

# **Impacts of Employer-Based Trip Reduction Programs and Vanpools on Passenger Vehicle Use and Greenhouse Gas Emissions**

## **Technical Background Document**

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Policy Brief: [http://www.arb.ca.gov/cc/sb375/policies/ebtr/ebtr\\_brief.pdf](http://www.arb.ca.gov/cc/sb375/policies/ebtr/ebtr_brief.pdf)

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## **Technical Background Document on the Impacts of Employer-Based Trip Reduction Programs and Vanpools on Passenger Vehicle Use and Greenhouse Gas Emissions**

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### **Study Selection**

Most of the studies on the effectiveness of employer-based trip reduction programs focus on changes in commute mode, such as the share of employees who drive to work alone (solo driving) or the transit mode share among employees. Only a few studies provide estimates for reduction in vehicle use, specifically in vehicle miles travelled (VMT), and only two studies (CTR Task Force 2005 Report and Herzog, et al., 2006) provide estimates of greenhouse gas (GHG) emission reductions. Therefore, the key criterion for including studies in this review was reporting VMT effects, as done by Lagerberg (1997), Hillsman, Reeves, and Blain (2001), CTR Task Force 2005 Report, and Herzog et al. (2006). These studies estimated VMT reduction either by a “before-and-after” survey or by a transportation simulation model.

Among those studies that only reported changes in commute mode, studies are reviewed here (but not included in the brief) that emphasize specific measures rather than comprehensive packages of employer-based trip reduction programs. For instance, Concas, Winters, and Wambalaba (2005) studied vanpool service. Dill and Wardell (2007) analyzed a reduced fare transit pass program and human resource incentives such as alternative work schedules, bike amenities, and transit marketing programs. Brown et al. (2003) focused on fare-free transit service.

More recent studies were given preference, but research from the early 1990s South Coast Air Quality Management District’s Regulation XV program (Giuliano, Hwang, and Wachs, 1993) was also included. Studies that discussed specific issues are considered as well. For example, Pagano and Verdin (1997) researched the management context for implementation of voluntary rather than mandatory employer-based trip reduction, and Higgins (1996) examined different research approaches used to study the impacts of employer-based trip reduction.

No recent studies provide direct evidence on the effects of vanpool programs on VMT. Evidence on the effects of vanpool programs (usually implemented in conjunction with other strategies) on vehicle trip rates (number of vehicle trips per employee) is reported in Kuzmyak et al. (2005). The new employer-sponsored bus services have not yet been evaluated for their impacts on vehicle travel.

### **Effect Size, Methodology and Applicability Issues**

The policy brief only presented studies that reported changes in VMT and GHG

emissions. This background document includes studies that report changes in mode share and other aspects of travel behavior, as well as studies that use cross-sectional methods to estimate the effects of trip reduction programs. Sorted by program, Table 1 provides detailed information regarding program name, location, year(s), description, and results. For each study, a short paragraph is included that explains the research methods, including the unit of analysis, sample size, survey administration, and the outcome variables. Typically the VMT impacts described in the policy brief are calculated from reductions in driving commute trips and survey data about commute length, and therefore are consistent with the evidence below. For some outcome variables, such as carpool or non-motorized travel, the base value was often small which resulted in the large percent increases in those variables.

*Table 1: Effects of Employer-based Trip Reduction: Results from Studies, Sorted by Program*

<b>Program, Location, &amp; Year(s)</b>	<b>Program Description</b>	<b>Study</b>	<b>Change in VMT</b>	<b>Change in Other Impacts*</b>
South Coast Air Quality Management District, CA, 1988-1991	1 <sup>st</sup> year results of Regulation XV's implementation, 1,110 worksites surveyed	Giuliano et al. (1993)		Solo driving: -6.3% (from 75.7% to 70.9%)  Carpool: +33.3% (from 13.8% to 18.4%)  Average vehicle ridership: +2.7% (from 1.21 to 1.25 employees per vehicle)
Bruin Go, CA, 2000 to 2001	A fare-free transit service at UCLA, 4,565 respondents in 2000 and 3,614 in 2001	Brown et al. (2003)		Solo driving: -20% (For faculty and staff: from 46% to 42%; for students: from 17% to 12%)  Bus ridership: +56% (For faculty and staff: from 9% to 20%; for students: from 17% to 24%)  Fare elasticity of demand for transit: -0.28

Commuter Trip Reduction (CTR) program, Puget Sound region, Washington State, every two years since 1993	Focus on vanpool service; 141,103 employees surveyed, 1999 CTR data	Concas et al. (2005)		Fare elasticity of vanpool demand: -0.73
	Focus on a segment of I-5 in downtown Seattle; 189 employers and 62,847 employees surveyed, 2005 CTR data	Georggi et al. (2007)	Total VMT reduction 17,297 miles in AM peak and 14,511 miles in PM peak	AM peak fuel savings: 3,489 gallons; AM peak CO savings: 1,109 kilograms  PM peak fuel savings: 4,314 gallons; PM peak CO savings: 1,545 kilograms
	237,141 respondents and 886 worksites	CTR Task Force 2005 Report	Annual commute VMT reduction is nearly 126 million miles	Solo driving: -7.2% (from 70.8% in 1993 to 65.7% in 2005)  Reduction in commute trip numbers each morning: about 20,000  Annual fuel savings: 5.8 million gallons resulting in a monetary savings of \$13.7 million  Annual reduction in GHG emissions: 74,000 tons
	Four central Puget Sound counties; 250,000 employees surveyed, 1999 CTR data	Hillsman et al. (2001)	Total VMT: -1.33%  Freeway VMT: -1.07% (during AM peak)	AM peak time delay per vehicle: -5.2% (from 1.50 to 1.43 minutes per vehicle)
	1995 CTR survey data	Lagerberg (1997)	VMT: -6%	Solo driving: -5.5% (from 72% in 1993 to 68% in 1995)
Best Workplaces for Commuters (BWC) program, 2004	Benefits packages offering services only; 6,708 employees surveyed	Herzog et al. (2006)	VMT: -7%	Fuel consumption and emissions: -7%
	Benefits packages offering services and financial incentives; 6,708 employees surveyed		VMT: -15%	Fuel consumption and emissions: -15%

Portland, Oregon, survey data from different years	Passport program, 830 worksites	Dill and Wardell (2007)	Solo driving: -18.4% (from 76% to 62%)
			Carpool: -20.2% (from 8.4% to 6.7%)
			Transit: +107.7% (from 13% to 27%)
			Linear regression prediction: +6.9% points in transit mode share with passport program
	Human Resource incentives, 830 worksites		Solo driving: -11.8% (from 76% to 67%)
			Carpool: -19.3% (from 8.8% to 7.1%)
			Transit: +69.2% (from 13% to 22%)
			Linear regression prediction: +3.9% points in transit mode share with HR incentives
	Bike amenities, 830 worksites		Linear regression prediction: +1.2% points in walking and bicycling and -2.7% points in transit mode share with bike amenities
	Transit marketing programs, 830 worksites		Solo driving: -8.1% (from 74% to 68%)
			Carpool: -13.1% (from 8.4% to 7.3%)
			Transit: +57.1% (from 14% to 22%)
			Linear regression predictions: -1.3% points in walking and bicycling mode share with transit marketing programs
Chicago, Illinois, 1995	Employee trip reduction (ETR) program without government mandates; 14 companies surveyed	Pagano and Verdin (1997)	Solo driving: -6.9% (from 80.1% to 74.6%)
			Carpool: +52.5% (from 11.8% to 18.0%)
			Each \$10 expenditure per employee is associated with a 1% reduction in the solo driving rate
			Every \$10 increase in annual incentive costs per employee

			is associated with a 1.3% decrease in the solo driving rate
Denver, Colorado, 1993	One year pilot program; 40 companies surveyed	Higgins (1996)	Walking: +22.2% (from 0.9% to 1.1%)  Solo driving: no significant change

\*Note: Percent changes in “Solo Driving”, “Carpool”, “Bus Ridership”, “Transit” and “Walking” are percentage changes in mode shares. For example, a change in solo driving from 76% to 62% mode share is shown as “-18.4%” in the table.

Details about the specific studies are provided below.

1. Giuliano, Hwang, and Wachs (1993):

Using a “before-and-after” survey of 1,110 worksites in the South Coast Air Quality Management District, this paper presented results from the first year of Regulation XV’s implementation in southern California. It examined the travel behavior effects of the program from mid-1988 to mid-1991. The outcome variable “average vehicle ridership” in Table 1 was estimated roughly as the quotient of the number of employees reporting to work during AM peak divided by the number of motor vehicles driven by these employees.

2. Brown et al. (2003):

Using year 2000 and 2001 survey data for employees and students at UCLA (4,565 respondents in 2000 and 3,614 in 2001) the authors examined the effects of a fare-free bus service. They conducted several difference of means tests to evaluate the effects on commuter mode choice. The home addresses of respondents were obtained in the survey and divided into two subgroups: those who lived inside the fare-free bus service area (experimental group) and those who did not (control group). Comparisons between the experimental group and the control group and “before-and-after” program implementation were conducted.

3. Concas, Winters, and Wambalaba (2005):

Using 1999 survey data for 141,103 employees from the Commute Trip Reduction (CTR) program in the Puget Sound region in Washington, the authors constructed a conditional discrete choice model to predict the fare pricing elasticity of demand for vanpooling. The study found that the probability of choosing vanpool more than doubles when a subsidy is offered.

4. Georggi et al. (2007):

Puget Sound CTR survey data from 189 employers and 62,847 employees, along with traffic network data, were input into a micro-simulation model. The model was used to generate performance measures such as peak hour delay, VMT, and fuel consumption on an 8.6-mile roadway corridor in downtown Seattle. The simulation model was run under two different scenarios: with and without the CTR program. In the “without CTR” scenario, the estimated 5,149 reduced vehicle trips due to the CTR program were

added back onto the network. By comparing the results from the two scenarios, the amounts of reduction in peak hour corridor delay, VMT, and fuel consumption were estimated.

#### 5. CTR Task Force 2005 Report:

The Washington State Legislature passed the Commute Trip Reduction (CTR) law in 1991 to reduce traffic delay, air pollution, and petroleum consumption. This 2005 legislative report contained the CTR Task Force's assessment of the program and recommendations for improvement. By analyzing survey data from about 237,141 employees and 886 worksites participating in the CTR program, the Task Force evaluated the performance of the CTR program by measuring the reduction in commute trips, VMT, fuel consumption, and GHG emissions. For the VMT measurement, employees were asked to report their travel distance to worksites in the employee commute survey. Results for each worksite were compared to a baseline survey conducted the year that the worksite entered the program to calculate the effect of the CTR program on VMT reduction.

#### 6. Hillsman, Reeves, and Blain (2001):

Using 1999 CTR program survey data for about 250,000 employees in the four central Puget Sound counties of Washington State, the authors estimated a reduction of 12,600 trips (compared to the previous year) during the morning peak period. The authors wanted to see if the estimated effect could be disaggregated and used in traffic assignment modeling, so they used the survey data to construct an origin-destination (O-D) table and then a four-step model to estimate the effects of the CTR program on traffic delay and VMT reduction. The model was run under two scenarios: with and without the CTR program (by adding back the estimated 12,600 reduced vehicle trips due to CTR program to the O-D table). VMT and delay reduction was then measured by comparing the results from the two scenarios.

#### 7. Lagerberg (1997):

This paper summarized lessons learned from the Phase I Washington State CTR program evaluation conducted between 1993 and 1995. Data collected for the evaluation came from a variety of sources, including biennial employee questionnaires (220,000 in 1993 and 1995), annual reports and program descriptions (900 per year), CTR cost surveys (290 in 1995), focus groups with employee transportation coordinators (ETC), local jurisdictions, and counties (17 conducted in 1995), employer forums (6 completed in 1994-1995), and employee interviews (380 conducted in 1995-1996). The data for reduction in VMT and solo driving rate were obtained from the CTR Task Force 1995 Report.

#### 8. Herzog et al. (2006):

Using year 2004 survey data for 6,708 employees from Best Workplaces for Commuters (BWC) in the Denver, Houston, San Francisco, and Washington D.C. metropolitan areas, the authors evaluated the effects of employee commuter benefits on commute trip reduction. They also estimated resulting savings in VMT, emissions, and fuel consumption. For VMT measurement, respondents were asked about the length of their trip to work by distance categories.

The 6,708 respondents were divided into two subgroups: those who were eligible for BWC level commuter benefits (6,075 respondents, experimental group) and those who were ineligible for BWC benefits (633 respondents, reference group). Since respondents in the reference group were still able to take advantage of some of the employer-provided services, such as carpool matching and bicycle facilities, their responses cannot be used to establish a control group that received no program services, but the study design approximates an “experimental – control group” evaluation. In addition to the reference group, the authors obtained mode share, trip distance, and carpool occupancy data for people working in the same zip codes as the survey areas from Census 2000, and used that data to form an additional control group. The effects of BWC benefits were then measured by comparison between these three groups.

9. Dill and Wardell (2007):

Using employee survey data from 830 large worksites in Portland, Oregon, the authors developed several multiple linear regression models to predict the influences of different employer-based trip reduction programs. The data are from firms that agreed to work with the Portland metropolitan planning organization on data, reporting, and implementation, or from firms that are voluntarily implementing transit-promotion programs, and so the authors note that impacts might overstate effects that would occur in a more representative sample of all the region’s firms. Program benefits included reduced fare transit passes and human resources (HR) incentives (such as alternative work schedules, bike amenities, and transit marketing programs). The authors report impacts on transit, bicycling, and walking mode share. Three categories of control variables were included in the regression model:

- Location characteristics, including whether light rail transit is within a quarter mile, frequent bus service within quarter mile, number of retail workers in the travel analysis zone, whether the firm is in the fareless square area of downtown Portland, and street connectivity.
- Employer TDM program elements, including human resources incentives, marketing, bike facilities, transit passport, and transit cost percentage paid by employee.
- Work site characteristics such as employer size.

10. Pagano and Verdin (1997):

Using before and after interviews and survey data for 14 companies with an average number of 641 employees in the Chicago metropolitan area, the authors evaluated the effects of voluntary employee trip reduction (ETR) programs on commuter mode choice. They also evaluated the cost and effectiveness of the ETR programs. A series of personal interviews with program administrators and employee trip coordinators at each company were conducted by the authors, and each company also conducted employee commute surveys before and approximately one year after implementation of the ETR program, and then aggregated the data to the company level.

11. Higgins (1996):

Using 1993 survey data of 40 companies (19 pilot program companies and 21 control companies) in Denver, Colorado, the author adopted an experimental design approach

to examine the before and after effects of a 1-year employer-based trip reduction pilot program on changes in commute behavior. Employees at both the pilot and control group companies were surveyed on travel behavior at exactly the same time by way of the same instrument both before and after the support service were administered. VMT was not measured.

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