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Policy Summary
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# Impacts of Transportation Policies on Greenhouse Gas Emissions in U.S. Regions

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A small portion of global $CO_2$ emissions are a byproduct of fossil fuel combustion. Most occur in the production of energy, but about a third are emitted during transportation. National $CO_2$ reduction policy options in the transportation sector focus primarily on the reduction of the underlying activity (i.e., travel), or on technology mandates that seek to achieve emissions reductions through increased efficiency. An example of the latter is the new Corporate Average Fuel Economy (CAFE) standards established by Congress (H.R. 6, P.L. 110-140), which set an overall new-car/truck efficiency of 35 MPG by 2020.

In addition to these national policies, many U.S. state and local governments are considering or implementing localized policies to curb GHG emissions, including from transportation. One report found that 36 states and several hundred local governments have "signed on to aggressive plans to cutback greenhouse gas emissions from electric energy generation, industry, and transportation." Most well known is California's requiring metropolitan area transportation plans to include measures to reduce greenhouse gas emissions to 1990 levels by 2020.

These policy initiatives are taking place without much region-specific research or economic assessment. While a few regions have conducted substantive analyses, most lack baseline estimates of $CO_2$ in their specific urban region and lack analysis of the cost-effectiveness of various measures being considered. Many policies intended to reduce local transportation $CO_2$ emissions, such as reducing miles traveled, improving highways, increasing transit use, reducing speed limits and others, have been proposed. But since many factors affect transporta-

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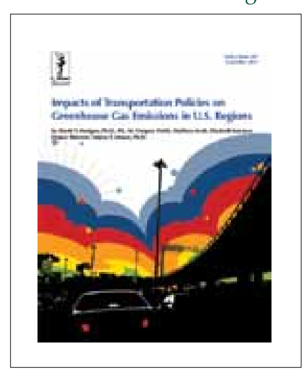

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For media inquiries, contact Chris Mitchell, Director of Communications at (310) 367-6109 or chris.mitchell@reason.org tion's contribution to greenhouse gas levels in urban regions, and urban areas vary in their transportation needs and behavior, the costs and effectiveness of such emission-reduction policies will also vary from region to region. Understanding the relative effectiveness of these policies within the local/regional context is important.

In this study we present estimates of the cost-effectiveness (impact and costs) for specific policies intended to reduce $CO_2$ emissions in the transportation sectors of 48 representative U.S. urbanized areas. The next section discusses how we gathered data and performed our analysis. Then the "Results" section shows a comparison of the effects likely to occur from full implementation of the federal CAFE standards currently in place with $CO_2$ reduction policies. Our findings, discussed in the "Recommendations" section of this summary, suggest that each urban area should tailor its strategies to its specific needs, especially since adopting the wrong policy mix is likely to result in substantial waste and little or no reduction in carbon emissions.

To provide a baseline for comparison, we assessed the effectiveness of policies with a hypothetical goal of limiting or returning $CO_2$ emissions to their 2005 level by 2030. It should be noted that this is not a goal we see as desirable; it was chosen merely for the purposes of comparison and perspective.

## HOW WE CALCULATED THE COSTS AND EFFECTIVENESS OF POLICIES

To estimate the regional cost-effectiveness of carbon emissions reductions strategies, we used these specific steps:

### A. Region Selection

We selected a total of 48 urban areas (Table 1). These include all regions over three million persons, most regions between one million and three million (a few, notably Boston, Salt Lake City, Cleveland, Kansas City, San Antonio, Baltimore, Memphis and Nashville are not included because of time and budget constraints) and selected smaller regions ranging in size from one million persons to 200,000 persons. Since we included all of the largest urban areas, most large regions and a cross-section of smaller regions, including 18 regions in the 100,000–500,000 population range, these results are indicative for similar U.S. regions. In total, these regions account for about 41% of the U.S. population, but 60% of transit use and 90% of congestion delay.

### B. Data Collection

We gathered data on travel and road mileage by functional class, for 1995 and 2005, along with speeds by functional class, population, employment, congestion (travel time index), transit use, carpooling, walking and work-at-home shares for each urbanized area. We used urbanized area statistics from the Census and the "modeled region" from the local regional long-range plans to ensure comparability. Travel was partitioned by peak/off peak and vehicle type (cars and light trucks, single-unit commercial trucks and combination trucks). We then forecast travel by functional class/vehicle type/time of day to 2030, using each region's long-range plan forecasts of VMT and shift-share allocations.

### C. Carbon Emissions Reduction Policies

We reviewed the academic and policy literature as well as plans for these regions, and identified the following general policies for study:

- Mandated fuel efficiency improvements, e.g. new CAFE standards enacted in 2007.
- Capacity improvements, primarily freeway and arterial widenings.
- Speed-change policies such as signal optimization, speed harmonization policies (where speed limits are lowered and made uniform by lane or direction during periods of congestion to keep traffic flowing more smoothly) and speed capping (setting lower speed limits).
- VMT reductions or changes in VMT growth rates.
- High-Occupancy-Vehicle (HOV) and High-Occupancy-Toll (HOT) lanes—one form of congestion pricing.
- Transit and carpooling increases in modal shares for work travel.

## Table 1: Regional Growth in $CO_2$ 2005–2030 and Percent Reduction from Policies

| Region (in size order) | % Change in $CO_2$ with NO new CAFE | % Reduction to Meet 2005 Level | Percent Reduction from New CAFE Standards | Added %Red Needed to Meet 2005 Level | % Reductions from Med-Small Cars | % Reductions from Signal Timing | % Reductions from 50 MPH Peak Speed | % Reductions from 55 MPH Speed Limit | % Reductions from NO LOS F | % Reductions from 50% more Work at Home | % Reductions from 2x HOV/T Lane | % Reductions from 25% more Carpool | % Reductions from -5 % VMT | % Reductions from +50% Transit | % Red from +50% Walk-to-Work | All | % Excess or Deficit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NYC-Newark | 37.6 | 27.3 | 31.2 | 0.0 | 2.9 | 2.1 | 1.1 | 3.0 | 3.7 | 0.5 | 0.1 | 0.6 | 4.3 | 4.6 | 0.9 | 23.8 | 23.8 |
| LA-Long Beach | 49.7 | 33.2 | 31.2 | 1.9 | 2.8 | 2.4 | 2.5 | 3.8 | 8.5 | 0.5 | 2.2 | 0.9 | 4.1 | 0.8 | 0.3 | 28.7 | 26.8 |
| Chicago | 21.0 | 17.4 | 31.3 | 0.0 | 2.5 | 2.9 | 1.0 | 2.2 | 6.8 | 0.4 | 0.3 | 0.6 | 3.7 | 1.5 | 0.4 | 22.2 | 22.2 |
| Philadelphia | 26.5 | 21.0 | 31.3 | 0.0 | 2.7 | 2.2 | 0.5 | 2.3 | 2.6 | 0.4 | 0.2 | 0.6 | 3.9 | 1.3 | 0.5 | 17.3 | 17.3 |
| Miami | 53.0 | 34.6 | 31.2 | 3.4 | 2.8 | 3.0 | 0.6 | 2.2 | 4.5 | 0.4 | 0.4 | 0.7 | 4.0 | 0.5 | 0.2 | 19.4 | 16.0 |
| SF.-Oakland | 40.0 | 28.6 | 31.2 | 0.0 | 2.8 | 2.6 | 2.2 | 4.4 | 6.4 | 0.7 | 2.1 | 0.8 | 4.1 | 2.3 | 0.7 | 29.2 | 29.2 |
| Washington | 31.6 | 24.0 | 31.2 | 0.0 | 2.9 | 2.7 | 1.1 | 2.7 | 6.5 | 0.6 | 1.1 | 0.9 | 4.2 | 2.3 | 0.4 | 25.5 | 25.5 |
| Dallas-Fort Worth | 59.4 | 37.3 | 31.3 | 6.0 | 2.6 | 1.9 | 1.1 | 3.3 | 3.8 | 0.5 | 0.4 | 0.8 | 3.8 | 0.3 | 0.2 | 18.7 | 12.7 |
| Houston | 112.8 | 53.0 | 31.3 | 21.8 | 2.7 | 2.1 | 1.2 | 3.4 | 3.5 | 0.4 | 0.7 | 0.9 | 3.9 | 0.4 | 0.2 | 19.3 | -2.4 |
| San Diego | 54.1 | 35.1 | 31.2 | 3.8 | 2.9 | 1.9 | 2.1 | 4.8 | 3.6 | 0.6 | 0.9 | 0.8 | 4.2 | 0.5 | 0.3 | 22.5 | 18.7 |
| Seattle-Tacoma | 47.6 | 32.2 | 31.3 | 1.0 | 2.7 | 2.3 | 0.9 | 3.0 | 4.8 | 0.6 | 0.9 | 0.8 | 4.0 | 1.1 | 0.4 | 21.4 | 20.4 |
| Atlanta | 41.1 | 29.1 | 31.3 | 0.0 | 2.7 | 2.9 | 1.0 | 2.7 | 5.6 | 0.6 | 0.5 | 0.7 | 3.9 | 0.5 | 0.2 | 21.4 | 21.4 |
| Minneapolis-St. Paul | 50.7 | 33.6 | 31.2 | 2.4 | 2.8 | 2.4 | 0.9 | 3.3 | 3.5 | 0.6 | 0.4 | 0.6 | 4.1 | 0.7 | 0.3 | 19.6 | 17.2 |
| Phoenix-Mesa | 125.2 | 55.6 | 31.3 | 24.3 | 2.3 | 1.9 | 0.9 | 2.5 | 3.5 | 0.5 | 0.6 | 0.9 | 3.4 | 0.3 | 0.2 | 17.0 | -7.4 |
| St. Louis | 26.6 | 21.0 | 31.3 | 0.0 | 2.6 | 2.2 | 0.8 | 3.0 | 2.0 | 0.4 | 0.1 | 0.6 | 3.8 | 0.4 | 0.2 | 16.0 | 16.0 |
| Tampa | 55.9 | 35.9 | 31.2 | 4.6 | 2.8 | 2.2 | 0.4 | 1.5 | 2.2 | 0.6 | 0.1 | 0.7 | 4.2 | 0.2 | 0.2 | 15.2 | 10.6 |
| Denver-Aurora | 79.3 | 44.2 | 31.2 | 13.0 | 2.9 | 2.4 | 0.8 | 2.8 | 4.0 | 0.7 | 0.2 | 0.7 | 4.2 | 0.6 | 0.4 | 19.7 | 6.8 |
| Milwaukee | 18.4 | 15.5 | 31.3 | 0.0 | 2.6 | 2.2 | 0.5 | 2.4 | 1.2 | 0.4 | 0.1 | 0.6 | 3.9 | 0.5 | 0.3 | 14.6 | 14.6 |
| Portland, OR | 38.7 | 27.9 | 31.2 | 0.0 | 2.8 | 2.2 | 0.2 | 2.6 | 2.1 | 0.7 | 0.1 | 0.8 | 4.1 | 1.1 | 0.4 | 17.0 | 17.0 |
| Providence-Fall River | 19.4 | 16.2 | 31.2 | 0.0 | 3.0 | 2.2 | 0.7 | 3.4 | 1.2 | 0.4 | 0.1 | 0.7 | 4.4 | 0.4 | 0.4 | 16.8 | 16.8 |
| Sacramento | 54.5 | 35.3 | 31.2 | 4.0 | 2.8 | 2.3 | 0.7 | 3.4 | 2.1 | 0.6 | 0.4 | 0.9 | 4.1 | 0.3 | 0.3 | 18.1 | 14.0 |
| Orlando | 71.0 | 41.5 | 31.3 | 10.3 | 2.7 | 2.3 | 0.3 | 2.0 | 1.9 | 0.6 | 0.0 | 0.7 | 4.0 | 0.3 | 0.2 | 15.0 | 4.7 |
| Louisville | 54.3 | 35.2 | 31.3 | 3.9 | 2.5 | 2.4 | 0.4 | 3.0 | 1.6 | 0.3 | 0.1 | 0.5 | 3.6 | 0.3 | 0.2 | 14.8 | 10.9 |
| Jacksonville | 67.7 | 40.4 | 31.3 | 9.1 | 2.7 | 2.2 | 0.4 | 2.4 | 1.1 | 0.4 | 0.0 | 0.7 | 4.0 | 0.2 | 0.2 | 14.3 | 5.2 |
| Bridgeport-Stamford | 25.0 | 20.0 | 31.2 | 0.0 | 2.8 | 2.3 | 0.5 | 3.6 | 2.0 | 0.6 | 0.1 | 0.5 | 4.0 | 1.3 | 0.3 | 18.0 | 18.0 |
| Richmond-Petersburg | 49.4 | 33.0 | 31.2 | 1.8 | 2.8 | 2.2 | 0.5 | 3.2 | 1.1 | 0.4 | 0.0 | 0.7 | 4.0 | 0.3 | 0.2 | 15.3 | 13.5 |
| Rochester, NY | 16.2 | 14.0 | 31.2 | 0.0 | 3.0 | 2.2 | 0.4 | 2.7 | 0.7 | 0.4 | 0.0 | 0.5 | 4.4 | 0.3 | 0.3 | 14.9 | 14.9 |
| Dayton | 26.4 | 20.9 | 31.3 | 0.0 | 2.6 | 2.1 | 0.4 | 2.7 | 0.9 | 0.2 | 0.0 | 0.5 | 3.8 | 0.2 | 0.2 | 13.7 | 13.7 |
| Austin | 139.1 | 58.2 | 31.2 | 26.9 | 2.8 | 2.3 | 0.7 | 3.4 | 1.7 | 0.7 | 0.1 | 0.8 | 4.2 | 0.6 | 0.2 | 17.5 | -9.4 |
| Albany | 14.9 | 12.9 | 31.2 | 0.0 | 2.8 | 2.2 | 0.5 | 3.0 | 1.0 | 0.4 | 0.1 | 0.6 | 4.1 | 0.4 | 0.5 | 15.5 | 15.5 |
| Albuquerque | 76.9 | 43.5 | 31.3 | 12.2 | 2.5 | 2.2 | 0.4 | 2.2 | 1.4 | 0.5 | 0.1 | 0.8 | 3.7 | 0.2 | 0.3 | 14.2 | 1.9 |
| Tulsa | 33.0 | 24.8 | 31.2 | 0.0 | 2.7 | 2.2 | 0.4 | 2.4 | 1.0 | 0.4 | 0.0 | 0.7 | 4.0 | 0.1 | 0.2 | 14.1 | 14.1 |
| Grand Rapids | 36.0 | 26.4 | 31.3 | 0.0 | 2.7 | 2.2 | 0.4 | 2.2 | 1.2 | 0.3 | 0.0 | 0.7 | 3.9 | 0.2 | 0.3 | 13.9 | 13.9 |
| Baton Rouge | 45.0 | 31.0 | 31.3 | 0.0 | 2.4 | 2.2 | 0.4 | 2.1 | 0.8 | 0.2 | 0.0 | 0.6 | 3.5 | 0.2 | 0.2 | 12.6 | 12.6 |
| Columbia | 40.0 | 28.6 | 31.3 | 0.0 | 2.6 | 2.2 | 0.5 | 3.0 | 1.0 | 0.3 | 0.0 | 0.8 | 3.8 | 0.2 | 0.2 | 14.6 | 14.6 |
| Raleigh | 123.9 | 55.3 | 31.3 | 24.1 | 2.6 | 2.2 | 0.3 | 2.0 | 1.3 | 0.7 | 0.0 | 0.7 | 3.9 | 0.1 | 0.2 | 14.0 | -10.1 |
| Knoxville | 43.9 | 30.5 | 31.3 | 0.0 | 2.7 | 2.2 | 0.4 | 2.3 | 1.1 | 0.4 | 0.0 | 0.7 | 3.9 | 0.1 | 0.2 | 14.0 | 14.0 |
| Bakersfield | 82.0 | 45.0 | 31.3 | 13.8 | 2.4 | 2.1 | 0.3 | 1.7 | 1.0 | 0.3 | 0.0 | 0.9 | 3.5 | 0.3 | 0.1 | 12.6 | -1.1 |
| Des Moines | 70.0 | 41.2 | 31.2 | 9.9 | 2.8 | 2.2 | 0.5 | 2.5 | 0.8 | 0.4 | 0.0 | 0.6 | 4.1 | 0.1 | 0.2 | 14.3 | 4.3 |
| Spokane | 40.9 | 29.0 | 31.3 | 0.0 | 2.6 | 2.3 | 0.4 | 1.9 | 0.9 | 0.7 | 0.0 | 0.6 | 3.9 | 0.3 | 0.4 | 14.0 | 14.0 |
| McAllen | 75.0 | 42.9 | 31.3 | 11.6 | 2.7 | 2.1 | 0.4 | 2.1 | 1.0 | 0.4 | 0.0 | 1.1 | 3.9 | 0.0 | 0.2 | 14.0 | 2.4 |
| Ogden-Layton | 59.5 | 37.3 | 31.3 | 6.1 | 2.4 | 2.3 | 0.7 | 2.8 | 0.7 | 0.6 | 0.2 | 0.7 | 3.5 | 0.3 | 0.2 | 14.5 | 8.5 |

**Table 1: Regional Growth in $CO_2$ 2005–2030 and Percent Reduction from Policies**

| Region (in size order) | % Change in $CO_2$ with NO new CAFE | % Reduction to Meet 2005 Level | Percent Reduction from New CAFE Standards | Added %Red Needed to Meet 2005 Level | % Reductions from Med-Small Cars | % Reductions from Signal Timing | % Reductions from 50 MPH Peak Speed | % Reductions from 55 MPH Speed Limit | % Reductions from NO LOS F | % Reductions from 50% more Work at Home | % Reductions from 2x HOV/T Lane | % Reductions from 25% more Carpool | % Reductions from -5 % VMT | % Reductions from +50% Transit | % Red from +50% Walk-to-Work | All | % Excess or Deficit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Madison | 35.0 | 25.9 | 31.3 | 0.0 | 2.5 | 2.3 | 0.5 | 2.4 | 0.9 | 0.4 | 0.0 | 0.6 | 3.7 | 0.6 | 0.7 | 14.5 | 14.5 |
| Cape Coral | 90.0 | 47.4 | 31.2 | 16.1 | 2.7 | 2.2 | 0.2 | 1.0 | 1.3 | 0.4 | 0.0 | 0.8 | 4.0 | 0.1 | 0.1 | 12.7 | -3.4 |
| Lancaster, PA | 30.0 | 23.1 | 31.3 | 0.0 | 2.7 | 2.2 | 0.4 | 1.8 | 1.0 | 0.4 | 0.0 | 0.7 | 3.9 | 0.2 | 0.5 | 13.8 | 13.8 |
| Boise City | 78.2 | 43.9 | 31.2 | 12.6 | 2.8 | 2.2 | 0.3 | 1.7 | 0.7 | 0.7 | 0.0 | 0.8 | 4.1 | 0.1 | 0.2 | 13.8 | 1.2 |
| Salem, OR | 50.0 | 33.3 | 31.3 | 2.1 | 2.6 | 2.1 | 0.4 | 2.5 | 1.1 | 0.3 | 0.0 | 1.0 | 3.8 | 0.3 | 0.3 | 14.4 | 12.3 |
| Fort Collins | 72.0 | 41.9 | 31.2 | 10.6 | 2.9 | 2.2 | 0.4 | 1.9 | 0.7 | 0.9 | 0.0 | 0.6 | 4.2 | 0.1 | 0.3 | 14.3 | 3.7 |
| Totals/Average | 51.8 | 34.1 | 31.2 | 2.9 | 2.7 | 2.3 | 1.1 | 3.0 | 4.1 | 0.5 | 0.6 | 0.7 | 4.0 | 1.1 | 0.3 | 20.6 | 17.7 |

- Work-at-home and walk-to-work strategies.
- Shifts in vehicle size mix, e.g. higher portions of small/medium cars.

We include major technology actions, commuting policies and more general all-day policies, such as VMT reductions, capacity improvements and speed controls. Although these are not the only policies one might look at, they cover most of those mentioned in transportation plans.

### D. Data Analysis

We first estimated the transportation-related $CO_2$ emissions for each region for the baseline (prior to the new CAFE standards) and the forecast (implementation of new CAFE standards) for 2005 and 2030. These years were chosen for consistency, since most long-range transportation plans in the U.S. are for 2030. We then analyzed the impact of each policy on $CO_2$ reduction, compared with the baseline forecast, for each region.

This step varied somewhat by policy, depending on the nature of the impact and its effect on traffic and emissions. The basic procedure was to simulate the policy's impact at a given reasonable level of penetration or adoption by calculating how a given policy would affect $CO_2$ emissions. All estimates of $CO_2$ emissions are in tons per day. This is necessary because virtually all regional and U.S. Federal Highway Administration (FHWA) VMT data are in average weekday VMT, not annual VMT. We report findings in reduction of $CO_2$ in tons per day, and in percent reduction from the baseline forecast, i.e., the $CO_2$ emissions that would be produced in 2030 under the prior CAFE standards.

We also estimated the overall global impact of each policy.

### E. Estimating Costs

Then we estimated the direct government and manufacturing cost of each policy by region using best estimates from the literature. These are for the initial implementation of each policy (for instance, additional manufacturing costs for increased fuel efficiency, government costs of more transit service, costs of higher gasoline prices needed to reduce VMT, etc.). They do not include second-order costs, such as resource extraction, lifecycle or social costs such as lost time, nor so-called "co-benefits" such as reduced accidents or operating costs. These steps might be included in selecting specific actions within each region, but are beyond the scope of this study.

### F. Estimating Cost-Effectiveness

Finally we estimated the approximate cost-effectiveness (approximate cost per ton of $CO_2$ emissions reduced) for each policy for each region.

These analytical steps and their results are fully explored in a larger report (Hartgen, et al., 2011); here we summarize the most interesting findings.

## RESULTS

### A. Baseline Forecast

If prior CAFE standards had remained in place, our baseline forecast indicates that $CO_2$ emissions from vehicle miles travelled (VMT) in the 48 regions studied would increase about 50% over the next several decades, in line with increases in travel. This means that, for the regions studied, transportation-related $CO_2$ emissions in 2030 would be about 2 million metric tons (MMT) daily, representing about 47% of U.S. gasoline and diesel $CO_2$ emissions (4.5 MMT), 13% of total U.S. $CO_2$ emissions (16.4 MMT), and about 3% of world $CO_2$ emissions (76.9 MMT).

### B. Higher Vehicle Fuel Efficiency Regulations

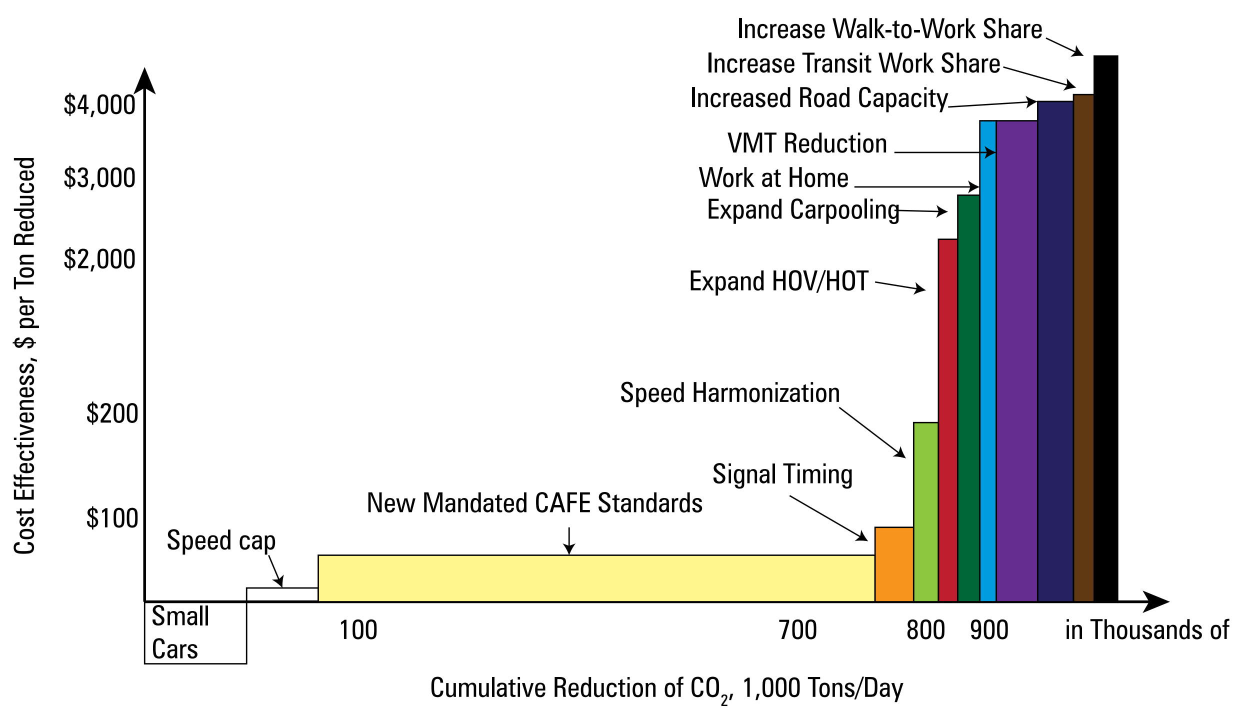
Mandated new CAFE standards for vehicle fleet fuel efficiency, however, are forecast to reduce the 2030 forecast of $CO_2$ emissions to about 1.45 million tons daily; that's a reduction of about 660,000 tons daily, which is about 31% lower than with prior CAFE standards. The overall cost-effectiveness of this policy is about $52 per ton reduced, though this does not count possible safety impacts of lighter cars nor take into account shifts to more fuel-efficient vehicles that might occur absent the mandates. Additional shifts to smaller cars would decrease another 39,000 tons daily, which is about a 3% reduction.

### C. Effects of Other Policies

Table 1 shows the relative size and the magnitude of emission reduction for each of the 48 metro areas. For example, the New York-Newark area would see about a 38% increase in VMT between about 2005 and 2030, with a proportional increase in $CO_2$ emissions. In other words, if the new CAFE standards were not in place, New York-Newark would have to reduce future $CO_2$ emissions about 27% to hold $CO_2$ at 2005 levels. However, the new CAFE standards are likely to reduce about 31% of 2030 $CO_2$ emissions, slightly more than needed to meet goals.

Since the regions vary widely in growth rates and modal shares, some are quite well positioned to meet possible $CO_2$ reductions, while others would not be able to do so without very large changes in travel behavior. The areas studied tend to fall into three growth categories: slow-growth regions in which the new CAFE standards will constrain the increase in $CO_2$ emissions to below 2005 levels; moderate-growth regions, which would require additional measures such as those analyzed here to reach the 2005 $CO_2$ emission levels in addition to the new CAFE standards, and fast-growth

**Figure 1: Summary of Cost-Effectiveness and $CO_2$ Reduction**



| Table 2: Summary of Findings | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Strategy | Description | $CO_2$, K Tons/ Day | Change, K Tons/ Day | % Change | % Impact on Global $CO_2$ | Increm Annual Cost, $B | Cost per Ton Reduced | Notes |
| Current | 2005 | 1,391 | | | | | | |
| 1. Baseline Forecast | 2030, No change in average vehicle fuel economy | 2,112 | + 721* | +51.8% | + 3.1% | | | Slow growers fare better |
| VEHICLE TECHNOLOGY | | | | | | | | |
| 2.A Fuel Economy Improvements (CAFE) | 2030, new mandated CAFE standards | 1,452 | - 660** | -31.2% | - 1.9% | $8.540 | $51.77 | Range $45-$55 per ton reduced |
| 2.B Vehicle Size Mix | Fleet is ½ small cars, conventional fuel | 1,413 | - 39*** | - 2.7% | - 0.16% | (Likely to be a savings) | | Likely to be uniform across regions |
| HIGHWAY IMPROVEMENTS | | | | | | | | |
| 3.A Signal Timing and Coordination | Improved signal coord arterials only. | 1,475 | - 35 (vs. 1,510)*** | - 2.3% | - 0.14% | $0.983 | $112 | Effective policy for most regions |
| 3.B Speed Harmonization | Uniform 50 mph, peak hours, freeways | 1,493 | -17 (vs.1,510)* | - 1.1% | -0.07% | $0.733 | $176 | $30-$370 per ton reduced |
| 3.C Capacity Improvements | 2030 capacity targeting congested links | 1,447 | - 62 (vs. 1,510)*** | -4.1% | - 0.25% | $62.17 | $3,995 | Wide range, $1,019 to $15,200 per ton reduced |
| 3.D Impose Speed Caps (Limits) | 55 mph speed limit on freeways | 1,465 | - 45 (vs. 1,510)* | -3.0% | - 0.18% | $0.0015 | $0.13 | Large social costs (lost travel time) |
| TRAVEL BEHAVIOR | | | | | | | | |
| 4.A Increase Work at Home (telecommuting) | 50% increase in work-at-home share, thru employer incentives | 1,444 | - 8*** | - 0.52% | - 0.03% | $6.584 | $3,496 | Range $503 to $6,700 per ton reduced |
| 4.B Expanded HOV/ HOT lanes | Add 10 to 200 lane-miles | 1,443 | - 9.3*** | -0.64% | - 0.04% | $5.695 | $2,462 | Range $422- $38,000 |
| 4.C Expand Carpooling Services | 25% higher carpool work share, through agency vanpool services | 1,441 | - 11*** | -0.75% | - 0.05% | $7.550 | $2,776 | Wide range |
| 4.D Reductions in Travel | 5% reduction in 2030 Car/Lt Truck VMT | 1,394 | - 58*** | -4.0% | - 0.24% | $56.75 | $3,923 | Small range, $3,880-$3,957 |
| 4.E Expand Transit Services | 50% higher transit work share | 1,436 | - 16*** | - 1.1% | - 0.07% | $16.60 | $4,257 | Wide range, $472-$12,000 |
| 4.F Increase Walk to Work | 50% increase in walk-to-work share | 1,447 | - 5*** | - 0.35% | -0.02% | unknown | unknown | Implementation cost is likely to be very high |

regions, which will not achieve 2005 emission levels even if they implement all the policies analyzed in this study.

### D. Cost-Effectiveness

In addition to estimates of the technical effectiveness of these policies in meeting emissions reductions goals, we surveyed the literature for cost estimates. Table 2 shows the typical emission effects and costs of each policy, and well as some observations about how they vary across regions.

Figure 1 shows each policy's relative cost-effectiveness and its relative technical effectiveness in meeting $CO_2$ reduction goals.

## RECOMMENDATIONS

Carbon reduction has become a policy goal for national governments around the globe. The transportation sector, in particular, has become a target of these initiatives. Urbanized areas, however, vary significantly in their ability to achieve specific carbon reduction strategies cost-effectively. This study reports the results of the relative technical- and cost-effectiveness of meeting carbon reduction goals through the transport sector for 48 urbanized areas in the U.S. Requirements for higher fuel economy that are already in place, along with market-driven shifts to smaller vehicles, will reduce U.S. transportation

$CO_2$ emissions 31% by 2030 at a cost of about $52/ton reduced. For slower-growing regions these effects alone are likely sufficient to reduce $CO_2$ emissions below 2005 levels and further intervention would be unlikely to yield significant additional reductions. The other policies examined are either much more costly or much less effective and would thus require substantial resources from a region to achieve further $CO_2$ reductions. For faster-growing regions, policymakers and transportation planners must carefully evaluate the technical- and cost-effectiveness of specific strategies because some regions are better able to benefit from particular approaches than others. Regions should consider if they therefore are the best use of resources, at a minimum comparing them to the cost-effectiveness of non-transportation $CO_2$ reduction policies.

## ABOUT THE AUTHORS

David T. Hartgen is Emeritus Professor of Transportation Studies at UNC Charlotte and president of The Hartgen Group. Professor Hartgen is widely known in transportation circles. He established the UNC Charlotte's Center for Interdisciplinary Transportation Studies in 1989 and now conducts research in transportation policy. He is the author of about 350 publications on a wide variety of topics in transportation policy and planning, is the U.S. editor of the international academic journal *Transportation*, and is active in professional organizations. He is a frequent media interviewee in local and national publications. Before coming to Charlotte he directed the statistics and analysis functions of the New York State Department of Transportation and served as a Policy Analyst at the Federal Highway Administration. He holds engineering degrees from Duke University and Northwestern University. He has taught at SUNY Albany, Union College and Syracuse University and lectures widely. He is well known for his annual assessments of the cost-effectiveness of the 50 state highway systems. His studies of road conditions and his recent national study of congestion reduction also attracted wide national attention.

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