandatory monitoring of individual vehicles. This approach is simply not feasible politically or administratively.

The more practical alternative for downstream trading schemes is to bring vehicle manufacturers into the programs. Vehicle technology is one of the major factors in reducing carbon emissions, and fuel price is a relatively weak lever to bring technology to market. Incentives and mandates affecting vehicle technology could have a major effect on vehicle GHG emissions. There are numerous advantages to this approach:

- In theory the mechanism is simple, requiring only that vehicle manufacturers turn in allowances for imputed lifetime emissions.
- It avoids fuel price increases, which would be politically sensitive.
- There are few automotive manufacturers, so the administrative costs are low.
- Vehicle manufacturers have a great deal of control over the installation of fuel efficiency technology.
- Vehicle manufacturers can influence fuel type.
- Vehicle manufacturers can influence purchase decisions with vehicle pricing and marketing, although manufacturers are limited in what they can do in isolation from changes in customer preferences and the broader carbon-related decision-making context.

It clearly makes sense to try to include vehicle manufacturers in trading programs. Some people stop here and just assume this is the best approach. Even those who acknowledge the problems with economic costs, administrative complexity, and double counting, such as the Pew report, often assume that the program can still be effectively enforced with careful attention to the structure. There are problems with downstream trading schemes focused on vehicle manufacturers, however, which may not be easily remedied.

Problem 1—Double Counting

Perhaps the largest problem with downstream trading schemes is the timing of the allocations and credits to vehicle manufacturers. Fuel producers and other upstream allocations are done for the current year. This is also true for downstream allocations and credits for electric utility companies. However, allocations for vehicle manufacturers are based on projected carbon for the vehicle lifetime. Technology added by vehicle manufacturers now will accrue actual carbon reductions in the future over the vehicle lifetime.

One consequence is double counting of credits. For example, assume that manufacturers improve fuel efficiency or sell alternative fueled vehicles. The carbon from these vehicles will be lower in the future. Manufacturers are given credits for the future reduction in carbon, which they can trade to someone else. In the future, fuel producers will receive credits when vehicles use less fuel, but these are the same credits that were already taken by vehicle manufacturers. The same credits, therefore, are traded twice. Note that increasing efficiency in the other parts of transportation would create similar problems. For example, if the fuel efficiency of freight trucks or the system/logistical efficiency improved, the carbon reductions would also be realized through long time horizons, often longer than light duty. Carbon reduction credits earned by the freight industry should not be double-counted by fuel suppliers in the future, either.

There are three possible ways to eliminate double counting. The first is to switch to upstream trading with fuel producers. This is not really a solution. It simply avoids downstream trading by reverting to upstream trading, with the problems discussed above.

Second, upstream trading with fuel producers could be eliminated and the trading system restricted solely to downstream trading with motor vehicle manufacturers. This would focus on efficiency technology for LDVs, which is likely to be a stronger lever than trying to reduce VMT or change product mix through higher fuel prices. Unfortunately, LDVs consume less than half of the petroleum fuel produced. It would not be desirable to eliminate all other transportation sectors from upstream trading just to focus on vehicle efficiency in LDVs. One possible solution would be to exempt vehicle fuel sales from the upstream cap-and-trade system for other fuel users. This requires forecasting future VMT, scrappage rates, and in-use efficiency. If these forecasts are low, then overall carbon emissions will exceed the cap. When combined with the elimination of incentives to reduce vehicle end-use, this is not likely to be a desirable option.

Finally, the downstream trading scheme could be modified to include a hybrid program, whereby allocations are split between vehicle manufacturers and fuel producers. This could provide some incentives for manufacturers to improve efficiency and for fuel producers to reduce use. While this approach is attractive in theory there are a number of problems, which are evaluated later in this chapter.

Problem 2—Manufacturer Allocations

All the normal problems with allocating versus auctioning carbon caps apply to trading with vehicle manufacturers. However, there are two additional considerations that apply to vehicles. The first is how to handle existing vehicles on the road in the carbon allocations. Who is responsible for the existing fleet of vehicles? The second issue is whether the manufacturers should be held responsible for the total lifetime carbon from their vehicles, or just the carbon intensity measured by CO_2 emissions per mile resulting from the operation of their vehicles.

The total carbon approach would allocate a set amount of carbon that could be emitted from each manufacturer's fleet over its lifetime. John DeCicco suggested this approach in his paper, "An Oil Consumption Cap-and-Trading Scheme for Light Duty Vehicles" (DeCicco, 1993). The advantage of this system is that it holds manufacturers responsible for customer purchase decisions and use, creating incentives for manufacturers to reduce carbon using all of the possible levers, including technology, vehicle characteristics, lower-carbon fuel, and reduced VMT.

The problem with the total carbon approach is that it holds manufacturers responsible for customer purchase decisions and use, as well as sales and market shifts. The compliance burden on manufacturers increases if their sales increase, if the market shifts to larger vehicles, or if people drive more. There are also very anticompetitive consequences. Increasing sales makes it more difficult to meet the requirements, while decreasing sales yields windfall credits without any improvement in efficiency. The net effect is to tend to freeze manufacturers into their existing market share. A total carbon system would be even worse than the Uniform Percentage Increase (UPI) method for CAFE standards. The problems with UPI were discussed at length in a National Academy of Science report on CAFE (National Research Council, 2002).

Downstream trading based on the carbon intensity of vehicle driving would hold manufacturers responsible for the average CO_2 per mile of their vehicles, not the total carbon per fleet. This would be similar to combining CO_2 emissions standards with broader trading. This is equitable and provides a good lever for efficiency technology. It has little influence on VMT or the type of vehicle purchased by consumers, however, and it does not control total carbon emissions. Manufacturers can earn credits even if total carbon increases due to higher sales or increasing in-use driving. While it would be desirable to combine a carbon intensity system for vehicle manufacturers with an upstream system for fuel producers, there are several problems with this approach as well, which are discussed later.

Problem 3—Accounting

To avoid double counting, vehicle efficiency improvements must be subtracted from future carbon allocations for other sectors. As carbon intensity allocation is likely to be the only workable system for vehicles, future changes in vehicle carbon emissions must be estimated annually by predicting yearly scrappage rates, annual VMT by vehicle age, in-use fuel economy shortfall resulting from a gap between certification test results and average in-use fuel economy, and the carbon content of the fuel. If vehicle carbon emissions are estimated incorrectly, then extra burden may be put on other sectors or the desired carbon reduction may not be achieved.

It is difficult to forecast the future and the assumptions may prove to be very inaccurate. For example, lifetime VMT per vehicle may change. This will cause vehicles to use more or less carbon compared to the original accounting. Also, in-use efficiency may change due to factors such as more congestion, higher speeds, and more sprawl, with similar impacts on total carbon emissions. To further compound the problem, most of these factors are not well known. For example, estimates of the in-use fuel economy shortfall are now based on 25-year-old data and scrappage rate estimates are based on very limited and imprecise surveys. In addition, vehicle use characteristics in terms of lifetime and annual VMT are likely to vary by vehicle type and manufacturer.

There are further issues with alternative fueled vehicles. How is double counting handled with respect to alternative fuel producers? How are credits determined for flexible fuel vehicles that can run on more than one fuel? The future use of alternative fuels on flexible fuel vehicles and the actual GHG emissions impact must both be accounted for with reasonable accuracy.

Another important issue is that vehicle accounting is not compatible with the rest of the trading system, due to the mismatch in the timing of the carbon reductions. For example, if carbon prices are low, manufacturers are encouraged to buy credits instead of using advanced technologies. However, the efficiency of the current in-use fleet doesn't change, and the credits are used to increase vehicle emissions in future years as the fleet turns over. Thus, the carbon ceiling for the current year goes down. The future vehicle fleet will use more fuel and less carbon will be allowed, which will cause oil producers to exceed their allocations in the future and force them to buy credits. This will drive up the price of carbon in the future.

On the other hand, if carbon prices are high, manufacturers are encouraged to exceed requirements and sell credits. Again, the efficiency of the current fleet doesn't change, so the carbon ceiling for the current year goes up. The future vehicle fleet will use less fuel and more carbon will be allowed, which will drive down prices in the future.

The mismatch in the timing of the carbon reductions results in an artificial cycling of both carbon availability and pricing, based on vehicle turnover. This will make it difficult for other sectors to manage their allocations, especially the oil producers.

Additional Concerns and Questions

There are a number of other potential problems that a downstream vehicle trading program must address, including the following:

- How should equipment other than the LDV fleet be handled, including pickups and sport utility vehicles over 8,500 pounds gross vehicle weight, heavy trucks, farm equipment, buses, lawnmowers, motorcycles, and construction equipment?

- If a vehicle efficiency standard is used alone, how should the lack of environmental certainty be addressed?
- There is a need to consider how to monetize non-GHG considerations, such as energy security and the trade deficit, into a vehicle trading system designed to reduce GHG emissions.

Upstream/Downstream Hybrid

The analysis in the last section suggests that a compromise approach between upstream and downstream vehicle trading programs might be to split the carbon allocation between vehicle manufacturers and fuel producers. In theory, this could provide some incentives both for manufacturers to improve efficiency and for fuel producers to reduce carbon use.

To help visualize how such a hybrid would operate, let us assume a 2015 target of 200 million tons (mmT) CO_2 reductions from vehicles and that the responsibility for achieving these reductions is split equally between vehicle manufacturers and fuel producers. Table 6-3 provides a summary of the assumptions and issues in this example to make it easier to follow the discussion.

The first step is to calculate baseline whole lifetime CO_2 emissions for the total number of vehicles sold annually. For cars and light-duty trucks, baseline CO_2 emissions over the vehicle lifetime are approximately 1,074 mmT per model year. This result is obtained by multiplying 17 million new LDV sales per year by 150,000 lifetime miles traveled per

TABLE 6-3. Hybrid Program Summary

	Vehicle Manufacturers	*Fuel Producers*
Baseline	Vehicle sales * Lifetime VMT / in-use MPG * carbon content	Gallons sold * carbon content
2005—million metric tons CO_2	17 * 150 / 21.0 * 19.5 / 2.205 = 1074 mmT	1982 mmT (inc. rail, bus, freight, ship, boat, air, 75-05 LD)
2020—each reduce 100 mmT	17 * 150 / 23.2 * 19.5 / 2.205 = 972 mmT	How is LD handled versus other transportation sectors?
	What if: sales change, lifetime VMT increases, in-use FE shortfall changes	How are vehicle efficiency improvements handled in the future?
	• Actions by one will reduce emissions of the other without any action, although offset in time by fleet turnover • If want to influence both manufacturers and oil producers, must hold both accountable for total reductions • Actions by each still influences requirements for the other	

vehicle, divided by an average in-use fuel economy of 21 miles per gallon (mpg), multiplied by 19.5 pounds of CO_2 per gallon of gasoline, divided by 2,205 pounds per metric ton. For fuel producers, baseline CO_2 emissions are simply the carbon content of the fuel sold. Per the Annual Energy Outlook 2005 with Projections to 2025 (EIA, 2005), total CO_2 emissions for all transportation sources are 1,982 mmT for 2005.

For 2020, additional assumptions are that new vehicle sales remain constant, in-use VMT doesn't change, and the average carbon content of in-use fuel doesn't change. With these assumptions it is possible to calculate the level of in-use mpg needed to reduce 100 mmT from vehicles. Next, manufacturers can back-calculate the new vehicle efficiency needed using estimates of scrappage rates and VMT/year by vehicle age, assuming that the relationship between fuel economy tests and in-use mpg doesn't change. Changes in the carbon content of in-use fuel can also be included in the model for new vehicle efficiency, although this raises the issue of whether vehicle manufacturers or fuel producers should receive credit. Of course, if any of these six assumptions are wrong it means that the projected savings will not equal the actual savings.

For fuel producers, there are some additional considerations. For the 2005 baseline year, LDVs emitted 1,074 mmT CO_2 and all transportation sources emitted 1,982 mmT, which means that over 900 mmT were generated by other sources, such as rail, buses, freight, shipping, boats, airplanes, construction, and lawnmowers. Should the fuel for LDVs be separated from other uses and, if so, how? Should the 100 mmT reduction for vehicles be included in a larger, overall reduction for all transportation? What is the baseline for the fuel producers? Should the 100 mmT reduction in CO_2 be compared to 2005 CO_2 emissions or to a "business as usual" base case for 2020? This last is a critical issue, as VMT has been steadily increasing and will continue to do so barring some catastrophic event.

Assuming that all the accounting issues can be managed, there is still a major problem with interactions between actions taken by vehicle manufacturers and fuel producers. For example, if vehicle manufacturers take steps to improve the efficiency of their vehicles from 2005 through 2020 such that the in-use vehicle fleet achieves a 100 mmT reduction in CO_2 emissions in 2020, then fuel producers don't have to do anything to reach their 100 mmT reduction goal. The vehicle manufacturers would have already accomplished the entire reduction.

This can be corrected by doubling the reduction required from fuel producers so that they will be held to a 100 mmT reduction in addition to the 100 mmT required from the vehicle manufacturers. This would force fuel producers to take steps to reduce carbon content in the fuel, carbon from refining, and transporting fuel, or raise the price of fuel by limiting quantities or buying credits from other sectors. Reducing the carbon content of fuel or raising fuel prices would reduce vehicle CO_2 emissions, both directly and indirectly by encouraging the purchase of more efficient vehicles and reducing VMT. Now the vehicle manufacturers can wait for the steps taken by the fuel producers to reduce vehicle CO_2 emissions by 100 mmT, without significant action on the manufacturers' part.

Actions taken by vehicle manufacturers and fuel producers will always reduce the emissions from the other without any action being taken. This interaction is offset in time by fleet turnover, making it virtually impossible to determine what the effects will be. This interaction between vehicle manufacturers and fuel producers makes it virtually impossible to determine separate allocations. If the goal is to involve both vehicle manufacturers and fuel producers to achieve a 200 mmT CO_2 reduction, both must be held accountable for the full amount of the 200 mmT. This would not be an enforceable system, as it would not be possible to allocate shortfalls between the vehicle manufacturers and fuel producers.

Incorporating Vehicles into a Carbon Trading Program

A single example is discussed in this section to help illustrate the difficulty in incorporating vehicles into an overall carbon trading program. The example is drawn from the U.S. Climate Stewardship Act of 2003 (U.S. Senate, 2003). Jonathan Hughes, who is conducting research on vehicle trading schemes for the UC Davis Institute of Transportation Studies, suggested the fuel economy credit conversion methodology presented in the sidebar (Hughes, 2005).

Sidebar: Hybrid Upstream Emissions Trading System

An upstream trading system for transportation was proposed in the McCain-Lieberman Climate Stewardship Act of 2003 and is currently under discussion by the California Climate Action Team in the state of California. These systems have the benefit of administrative simplicity due to the relatively small number of firms that would be regulated and a high potential for environmental effectiveness due to broad coverage, certainty, and enforceability. However, incentives to reduce fuel consumption via the indirect mechanism of price signals are less than those for systems specifically targeting VMT reduction or fuel economy improvements. In order to promote improvements in vehicle fuel economy, a pure upstream system could be modified to incorporate vehicle manufacturers. As an example, the Climate Stewardship Act of 2003 would allow vehicle producers that more than comply with the CAFE standards to sell excess credits to a central GHG allowance market. However, the provision would require a complex accounting methodology to convert improvements in fuel economy to GHG emission allowances. In order to avoid double counting and estimation issues, allocations of allowances to vehicle manufacturers for improved vehicles would need to occur annually over the vehicle lifetime. In addition, such a system must reduce the annual allocation of emission allowances to the allowance market and to fuel producers by an amount equivalent to the annual amount awarded to automakers in order to avoid double counting of emissions reductions.

The advantage of this system is better accounting and control of the emissions reductions. Instead of allocating the entire credit to the manufacturer when the vehicle is produced, it would allocate credits annually over the vehicle lifetime as the carbon savings occur. The annual allocation to fuel producers would be reduced by the annual amount awarded to vehicle manufacturers. This would ensure that emissions reductions would not be double counted.

This is the best approach proposed to date for a hybrid upstream/downstream vehicle program. Nonetheless, there is still an issue with allocation between vehicle manufacturers and oil producers, although there is no longer a possibility of double-counting credits. The allocation is done annually, which means scrappage rates, VMT by vehicle age, in-use fuel economy shortfall, and fuel carbon content must be calculated for each model year. If the estimates are not accurate, it will benefit one of the parties and make it harder for the other. Also, changes in these variables will affect the allocations to vehicle manufacturers and fuel producers, changing the cost of complying with trading requirements.

Allocating credits annually substantially reduces the incentive for vehicle manufacturers to participate. Manufacturers will have to utilize engineering resources and spend capital up front to implement efficiency improvements, but the credits will be allocated over the 25- to 30-year vehicle life. While this is also true for other sectors, especially the electric sector, vehicle manufacturers are unique in that they do not capture the savings from the future reduction in fuel use and they would not be required to participate in carbon trading. Further, the amount of the future credits would be uncertain, as they depend on assumptions about future lifetime VMT and fuel carbon content, which are likely to be inaccurate. Thus, there would likely be little motivation for vehicle manufacturers to significantly improve vehicle efficiency.

Another problem is that offering an alternative fueled or flexible fueled vehicle does not do any good if the fuel is not available. On the other hand, offering alternative fuels does not do any good if vehicles are not available. Both are needed to move the market toward lower carbon fuels. The system does not address this problem.

Finally, the system does not reduce overall carbon emissions. Oil producer allocations are reduced, but this is offset by allocations to the vehicle manufacturers. In sum, the total number of allocations does not change. This is also true if the vehicle credits are given to vehicle manufacturers when the vehicles are sold instead of when the fuel is used. Allowable CO_2

emissions will increase in the baseline year when the vehicle manufacturers are allowed to sell CAFE credits into the system, as the reductions in vehicle CO_2 only occurs in the future. Then, in the future, overall CO_2 allowances are reduced corresponding to the reduced CO_2 allocation to fuel producers. In sum, over the vehicle lifetime, the initial increase in credits and the future reductions in allocations will exactly offset each other, assuming all the factors were estimated correctly. There is no net decrease in CO_2 emissions.

One argument in support of a hybrid vehicle trading system is that, even if it doesn't reduce overall carbon emissions, it could help to reduce the overall cost by encouraging fuel efficiency technology. However, this system has no explicit mechanism to minimize GHG reduction costs in transportation by selecting between fuel and vehicle technologies that offer lower marginal costs. It just requires that any improvements made by vehicle manufacturers be subtracted from future fuel producer allocations. The cost control is entirely on the side of the vehicle manufacturers.

Another argument in support of a hybrid vehicle trading system is that there are other benefits to reducing oil consumption, such as energy security, trade deficits, and the effect of oil price shocks on the economy. However, creating a very complex trading system, with no mandatory participation by vehicle manufacturers, is unlikely to be the optimum solution.

Conclusion

Previous studies have identified most of the problems with trying to incorporate vehicles into carbon trading programs, but none are comprehensive. The 2003 study by the Pew Center, for example, simply presented the advantages and disadvantages of all the different options. The CCAP study in 2000 was based primarily on arguments that there were other reasons for improving vehicle efficiency than just carbon emissions. Neither study tried to solve the problems from integrating vehicle manufacturers into overall carbon trading programs, which are overwhelming. Some of the key problems are outlined below.

Double counting must be avoided. This is not a problem if only fuel producers or vehicle manufacturers are included in a trading program. Vehicle manufacturers have little impact on VMT and fuel producers have little impact on vehicle technology, so it is desirable to include both. Systems that provide allocations to vehicle manufacturers must subtract this amount from fuel producer allocations.

Currently, only vehicles with gross vehicle weight ratings less than 8,500 pounds are subject to the fuel economy testing necessary for proper emissions accounting. This requires that fuel producer allocations be divided between LDVs and all other transportation uses. It also raises the question as to how the other transportation uses should be handled in the trading system.

Proper allocation requires accurate estimates of vehicle scrappage rates, VMT by vehicle age, average carbon content of in-use fuel, and in-use mpg compared to test results. Except for the average carbon content in fuel, none of these factors is well understood. None of the factors can be forecasted with any accuracy.

Actions taken by vehicle manufacturers to improve efficiency do not affect current year carbon emissions but only future emissions. Other sectors are dealing with current year emissions. This time offset creates multiple problems in accounting and operation of incentives.

If allocations are given to manufacturers for the lifetime estimated emissions when the vehicle is built, it results in an artificial cycling of both carbon availability and pricing, based on vehicle turnover. This will make it difficult for other sectors to manage their allocations, especially the oil producers. This can be fixed by allocating manufacturer credits annually over the vehicle lifetimes as the carbon savings occur. However, allocating credits annually instead of when the vehicle costs are incurred substantially reduces the incentive for manufacturers to participate.

Actions taken by vehicle manufacturers affect the allocation for fuel producers and vice versa. This makes it impossible to set separate allocations for manufacturers and fuel producers. Both must be held accountable for the entire reduction in carbon emissions, but currently there is no known way to administer such a program.

Handling of alternative fueled vehicles is problematic. Vehicle manufacturers are needed to produce the vehicle and fuel producers must make the fuel available, but there is no way to split the carbon allocation between manufacturers and producers. Flexible fueled vehicles create an additional problem, which is accounting for the amount of the alternative fuel that will actually be used.

Maybe there is a way to solve all of the problems and make a workable hybrid vehicle trading system, but ten years of effort by many different organizations has yet to yield a good system. Different systems solve some of the problems, but the overall complexity is overwhelming.

Even if the problems could be solved, vehicles would still not reduce overall carbon emissions. To avoid double counting, the vehicle manufacturer allocations must be subtracted from the fuel producer allocations. Thus, the primary justifications for creating a hybrid vehicle trading system are to reduce the overall costs of reducing carbon emissions and to capture other benefits for reducing fuel use beyond just GHGs, such as energy security, trade deficit, and oil price shocks. Incorporation of vehicles into an overall carbon trading system is a very complex and likely unworkable way to try to capture these benefits. The sidebar offers a proposal that could avoid several of the problems identified in this chapter.

Sidebar: A Better Approach

The primary arguments for creating a hybrid vehicle trading system are that it could reduce the overall costs of reducing carbon emissions and that there are other reasons for reducing fuel use beyond just greenhouse gases.

These same advantages could be obtained with a lot less complexity by creating a stand-alone incentive program for vehicle efficiency. This would still be based on vehicle carbon-intensity incentives based on CO_2 emissions per mile. If desired, the incentives could be class-based to address customer choice, safety, and intermanufacturer equity concerns. Due to the limited number of manufacturers who control the large majority of the market, trading between manufacturers is not likely to be very successful. Thus, the system should allow manufacturers to buy and sell efficiency credits to and from the government at a fixed rate. This rate could be set based on the going carbon trading rate plus monetization of benefits to the nation for conserving energy and reducing oil consumption.

Such a system would provide certainty on the monetary value for improving efficiency and would allocate the full value immediately, increasing the incentive for manufacturers to bring technology to the market. It would also be far simpler to administer and would keep the credits out of the overall sector carbon trading system, avoiding most of the problems with incorporating vehicles into an overall trading system.

One unavoidable problem is that the improvements in vehicle efficiency would still need to be subtracted from the fuel producers' allocation. Otherwise, oil producers would have windfall benefits from vehicle manufacturer actions. The government would need to monitor actual efficiency improvements and in-use VMT and use this data to adjust carbon caps for the fuel producers.

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