Emissions Trading with Telecommuting Credits: Regulatory Background and Institutional Barriers

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Abstract

The 1999 National Telecommuting and Air Quality Act created pilot programs in five metropolitan areas in the United States to examine whether a particular type of economic incentive, tradable emissions credits created from telecommuting, represents a viable strategy for reducing vehicle miles traveled and improving air quality (H.R. 2094, 2000). Under the ecommute program, companies could generate emissions credits by reducing the vehicle miles traveled (VMT) of their workforce through telework programs. They would then be able to sell the credits to firms that needed the reductions to comply with air quality regulations. This paper provides some context for evaluating whether such a trading scheme represents a feasible approach to reducing mobile source emissions and promoting telecommuting and reviews the limited experience with mobile source emission trading programs.

From a regulatory perspective, the most substantial drawback to such a program is its questionable environmental integrity, which is a result of difficulties in establishing sufficiently rigorous quantification protocols to measure accurately the emission reductions from telecommuting. Perhaps more importantly, such a program is not likely to be cost-effective; the emissions reductions from a single telecommuter are extremely small, meaning that any trading program will have relatively high transaction costs to environmental benefits. A comparison of estimated emission reductions from the five pilot cities with historical and projected emission credit and allowance prices indicates that the yearly revenue per participant is likely to be well under $100, substantially below what firms participating in the program said would be an adequate incentive to induce a substantial increase in telecommuting.

This discussion paper is the final paper in a series of four on telecommuting published in by RFF in December 2004. In discussion paper 04-42, Walls and Nelson analyze data from five pilot cities enrolled in the "ecommute" program. In 04-43 Safirova and Walls examine the 2002 Telework survey conducted in California and, in 04-44, these authors review the empirical literature on telecommuting with a focus on trip reduction impacts. The studies by RFF are part of a larger report on the ecommute program completed by the Global Environment and Technology Foundation (GETF) for the U.S. Environmental Protection Agency. More information about the overall project can be found on the ecommute/GETF website: http://www.ecommute.net/program/.

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Contents

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I. Introduction

Over the past 30 years, emissions trading has emerged as an accepted strategy for achieving environmental goals. The sulfur dioxide (SO_2) trading system under Title IV of the 1991 Clean Air Act Amendments is undoubtedly the most notable trading program in the United States, but there are many other examples. Applications include the leaded gasoline phasedown, water quality permit trading, chlorofluorocarbon (CFC) trading, and the RECLAIM program in the Los Angeles metropolitan region (see Stavins 2001 for a survey).

During the same period, there has been a dramatic reduction in emissions from automobiles and trucks. Emissions rates for new light-duty vehicles are now 70% to 90% less than in 1970. The reductions from 1970 to 1999 are so dramatic that aggregate motor vehicle emissions of carbon monoxide, particulate matter, and volatile organic compounds (VOCs, an ozone precursor) dropped even though vehicle miles traveled (VMT) more than doubled (Federal Highway Administration 2002). Interestingly, economic incentive policies, and especially trading policies, have played a negligible role in this achievement. The progress in mobile source emissions has occurred almost exclusively through technology-based approaches, such as tightened vehicle standards and fuel improvements.

Recently, concerns that future technological improvements in the vehicle fleet are likely to be increasingly expensive have led analysts at the Environmental Protection Agency (EPA) and others to look toward measures that lower total emissions by reducing VMT and vehicle trips (U.S. EPA 1997). Examples include policies to encourage ride-sharing and mass transit, as well as trip reduction strategies like compressed workweeks and telecommuting. Economic

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incentives have a potential role in such programs, since success depends on large-scale behavioral changes on the part of drivers.

The 1999 National Telecommuting and Air Quality Act created pilot programs in five metropolitan areas in the United States to examine whether a particular type of economic incentive, tradable emissions credits created from telecommuting, represents a viable strategy for reducing vehicle miles traveled and improving air quality (H.R. 2094, 2000). Under the ecommute program, companies could generate emissions credits by reducing the VMT of their workforce through telework programs. They would then be able to sell the credits to firms that needed the reductions to comply with air quality regulations.

This paper provides some context for evaluating whether such a trading scheme represents a feasible approach to reducing mobile source emissions and promoting telecommuting. Section II briefly introduces the concept of emissions trading and gives an overview of the various air emissions trading programs in the United States. Section III summarizes the fairly limited U.S. experience with mobile source emissions trading. Section IV looks more specifically at the regulatory and institutional frameworks for emissions trading in the pilot cities and considers how the ecommute concept fits into those frameworks. Section V examines the potential strength of the telecommuting incentive from allowing the sale of emissions credits. Section VI looks ahead to longer-term developments that may influence the relative attractiveness of programs to promote telecommuting through emissions trading. Concluding remarks are provided in Section VII.

II. Emissions Trading

Emissions trading is a fairly simple concept, even though in practice many complexities arise. Because firms differ in their ability to reduce pollution, there are potential benefits from specialization through gains from trade. Instead of forcing high-cost firms to reduce emissions by some fixed amount or to install expensive technology, it is more cost-effective to allow them to purchase needed reductions from those who can reduce emissions cheaply. By improving the allocation of costs, emissions trading should enable a given environmental goal to be achieved at a lower total cost to society. In theory, the efficient outcome will occur when the marginal cost of abatement is equalized across polluters.

The intellectual origins of emissions trading date back to Coase's (1960) argument for assigning transferable property rights for "bads," such as pollution. The explicit application of this approach to environmental policy was developed separately by Crocker (1966) and Dales

(1968). An advantage of emissions trading is that it frees the regulator from the substantial informational requirements associated with command-and-control regulation or a system of pollution fees. The value of the emissions rights is determined through the market rather than by a centralized authority, and the regulatory agency can simply set the desired emissions target without reference to the various firms' abatement cost functions or pollution damage functions.

The direct benefits of emissions trading flow from the lower total costs of compliance. Trading by itself does not reduce aggregate emissions; those remain a function of goals or standards set by regulation. However, indirect environmental benefits can result from trading. The federal emissions offset program, for example, requires "trading ratios" so that firms must in effect purchase "extra" emissions reductions to achieve compliance. The ratios can as high as 1:1.5 depending on sources and nonattainment status.[1] In addition, credits and allowances can be retired—that is, purchased by or donated to an entity (often an environmental group) that opts not to use them to comply with regulations. Finally, if a trading program lowers the costs of regulation, the government may be able to set more aggressive environmental targets than would otherwise be the case.

In the United States, two basic types of interfirm trading regimes are currently used in air pollution policy: *allowance-based cap and trade* and *emissions reduction credit trading*. Emission credits are generally used in two types of programs: *emissions offset* and *open-market trading* programs.

Allowance-Based Cap and Trade

In a cap-and-trade system, an overall limit is placed on aggregate emissions during a specified compliance period. Emissions allowances that entitle the holder to emit a set amount of a pollutant are allocated to firms, with the total number of allowances set equal to the cap.[2] Allowances may be traded among eligible sources, but at the end of the compliance period, each firm must hold sufficient allowances to cover its emissions for the period. Usually, there are provisions for limited banking of allowances for later use. The attraction of a cap-and-trade system is that it retains the certainty of a hard target through the cap on total emissions while allowing firms flexibility in reaching the target.

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[1] Several states have additional offset ratio requirements over and above the federal mandates.

[2] The number of allowances equals the emissions cap if one allowance is equal to one ton of emissions, as is often the case (as in the SO_2 program), but any fixed ratio between emissions and allowances is acceptable.

The flagship cap-and-trade program is the SO_2 allowance market created under Title IV of the 1990 Clean Air Act Amendments. The program, designed to reduce emissions that lead to acid rain, caps annual SO_2 emissions from electric utilities' generation facilities at 8.95 million tons (approximately 50% of 1980 levels). Firms possessing surplus allowances may either sell them or bank them for future compliance needs. The program is widely considered a major success. A review of published estimates reveals a general consensus that the SO_2 trading system has resulted in, and will continue to account for, substantial costs savings over a command-and-control regime (Burtraw and Palmer 2003).

The program's success is attributed to many factors, but foremost among these is the flexibility it allows in compliance options and the timing of reductions. The fact that the regulation does not mandate a specific technological approach has enabled firms to take advantage of alternative ways of reducing emissions, such as using low-sulfur coal from Montana and Wyoming (made more available through rail deregulation). The program is also credited with spurring more process innovation than would have occurred under mandated technology standards.

Besides SO_2 allowance trading, other prominent examples of cap and trade include programs to control regional emissions of nitrogen oxides (NO_x) in the Northeast and state programs in California, Illinois, and Texas. Beginning in 1999, nine northeastern states established a regional NO_x cap-and-trade system to address the issue of ozone transport. The program, run by the Ozone Transport Commission, has since expanded to include additional states in the South and Midwest. EPA facilitates the program by running the allowance and emissions registries and verifying emissions data.

The Emissions Reduction Market System, a cap-and-trade program established by the Illinois Environmental Protection Agency, addresses certain stationary sources of volatile organic material in the ozone nonattainment area in northeastern Illinois. The local programs in Los Angeles (RECLAIM) and Houston are examples of "hybrid" cap and trade because allowances can be created from outside the capped stationary sector and used for compliance. Under recently adopted rules, large stationary sources were removed from the RECLAIM participants' allowance program and instead pay a per ton fee to an air quality improvement fund managed by the local air district; the revenues fund emissions-reducing projects.

In 2005, the European Union will inaugurate a highly ambitious cap-and-trade program covering CO_2 and other greenhouse gases.[3] In the United States, there are competing proposals to extend cap and trade for further SO_2 reductions and the national regulation of NO_x. Several northeastern states have NO_x and carbon cap-and-trade programs that are slated to begin in the next few years. The cap-and-trade approach has also been proposed for addressing mercury emissions and CO_2 at the national level.

Emissions Reduction Credit Trading

Unlike cap-and-trade programs, in which the emissions cap establishes the level of pollution allowed by the polluting industry, emissions reduction credit programs rely on other regulatory policies, such as rate-based emissions standards, to establish a baseline level of pollution. Credits are generated when firms reduce emissions below this baseline. The credits can then be used for other compliance purposes, such as offsetting pollution from a new source, dealing with penalties, or avoiding requirements to install reasonably available control technology (RACT). In the United States, there two major types of emissions credit programs: *offset* programs, which are used for compliance with the Clean Air Act requirements for new large stationary sources in nonattainment areas; and *open market* programs, adopted by some states to give firms flexibility in complying with certain state and federal regulations. Offset programs primarily use emissions reduction credits (ERCs), which are denoted in a mass of emissions per unit of time (e.g., tons of NO_x per year). In contrast, open-market programs use discrete emissions reduction (DER) credits. These are mass-based (e.g., tons of NO_x) and are usually generated from a one-off emissions reduction.

Emission reductions may be converted to ERCs or DERs if certain criteria are met. These criteria have been set out in a series of EPA guidance documents dating back to the 1980s. Specifically, the reductions must be *surplus, permanent, quantifiable,* and *enforceable* (U.S. EPA 1986):

- *Surplus.* To avoid double counting, the reductions must be additional to reductions required by state and federal regulations. If the purpose of the trades is to allow for flexible compliance, it must be shown that the trades do not end up increasing aggregate emissions.

[3] See Kruger and Pizer (2004) for an overview and potential pitfalls in the program.

- *Permanent.* The reductions must occur for as long as they are relied on in the state implementation plan (SIP) or SIP-related requirements.
- *Quantifiable.* The emissions reductions can be reliably measured.
- *Enforceable.* Violations can be identified and liability can be determined. State and/or federal agencies are able to apply penalties and secure appropriate corrective actions if necessary.

If the above criteria are met, the emissions reductions are said to have "integrity"—that is, they do not result in emissions above what would occur in the absence of a trading program.

Emissions Offsets

Under the New Source Review provisions of the Clean Air Act, new large stationary sources in nonattainment areas (as well as existing sources that undergo major modifications) are required to implement lowest achievable emissions rate (LAER) technology. In addition, they must more than offset any increase in total emissions that results from their activity by securing emissions reduction credits from existing sources in the same area. For example, if a new power plant emitting 100 tons of NO_x per year is built in a nonattainment area, it must secure more than 100 tons' worth of ERCs to meet its offset requirements. Federal law specifies trading ratios for offsets that can be as high as 1:1.5, depending on source and nonattainment status. Thus, the firm in the example might be required to purchase ERCs equivalent to 150 tons of NO_x emissions per year.

The idea behind offsets is to enable economic growth without jeopardizing progress toward attainment of air quality goals. However, new sources are required to comply with stringent technology standards before purchasing credits from elsewhere, and therefore the compliance flexibility advantage of trading is weakened. Offsets are available for a variety of pollutants, most prominently NO_x and VOCs.

ERC programs are administered by states and local air districts, and their rules and structure vary considerably. Many of the most active state programs maintain a registry or bank of ERCs to facilitate trades. The most common method for generating an ERC has been the closing of a stationary source or reduction of its production, no doubt because it is comparatively easy to demonstrate that such actions meet EPA's integrity criteria.

The performance of ERC programs has been mixed. *The United States Experience with Economic Incentives for Protecting the Environment* (U.S. EPA 2001a) concludes that because of few trades and low offset prices, ERC trading has not fulfilled initial expectations. "In many areas," according to the report, "it appears that ERCs had an economic value less than the transaction costs of completing a sale to another party." The transaction costs include the often lengthy and involved technical reviews associated with the trades and the offset ratios mentioned above.

Swift and Haites (2002) conclude that the use of ERCs for offset purposes has comparatively high environmental integrity because of the "semicapped" nature of emissions from large stationary sources in nonattainment areas. As long as ERCs are generated within the stationary sector (as has been typically the case), New Source Review rules will work to produce an implied cap on large stationary source emissions.

Open-Market Trading

In recent years, some states have attempted to expand emissions trading through "open-market" trading programs.[4] These programs were developed after EPA released its proposed open-market trading rule in 1994, which provided a framework for expanding emissions trading beyond electric utilities and other large stationary sources. This rule was never finalized, but elements of it were incorporated into EPA's guidance for economic incentive programs, released in 2000. The open-market trading programs rely on discrete emissions reductions—mass-based, one-time reductions in emissions of pollutants (usually NO_x or VOCs). DER credits are defined retrospectively, after the reductions have taken place. Whereas ERCs are necessarily a stream of reductions, DERs are usually created from activities of limited duration. An example of a DER is the reduction of NO_x emissions that would occur when a coal-fired cogeneration plant switches its fuel to natural gas. The estimated reduction could then be banked and used or traded at a later date. According to EPA guidance, shutdowns and activity curtailment are not approved methods for generating DERs; rather, DERs are generally created from overcompliance with existing regulation and represent a reduction from an estimated baseline level of emissions.

The most significant difference between open-market and offset trading is the use of the credits. DERs are designed to be used where there is no offset requirement, such as for compliance with EPA's RACT standards, which apply to all large stationary sources in

[4] Texas, New Hampshire, Michigan, Connecticut, New Jersey, and Massachusetts all have programs, though New Jersey recently rescinded its program.

nonattainment areas, or for dealing with state penalties and special circumstances. (In theory, DERs can also be used for offsets if a state allows such transactions, but there is a fundamental mismatch between the need of firms to secure a stream of emissions reductions for offset purposes and the one-time nature of DERs.)

The rationale for open-market programs has been to expand emissions trading beyond the traditional constituency of large stationary sources and provide a vehicle for intersector trading, which many believe will open up new possibilities for cost savings. However, an open market does not have the firm emissions cap generally associated with allowance trading or even the implicit cap associated with New Source Review offsets. Because the open-market framework is explicitly designed for intersector trading and for uses other than the strict federal new source requirements, there is a higher risk that trades will lack integrity. For many types of sources often included in open-market programs (such as area or mobile sources), there is no meaningful inventory of the covered sources or reliable mechanism to monitor emissions at those sources. Thus, the universe of covered sources is not as well defined as it is for allowance trading or new sources in nonattainment areas.

Furthermore, open-market trades are predicated on the establishment of an emissions baseline for the source that wishes to generate credits. Environmentalists have questioned the veracity of these baselines (Environmental Defense 2001). One worry is that firms may attempt to take credit for reductions that would have occurred without the program, sometimes called "anyway tons." If trades of such credits take place, the net effect would be to raise emissions over what would have occurred absent the program: the reductions would not have integrity. The quantification protocols needed to ensure that the emissions reductions are real place large informational burdens on the regulatory agency. For a critical appraisal of open-market programs, see PEER (2000); for a more positive assessment of their potential, see Clean Air Action Corporation (2002).

In 2002, EPA's Inspector General issued a report highly critical of the New Jersey and Michigan open-market programs (U.S. EPA 2002).[5] New Jersey shuttered its open-market

[5] "Open Market Trading Program for Air Emissions Needs Strengthening," Report No. 2002-P-00019, September 30, 2002.

program in February 2004 after finding that it "suffered from problems that diminished its effectiveness and may have resulted in an environmental disbenefit."[6]

Swift and Haites's (2002) survey of open-market programs contains several empirical findings concerning the performance of the programs. First, the authors find that there has been little relatively little trading activity; credit generation far outweighs use, resulting in an oversupply of DERs. Second, although the primary focus of DER programs was initially permit compliance, almost half the uses of DERs have been for penalties and special circumstances. The use of DERs for permit compliance has been less than 1% of stationary NO_x emissions. Finally, in most states, more than 90% of the NO_x DERs have been created at a handful of large stationary sources. Swift and Haites conclude that open-market programs suffer from inherently weak environmental integrity unless certain best practices are instituted.

III. Emissions Trading with Mobile Source Credits

Although emissions reduction credits and discrete emissions reduction credits are predominantly created by stationary sources, trades involving mobile sources are permitted under federal law. EPA has allowed mobile source emissions reductions to be a source of tradable credits since 1986. According to EPA's (1993) *Interim Guidance on the Generation of Mobile Source Emission Reduction Credits*, mobile emissions reduction credits (MERCs) can be used to comply with RACT standards, to offset emissions under New Source Review, to address temporary emissions spikes or temporary noncompliance with regulations, and to satisfy emissions reduction requirements that are over and above RACT. But MERCs cannot be used to satisfy the requirements of best available control technology, lowest achievable emissions rate, or new source performance standards. Furthermore, the guidance prohibits the use of MERCs for inspection and maintenance programs and employer trip reduction programs.[7] The guidance does not address implementation issues in much detail, in particular how MERCs would be used by stationary sources.

[6]New Jersey Department of Environmental Protection. 2003. Proposed Rulemaking to Repeal New Jersey's Open Market Emissions Trading (OMET) Program. http://www.nj.gov/dep/aqm/OMETrepealnotice.pdf

[7] At one time, employer trip reduction programs were mandatory for severe nonattainment areas, but that requirement was rescinded by Congress in 1995. A few areas still have these programs.

MERCs can be generated from a range of actions, including vehicle scrappage programs, modifications of vehicle fleets, inspection and maintenance programs in areas where they are not required, clean fuel programs, and trip reduction measures. The orientation has been toward using technological approaches to create MERCs rather than relying on VMT reduction strategies. Scrappage, engine retrofit, and clean fleet programs are the most common methods for creating MERCs.

In practice, MERC trading has been very limited. Although some states have provisions for including mobile sources in their offset programs, only a few—Connecticut, New Jersey, Michigan, and three air districts in California—have approved the creation of mobile emissions reduction credits. In those states, MERC trades have accounted for a tiny fraction of the emissions trades that have taken place. For example, according to Haites and Haider's (1998) review, MERCs have been involved in less than 1% of the offset trades in California. The most significant current MERC project in California created offsets for PG&E National Energy Group's Otay Mesa Generating Project in San Diego County. The offsets were generated from the conversion of diesel-fueled trash trucks to compressed natural gas and the conversion of ferries to clean diesel technology (Diesel Technology Forum 2003). Houston has had a MERC program but is only now preparing to authorize the creation of its first MERC, involving a marine source. Several states allow credits to be created through trip reduction activities, but no MERCs have yet been created this way.

Explaining the Limited Use of MERCS

Possible reasons for the limited use of MERCs include (1) the inherent difficulty of applying emissions trading to a sector with large numbers of relatively low-emitting sources; (2) a mismatch between the nature of mobile source credits and the needs of credit buyers; and (3) problems demonstrating that MERCs meet EPA's criteria for integrity. Each of these issues is addressed in turn.

Difficulties in Applying Emissions Trading to Mobile Sources

One key to the economic efficiency of a trading program is low transaction costs relative to the value of the credits. Because potential emissions reductions from any individual vehicle are relatively small, the costs of monitoring and certifying individual emissions reductions will tend to dwarf the potential value of the credit generated. Credit generation is more attractive for those who own and maintain vehicle fleets because they can take actions that reduce emissions from a large number of sources. However, relatively few actors are in the position to create substantial enough emissions reductions to justify the effort involved in getting the credits approved.

Creating credits through telecommuting is likely to be a more attractive strategy for large firms. Because these firms have the potential to encourage telecommuting on a significant scale, the transaction costs of certifying the credits are likely to be less of a barrier than for smaller firms.

Mismatch between Buyers and Mobile Source Credits

A second problem with mobile source trading is a mismatch between the characteristics of mobile source credits and the needs of buyers. One of the drivers of credit creation is the federal offset program, which does not lend itself to mobile source credits. By their nature, mobile source emissions reductions are temporary. Even “permanent” reductions like engine replacement or vehicle scrappage achieve reductions only over the expected life of the vehicle. For this reason, states and air districts have required that MERCs be considered temporary. Firms requiring offsets, on the other hand, must take steps to reduce emissions indefinitely. The limited lifespan of MERCs means that firms using them for offset purposes must go to the market and buy additional MERCs every few years. This creates not only additional work for the firm but also carries with it inherent uncertainty regarding future prices. Purchasing ERCs from stationary sources with an indefinite life, such as those created from plant shutdowns, is obviously a better strategy for these firms. MERCs are better suited for use with open-market programs, but as discussed above, these programs have been limited and controversial.

Problems Demonstrating Integrity of Mobile Source Credits

The demand for environmental integrity also limits the potential use for mobile credits. State agencies are not likely to pursue strategies that may not pass muster with EPA. And although a state may allow the creation of mobile source credits, absent EPA approval, the users of the credits could be vulnerable to third-party lawsuits. California’s experience with MERCs is an example of what can happen without EPA approval. State law permitted the creation and use of mobile source credits in the RECLAIM allowance program, but because EPA had not approved the program, each credit carried a disclaimer saying that buyers and sellers could be subject to a third-party lawsuit if they attempted to use them. Environmental groups in fact sued the city of Burbank and several firms for their use of mobile source credits. The firms and city settled the suit and agreed to retire more than 100,000 NO_x credits (Air Daily 2003). Similarly, environmental groups successfully sued firms using VOC credits created from vehicle scrappage for offset purposes. That suit was filed on environmental justice grounds (Drury et al. 1999).

Of the integrity criteria, the requirements that reductions be quantifiable and surplus present the biggest challenge for mobile source reductions. It is more difficult to quantify emissions reductions from many mobile sources than those from a few large stationary sources. Stationary source emissions can be directly monitored, thus providing a high degree of assurance that claimed reductions are actually occurring. There exists no corresponding monitoring regime for automobiles, and MERC programs frequently rely on emissions factor approaches rather than on monitored emissions.[8]

In addition, to meet EPA's integrity criteria, states must demonstrate that the strategy used to generate credits achieves reductions from a credible baseline. A crucial component of any emissions credit trading program is the "quantification protocol," the methodology used to quantify baseline emissions and emissions reductions. A robust method of quantifying reductions is necessary to ensure that they are real. Baselines by their nature are hypothetical, and even "straightforward" examples of credit generation involve certain assumptions. For example, credits given for vehicle scrappage make assumptions concerning how many miles the vehicles would have traveled had they not been scrapped. Similarly, engine replacement programs must make assumptions about the life spans of the original engines.

The assumptions about VMT reduction strategies are even more contestable. Baselines are easier to establish for technological improvements because it can be assumed that the strategy does not affect driving activity; the baseline is observed activity multiplied by the baseline emissions rate. In contrast, baseline estimates for VMT strategies are less firm. For example, a policy may reduce commute trips, but it can be difficult to ascertain how much of the reduction is actually a result of the policy and how much would have occurred anyway.

Furthermore, even if policies like telecommuting subsidies reduce commute trips, they may spur other nonwork-related trips, thus lessening the net pollution reduction. Accurately capturing the effects of the program then requires discounting the VMT reduction by some factor. In an aggregate context, the use of a generic discount factor may be appropriate, but in a trading context, it may inaccurately estimate the individual, specific reductions. Allowing speculative reductions to substitute for more verifiable reductions in the stationary sector could

[8] EPA's MOBILE emissions factor model and California's EMFAC model are often used.

result in increased emissions. Therefore, intersector trading between the mobile and stationary sectors will demand a fairly strict quantification of mobile source reductions.

EPA's concerns about verification can be seen in its response to new mobile source credit creation rules in southern California (Rule 1610): "These five credit rules are fundamentally different than the [unapproved] car scrappage program because they require utilization of a cleaner technology to generate emission reduction credits.…Oversight, for example, of these credit rules is more straightforward because they require changes to equipment which can be easily verified." [9]

According to Haites and Haider (1998): "The relatively limited creation of MERCs in jurisdictions where they are allowed is probably due to difficulties in quantification and the need to get approval for new quantification protocols." They suggest that as more experience is gained with these programs, "the approval process should become more routine." EPA is committed to preparing new guidance concerning mobile source quantification protocols.

The surplus requirement—that emissions reductions used for credits be over and above any reductions relied on in air quality plans—creates complications for trading mobile source credits. This is particularly true for credits created by reductions in driving. Many areas are under extreme pressure to reduce their emissions from all sectors, including the mobile sector. Simply put, in these areas there may be few reductions available for trade. The primary claimants on mobile source reductions are metropolitan planning organizations that seek to include them in their regional transportation plans for the purposes of demonstrating transportation conformity and air quality agencies that want to include them in state implementation plans for attainment purposes.

Under the provisions of the Clean Air Act Amendments and Transportation Equity Act for the 21st Century (TEA-21), transportation plans in nonattainment and maintenance areas are required to be in "conformity" with state air quality plans. States and metropolitan planning organizations (MPOs) must ensure that on-road mobile emissions stay within budgets specified in the SIP or risk having restrictions placed on the use of federal transportation dollars. In some areas, staying within these budgets has proved challenging. Many MPOs have pursued a host of VMT reduction measures to lower emissions, including investment in transit, carpooling

[9] 67 FR 5731, February 7, 2002

programs, and programs to promote telecommuting. According to EPA's (2001b) guidance on economic incentive programs, "reductions the MPO relies on in a transportation conformity determination must be precluded from use in trading."

Beyond explicit programmatic commitments, some areas have made aggressive assumptions in their regional transportation plans concerning the growth in telecommuting—assumptions that help them stay in conformity. The 1998 plan for southern California assumed in its 2010 and 2020 outlooks that on any given weekday, 2.7% of full-time workers would commute from home. However, data from the Telework Survey conducted by the Southern California Association of Government (SCAG) indicated that the average telecommuting level for full-time employees from 1989 to 1998 was actually 1.7%. A program that allowed individuals to sell telecommuting credits outside the mobile sector could create problems in nonattainment and maintenance areas, since the reductions would no longer be available for conformity purposes.

In areas with severe air quality problems, mobile reductions may be written into the state air quality plan. For example, Houston's SIP includes a commitment to reduce 1.8 tons of NO_x emissions each day from various vehicle trip reduction strategies (HGAC 2000). Therefore, telecommuting credits can be traded only after that target has been met.

Additional Regulatory Uses for Telecommuting Credits

There are other potential uses for credits generated from telecommuting besides interfirm trading programs of the sort discussed above. The most obvious regulatory uses are for achieving compliance with rideshare programs, helping demonstrate transportation conformity, and contributing to voluntary mobile emissions reduction programs (VMEPs) in the SIP.

Rideshare Programs

Although Congress rescinded the employee commute option (ECO) program requirements in 1998, some areas (including Portland, Oregon; Phoenix; and Los Angeles) maintain rideshare regulations. These set average ridership goals for the workforce of firms over a certain size. In most cases firms can demonstrate compliance by providing evidence of a good-faith effort to reduce workers' vehicle trips (e.g., having an approved commute options plan) or by paying fees. EPA's original guidance for the ECO program explicitly allowed averaging and trading, and there is nothing preventing states from incorporating trading into rideshare programs. Los Angeles' Rule 2202 contains provisions allowing firms to meet their rideshare goals by purchasing mobile source emissions reduction credits, and this is now the primary use of credits created under the district's vehicle scrappage rule.[10] Under Rule 2202, firms cannot trade credits created from trip reduction strategies. In most areas, rideshare programs don't have much regulatory bite, so there is little impetus for credit creation.

Transportation Conformity

As noted above, the transportation conformity rule requires transportation plans in maintenance and nonattainment areas to be consistent with state air quality plans. Emissions from the on-road mobile sector must remain within a set emissions budget specified in the SIP. To help demonstrate conformity, MPOs have adopted various emissions reduction measures, including telecommuting programs. For example, an expanded telecommuting program was part of the Washington, D.C., package for resolving a conformity difficulty in 2002 (Harrington et al. 2003).

Under tight emissions budgets, an MPO may have an interest in purchasing telecommuting credits from firms that can demonstrate that these reductions are surplus. In effect, this would amount to a telecommuting subsidy from the MPO to firms that generate new teleworkers. Whether this makes sense as a strategy depends on its cost-effectiveness compared with other uses of the money. Complicating matters is the possibility that the government agency may be reluctant to set a precedent of giving property rights to private parties for emissions reductions it is already counting on to attain conformity.

VMEPs

In 1997, EPA released its *Guidance on Incorporating Voluntary Mobile Source Emission Reduction Programs in State Implementation Plans.* The purpose of the policy is to make it easier for states to obtain SIP credits for innovative emissions reduction strategies, such as those aimed at reducing VMT. Among the potential voluntary measures are employer-based commuter choice and small-scale financial mechanisms. EPA limits the total amount of reductions that can be claimed from VMEPs to 3% of the total future-year emissions reductions required to attain the appropriate air quality standard.

[10] Although EPA's mobile source guidance prohibits the use of MERCs for employer trip reduction programs, the guidance does not apply to Rule 2202 because it is not relied upon in the SIP.

Houston has taken the full 3% (or 23 tons of NO_x per day) in its air quality plan. Among the relevant VMEPs are a pilot trading program with the goal of retiring six tons of NO_x per day, and a "Commute Solutions" initiative with a goal of reducing 1.8 tons of NO_x per day by getting 10% of the workforce to avoid one round-trip commute per week. VMEP programs thus offer a potential use for telecommuting credits as a quantification protocol to ensure that the telecommuting programs meet their targets. As with the conformity situation, credits purchased from private firms would in effect be a government subsidy for teleworking, and such a program would have to be judged on its relative cost-effectiveness.

IV. Institutions in Five Pilot Cities

This section contains an overview of the regulatory context of trading in the five ecommute pilot cities.

Los Angeles

Coastal southern California is an extreme nonattainment area for ground-level ozone and is in serious nonattainment for both particulate matter and carbon monoxide. As part of its air quality plan, the South Coast Air Quality Management District has committed to a total of 75 tons of daily reductions in VOC from not-yet-specified sources (the "black box"). The region has a long-standing allowance-based cap-and-trade program for NO_x and SO_2, the REgional CLean Air Incentives Market (RECLAIM), which allows the use of credits generated from mobile sources. State rules allow mobile source emissions reduction credits to be created from vehicle scrappage, clean fleet programs, and other technological approaches, although EPA has not approved all such programs for the SIP. RECLAIM's structure changed dramatically after the electricity crisis in the summer of 2001 sent allowance prices soaring as high as $100,000 a ton. Large power plants have been removed from the program and now pay into a state-run clean air fund.

A possible avenue for using telecommuting credits is the above-mentioned regional rideshare regulation. Rule 2202 is aimed at reducing vehicle emissions associated with commuting trips. All companies with more than 250 employees must meet an emissions reduction target that is based on daily average vehicle ridership goals, specific to three subzones of the nonattainment region. Firms can comply with the regulation in one of three ways: (1) by directly pursuing mobile source emissions reduction strategies or purchasing MERCs; (2) by paying a per employee fee to the regional Air Quality Improvement Program; or (3) by implementing an employee commute reduction program.

Emissions reduction strategies. Firms can purchase MERCs that qualify under provisions of the state's Rule X16 (on vehicle scrappage, clean vehicle retrofits, and clean off-road retrofits) to meet their emissions reduction targets. In addition, they can purchase area source credits, short-term emissions reduction credits from stationary sources, and trading credits from sources participating in RECLAIM. They can also generate vehicle trip emissions credits themselves through rideshare programs, transit subsidies, telecommuting initiatives, and other programs.

Air Quality Improvement Program fund. Rather than purchasing or finding reductions directly, firms may opt to pay a fee of $60 per employee each year or a triennial payment of $125 per employee to the Air Quality Improvement Program. Funds from this program are used to finance emissions reduction strategies in the region, such as vehicle scrapping and engine replacement projects.

Employee commute reduction programs. Firms may opt out of the emissions reduction target requirement by implementing commute reduction programs that can be credibly assumed to meet their average vehicle ridership goals within three years. If a firm cannot meet its goal, it can make up the shortfall through payments into the Air Quality Improvement Program fund.

Although firms may trade excess MERCs and ERCs, the trading of vehicle trip emissions credits generated through rideshare programs, transit subsidies, telecommuting, and other programs is prohibited. Therefore, under current rules, firms cannot purchase emissions reduction credits generated from telecommuting programs. One proposal is to broaden the program to allow firms with fewer than 250 employees to sell their ecommute credits to larger firms that are having difficulties meeting their emissions reduction targets. A separate proposal that does not require regulatory action is to use Air Quality Improvement Program funds to purchase telecommuting credits from firms. However, air district officials have concluded that this is a relatively cost-ineffective use of these funds.

Houston

The Houston-Galveston region is in severe nonattainment for ozone, and Houston rivals Los Angeles for having the worst smog problem in the United States. The state of Texas has created area emissions reduction credit organizations (AERCOs), institutions explicitly designed to facilitate the trading of emissions credits in the state's nonattainment areas.

The region's trading system comprises three programs: the Emissions Reduction Credit Banking and Trading Program and the Discrete Emissions Reduction Credit Banking and Trading Program, both of which are open-market systems; and the Mass Emissions Cap-and-Trade Program, which is allowance-based and covers large stationary sources. Mobile sources can be used to generate MERCs and mobile discrete emissions reduction credits. There are provisions for converting all three kinds of credits into allowances, so the system is something of a hybrid between cap-and-trade and open-market. In theory, these interacting programs provide the framework for full trading across sectors.[11]

The role of the Houston-Galveston AERCO is to assist in the process of creating, documenting, and certifying emissions credits and allowances. All credits and allowances are certified with the Texas Commission on Environmental Quality. As a component of Houston's VMEP package, AERCO will purchase and retire emissions credits. The Houston SIP calls for credits worth six tons per day in mobile source NO_x emissions reductions to be retired through AERCO. No mobile source trades have yet been certified, although the first approval for a mobile source credit is expected shortly, for a marine MERC.

Because AERCO has been designated a 501(c)3 by the U.S. Internal Revenue Service, it can receive tax-deductible donations of emissions reduction credits or contributions. AERCO is accepting credit donations from employers who have implemented ecommute programs. Firms can potentially claim tax deductions based on the current market value for emissions credits. There is some precedent for this; firms have donated SO_2 credits to environmental groups and received a tax write-off. Because the SO_2 market is active, current market value for SO_2 allowances is easy to calculate. It may be difficult to claim comparable tax credit for telecommuting reductions in the absence of a private market for them.

The Houston SIP also calls for a reduction of 1.8 tons of NO_x per day from reduced work-related car travel. This figure translates into avoidance of one round-trip commute by car per week by 10% of the workforce. Because telecommuting is a logical strategy for meeting this goal, the implication is that substantial claims on the emissions reductions from telecommuting already exist.

[11] Interpollutant trading is generally not allowed.

Denver

Colorado has two regulations governing emissions trading. Regulation 3 contains provisions for the use of emissions trading for satisfying New Source Review requirements and special circumstances. Each trade is approved through a source-specific SIP revision, a cumbersome process that greatly inhibits trading activity. Regulation 5, a generic emissions trading rule, was signed into law in 1996. This would allow trades to go forward without requiring a SIP revision for each individual trade. Because the rule had to be approved by EPA, the regulation made the effective date of the provisions contingent on EPA approval. Colorado submitted the rule to EPA as a SIP revision. EPA responded with its concerns, and in the summer of 2003, the state elected to withdraw its submission to EPA. Because the region is a maintenance area and not a nonattainment area, there is little incentive to redo the regulation and seek EPA approval.

Philadelphia

In Pennsylvania's ERC trading program, which began in 1994, the use of ERCs is limited to achieving compliance with New Source Review requirements. State law allows mobile sources to be a source of ERCs provided the mobile source program is approved by EPA as a SIP revision. At the moment there is no approved program permitting the generation, trade, and use of mobile source emissions credits. Pennsylvania is a member of the Ozone Transport Region and participates in the regional NO_x cap-and-trade program, but that program is limited to large stationary sources.

An additional complicating factor for telecommuting strategies is Philadelphia's wage tax. City residents pay 4.5% on all wages and salaries earned regardless of their job location, and nonresidents pay about 3.9% on wages and salaries they earn within the city limits. On days when nonresidents do not work within city limits, they are exempt from the wage tax. Therefore, suburban residents could use telecommuting as tax avoidance strategy. Since the wage tax is an important source of revenue for the city, programs that promote telecommuting by suburban residents raise issues that other trip reduction programs (like ridesharing) do not.[12] The region is

[12] Other distributional issues arise regarding telecommuting in an interjurisdictional setting, particularly the erosion of the tax bases in central cities from reduced sales tax and parking tax revenue.

looking at reforming its tax structure, mainly because of concerns about the wage tax's impact on Philadelphia's job base.

Washington, D.C.

The Washington, D.C., area is classified as a severe nonattainment area under the one-hour standard and moderate nonattainment for the eight-hour standard. The nonattainment area contains three separate jurisdictions: Maryland, Virginia, and the District of Columbia. There are no provisions for mobile source trading in any of the jurisdictions.

The Washington metropolitan area has one of the most active telework programs in the country, and the region has relied on telework growth as part of its strategy for meeting transportation conformity requirements.

V. Potential Value of Credits Generated from Telecommuting

As we have seen, the current institutional context has many barriers to trading telecommuting credits. If the regulatory situation becomes more hospitable, however, what is the potential for emissions trading with telecommuting credits? This section presents estimates for the potential credit value per teleworker, assuming no barriers to trading. The value of the emissions reductions per teleworker is based on two components: the reduction in emissions from telecommuting and the market price for emissions reduction credits.

Emissions Reductions from Telecommuting

The emissions benefits from telecommuting are often reported in aggregate terms—that is, total pounds of pollution avoided. This is fairly misleading because the category of pollutants includes things like carbon dioxide and carbon monoxide. But not all pounds of pollution are created equal. In 2002 about 20 million tons of NO_x was emitted in the United States, versus CO_2 emissions of 5.8 *billion* tons. A number that aggregates the two pollutants is not meaningful. If pollution reductions from telecommuting are presented in aggregate terms, CO_2 reductions will account for more than 90% of "total pollutants avoided." Moreover, the two pollutants have very different impacts on the environment.

The reductions in NO_x and VOC emissions (the two pollutants that have the most active markets) from an avoided vehicle trip are fairly small. Cars today are far cleaner than they were even 10 years ago, and this trend will continue, thanks to new vehicle and fuel standards. The upshot is that reducing a vehicle mile traveled does not deliver all that much in the way of pollution reduction.

Table 1 provides estimates for the reductions per telework day for each of the five pilot cities.[13]

Table 1. Emissions Reductions from ecommute Program, per Telecommuting Day, June 1, 2001–February 28, 2004 (pounds per day)

	Scenario 1[1]		*Scenario 2*[2]	
	VOCs	*NO_x*	*VOCs*	*NO_x*
Washington, D.C.	0.139	0.126	0.116	0.108
Denver	0.157	0.122	0.134	0.104
Houston	0.107	0.097	0.077	0.076
Los Angeles	0.123	0.062	0.100	0.048
Philadelphia	0.120	0.140	0.105	0.118
ALL CITIES	0.142	0.124	0.120	0.105

[1]Under Scenario 1, it is assumed that employees would have driven alone to work every telecommuting day had they not telecommuted.
[2]Under Scenario 2, it is assumed that employees would have driven alone to work some fraction of the time based on reported mode choices.

Credit Values

The other component of the emissions credit incentive is the value of the credit. Credit values depend greatly on the specific conditions. These values are based on six scenarios: (1) current and predicted NO_x allowance prices in regional cap-and-trade programs; (2) current and historical prices of DERs in various state programs; (3) a comparison with the costs of other on-road mobile source reductions; (4) the costs of MERCs used by firms to comply with southern California's rideshare regulation; and (5) the price of NO_x allowances in the RECLAIM program during the California electricity crisis, which represents a likely upper bound for the value of credits; and (6) the cost-effectiveness of other telecommuting programs.

[13] Based on calculations in Walls and Nelson (2004).

NO_x Allowance Prices

After an initial spike in 1999 that sent NO_x allowances in the Ozone Transport Region above $7,000 per ton, prices settled down, dropping below $1,000. Prices have risen recently and peaked in the spring of 2003 at almost $8,000 per ton. Allowances are currently trading at around $2,500 per ton (Electric Utility Weekly 2004).

For 2020 to 2025, the Energy Information Administration (2003) analysis of the administration's proposed Clear Skies trading program forecasts NO_x allowance prices to be $2,400 to $2,600 per ton in the eastern region and $1,700 to $1,900 per ton in the western region (2001 dollars). For 2010 to 2020, EPA's analysis (U.S. EPA 2003) places eastern region prices between $1,000 and $1,400 and western region prices between $800 and $900 (1999 dollars).

DER Prices

Current activity in DER markets is minimal; historically, prices have been very dependent on local supply and demand, as seen in Table 2, taken from Swift and Haite's (2002) survey of open-market programs. The prices average about $800 a ton. In late 2004, NO_x DERs in Houston were trading at $840 a ton.[14]

Table 2. Prices of Discrete Emissions Reduction Credits per Ton of NO_x in Selected States, November 2000

State	*Ozone season*	*Nonozone season*
Connecticut	$1,000	$ 750
Massachusetts	750	500
New Jersey	1,300	1,150
New Hampshire	600	300
Texas	1,100	n/a

Other On-Road Mobile Source Reductions

As noted above, the tightening of vehicle emissions standards has diminished the potential for reducing pollution from strategies targeting passenger vehicles, and it will continue

[14] Cantor Fitzgerald Website. Accessed May 21, 2004.

to do so for the foreseeable future. However, other on-road mobile sources still produce considerable emissions and are ripe for cost-effective intervention.

In particular, a heavy-duty diesel truck emits NO_x at a rate 20 times that of a light-duty gasoline vehicle. In 1999, diesel vehicles accounted for 42% of on-road mobile source NO_x emissions. Policymakers have begun to turn their attention to heavy-duty diesel vehicles as a source of reductions. In December 2000, EPA issued the final rule for the two-part strategy to reduce diesel emissions from heavy-duty trucks and buses. New diesel engine standards begin in model year 2004 for all diesel vehicles over 8,500 pounds, and additional diesel standards and test procedures will begin in 2007. EPA is also initiating a program requiring cleaner diesel fuels. Together, these regulations will dramatically reduce emissions from heavy-duty diesel trucks over the next 30 years.

In the meantime, however, there are opportunities for relatively cost-effective reductions from strategies that target trucks already on the road. Engine replacement and scrappage programs targeting very old trucks are examples of programs that are attracting interest among transportation and air quality planners. In southern California, for example, the Gateway Cities Clean Air Program targets both on-road and off-road diesel emissions through fleet modernization, engine retrofit, and new fuel strategies. The program is producing reasonably cost-effective NO_x reductions of around $7,200 per ton for the fleet modernization strategies targeting older trucks. Particulate matter reductions come in at around $32,000 per ton.[15]

Alternatively, one can look at the options that MPOs actually face when trying to curtail on-road mobile source emissions. When the Metropolitan Washington Transportation Planning Board went to amend its transportation plan in the summer of 2001, it found that projected NO_x emissions from the on-road mobile sector were eight tons over the conformity budget for 2005. As part of its efforts to craft a solution, the board analyzed a host of emissions reduction measures, including traffic signal improvements, the purchase of buses that run on compressed natural gas (CNG), and smart growth initiatives. The measures varied widely in their cost-effectiveness. Most were between $20,000 and $40,000 a ton, although some measures, such as the purchase of CNG buses and improvements to pedestrian access in transit-oriented development areas, cost more than $100,000 per ton. A weighted average of the cost-

[15] Personal communication, Sarah Siwek, June 30, 2004.

effectiveness of technological approaches considered by the metropolitan Washington MPO was about $33,700 a ton.

Rideshare Programs

Firms falling under Rule 2202, the rideshare program, in southern California are able to meet their requirements through the purchase of mobile source emissions reduction credits,[16] emission reduction credits, area source credits, and other emissions reduction strategies that are generated through a worksite's own efforts. MERCs from vehicle scrapping (Rule 1610) are the biggest source. Prices of the three kinds of credits are not known, since the trades are administered privately. A survey of covered firms conducted by the air district in December 2002 indicated that the price for MERCs traded for Rule 2202 purposes ranged from $4 to $9 per pound, or $8,000 to $19,000 per ton (South Coast Air Quality Management District 2004).

RECLAIM Trading Credit Prices

The upper bound for the value of NO_x credits is likely the level reached by RECLAIM trading credits in the summer of 2001. A variety of factors conspired to briefly send prices to stratospheric levels of more than $100,000 a ton. Although this spike prompted major changes to the program, it proved only temporary and is thus not a very plausible scenario for a sustained credit price. One of the reforms was to remove large stationary sources from the program and have them pay a fee into an air quality fund rather than purchase credits. The fee is equivalent to $15,000 per ton of NO_x, which may offer an estimate of the backstop levels of the allowance price that regulators are willing to tolerate before taking some sort of mitigating action.

Other Telecommuting Programs

As part of its analysis of cost-effectiveness of alternative transportation emissions reduction measures, the MPO of Washington, D.C. estimated the cost-effectiveness of its telework program to be $16,250 per ton of NO_x (Kirby, memorandum to Transportation Planning Board, 2002).

[16] MSERCs are calculated based on a combination of VOC, NO_x, and one-seventh of CO.

Potential Revenue from Telecommuting

Given figures for the yearly emissions saving from telecommuting and the prices of credits, it is possible to estimate the revenue that a firm would generate per year per telecommuter. Table 3 displays revenue estimates based on the range of NO_x credit prices presented in the above scenarios and an emissions reduction of 10 pounds of NO_x per year per telecommuter. Revenue can be as low as $1.50 per year per telecommuter based on the low prices for DERs. Higher prices are found when credit prices are based on other mobile source strategies. The range of revenue is mainly between $40 and $100 per year per telecommuter.

Table 3. Estimated Value of Emissions Reduction Credits per Teleworker per Year

	NO_x credit prices		*Revenue per teleworker per year*	
Scenario	*Low price*	*High price*	*Low revenue*	*High revenue*
NO_x allowance prices	$ 1,000	$7,500	$5.00	$35.00
DER prices	300	1,300	1.50	6.50
Mobile source reductions	7,200	33,700	36.00	168.0
Rideshare programs	8,000	19,000	40.00	95.00
RECLAIM		15,000		75.00
Other telework programs	16,250		81.26	

Strength of the Incentive

The potential revenue from telecommuting credits is part of the equation for evaluating whether emissions trading will promote telework on a large scale. The other piece of information is an understanding of how responsive telecommuting is to financial incentives. Unfortunately, there has been little experience with direct subsidies for telecommuting, and thus, how it responds to financial incentives is not well understood.

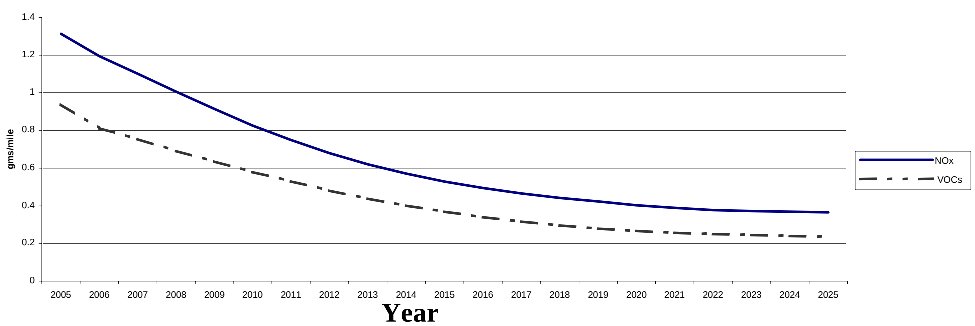
Discussions with business leaders participating in the ecommute Business Roundtable produced estimates of about $500 to $1,000 per teleworker per year as an amount needed to prompt firms to implement formal telework programs. The proposed Teleworking Advancement Act sponsored by Sen. John Kerry of Massachusetts would give employers a tax credit of $500 for each employee participating in an employer-sponsored telework program.[17] If $500 per employee per year is indeed the sort of number necessary to get major increases in telecommuting activity, revenue from emissions trading is likely to fall short, even using high-end estimates for the future value of credits. However, as stated above, the responsiveness of telecommuting behavior to financial inducements is not well understood, and a lower dollar figure could conceivably be sufficient to promote large-scale increases in telecommuting.

VI. Looking Ahead

Cleaner Vehicles

The emissions characteristics of the vehicle fleet (particularly light-duty vehicles) are expected to improve dramatically over the next 20 years, making per trip emissions reductions from transportation demand management strategies still smaller. Figure 1 shows projected composite emissions factors for light-duty gasoline vehicles over the next 20 years. Paradoxically, improvements in vehicle technology will reduce the emissions benefits from each teleworked day.

Composite Emission Factors for LDGVs 2005-2025



Source: Author’s calculations using MOBILE6

[17] Teleworking Advancement Act, S. 1856, 107th Congress, December 18, 2001.

Climate Change Policies

The issue of climate change offers perhaps the most hospitable context for emissions trading. The environmental impacts of CO_2 and most other greenhouse gas emissions are independent of where they occur. A ton of CO_2 emitted in Los Angeles has essentially the same environmental effect as a ton emitted in Wyoming or India. The geographic scope of the market is much larger than for pollutants like NO_x and hydrocarbons, which affect local and regional air quality. Thus, whereas the market for NO_x, VOC, carbon monoxide, and particulate matter reductions from telecommuting will necessarily depend on local environmental and regulatory conditions in a nonattainment area, a firm wishing to sell carbon credits from telecommuting has a much larger potential market of buyers.

Carbon emissions are not currently regulated in the United States, but as noted above, the European Union is preparing to implement a carbon trading regime in early 2005. The transport sector is currently excluded from this regime but may have to be included at some point if EU nations have difficulty meeting their targets under the Kyoto Protocol. Because the United States is not a signatory to the protocol, it is not possible to trade U.S.-generated credits in the European Union or Kyoto systems. Within the United States and Canada there are scattered voluntary trading programs, and several northeastern U.S. states are moving to a limited cap-and-trade system for CO_2 emissions; the level of the cap is not yet known, making it impossible to forecast allowance prices.

The lack of a national and comprehensive policy on greenhouse gas emissions seriously limits the demand for reductions. Within U.S. voluntary trading programs, prices for CO_2 credits and allowances have ranged between $0.50 and $2.50 per ton, and comparable prices have been seen in Canada’s trading programs, GERT and PERT (Zaborowski and Reamer 2004). To give some perspective, a price of $25 per ton of carbon translates into about an additional six cents per gallon of gasoline.

VII. Concluding Observations

Mobile source emissions come from a large number of vehicles, each emitting a relatively small amount, and as a result the costs of monitoring and verifying the emissions will greatly cut into the efficiency benefits of an emissions trading regime. It is worth noting that even when including the transport sector in carbon cap-and-trade regimes has been discussed, the focus has been *upstream,* for either fuel producers or vehicle producers, rather than *downstream*, for drivers (Australian Bureau of Transport and Communications Economics 1998). The reason, of course, is the significant administrative burden associated with monitoring individual driving activity.

EPA requires that emissions trades demonstrate environmental integrity by showing that the reductions are surplus, permanent, quantifiable, and enforceable. In practice, the surplus requirement brings emissions trading of telecommuting credits into conflict with other claims on telecommuting, notably from MPOs seeking reductions in the conformity process and regional transportation plans, and from state environmental agencies seeking compliance in their air quality plans.

The quantification protocols for activity-based vehicle emissions reductions are not well developed and necessarily rely on a hypothetical baseline. Thus, the emissions reductions from telecommuting, even in a carefully designed program like ecommute, will remain speculative when compared with emissions reductions from continually monitored sources like power plants. Furthermore, the administrative burdens associated with making sure that firms aren't cheating and claiming excess telecommuting are fairly high and might make the reductions difficult to enforce.

The above issues could conceivably be overcome. For example, a cost-effective technology could emerge that would ease the monitoring of individual driving activity. Similarly, the Clean Air Act could be amended or interpreted differently to ease the integrity requirements as they apply to mobile sources and provide more latitude for trading of pollution credits generated from reduced driving (although whether such changes are worth the reduced certainty of the reductions will be a subject for debate).

But the most intractable issue is probably economic—the low value of the credit revenue. The emissions reductions from a single avoided trip are not large. Given the range of estimates for the future value of pollution credits, it is hard to see the potential revenue to firms being large enough to induce large-scale changes in driving activity. From the point of view of MPOs and state agencies looking to direct scarce public funds to emissions reduction activities, in the short and medium term there are far more cost-effective uses for the funds (if the measure is purely emissions reductions). This situation is likely to persist for the foreseeable future.

All of this is not to say that the government does not have any reason to promote telecommuting. A large-scale increase in telecommuting could produce welcome emissions benefits for many highly polluted areas. Approaches that minimize transaction costs—wholesale approaches like public outreach programs and eliminating regulatory obstacles to teleworking—may be warranted, especially considering the other potential social benefits from telecommuting.

The strongest argument for promoting telework may be the benefits for traffic congestion. In a recent review of studies on the social costs of driving, a Federal Highway Administration (2000b) report presents a figure of 7.7 cents per mile (2000 dollars) in external congestion costs from auto travel in urban areas. The same report places external air pollution costs in urban areas at 1.33 cents. In other words, a 10-mile automobile trip in an average urban area will generate 77 cents in external congestion costs and only 13 cents in external pollution costs. Along specific corridors, external congestion costs can be much higher. A recent study estimates that marginal congestion costs on the most crowded roads in the Washington, D.C., area are well over $1 a mile (Safirova and Gillingham 2004).

Looking ahead, while cars are projected to get cleaner, all estimates show traffic congestion worsening. Vehicle miles traveled will continue to rise thanks to demographic factors, such as population growth, rising incomes, and a larger share of licensed drivers in the population. Many metropolitan areas are dealing with tight budgets and an inability to fund new road and transit infrastructure to keep pace with travel demand. Recent construction cost data suggest that average costs for providing additional peak-period capacity on urban freeways can run as much as $10 million per lane mile (Federal Highway Administration 2000b). State transportation agencies have a strong interest in delaying or averting costly road construction, and strategies like telecommuting may lessen the pressure for the investments by reducing vehicle trips. Therefore, transportation agencies and metropolitan planning agencies are likely to continue to pursue telecommuting, as one strategy among many, to reduce both traffic congestion and air pollution.

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