Reducing Your Organization's Carbon Footprint:

Addressing Commuter-Related Emissions

As organizations seek to effectively address their environmental impacts, carbon footprint reduction has become a common practice. One area that may dramatically reduce an organization's carbon footprint is the reduction of carbon emissions resulting from employee commuter travel. Most U.S. employees (77 percent) travel to and from work via single-occupant vehicle. Data shows that when employees switch to bus, subway/light rail, carpooling and vanpooling, bicycling, or telecommuting, the overall organizational emissions attributed to commuting can be dramatically reduced. This reduction can play a significant role in reducing an organization's overall carbon footprint. Some commuting strategy alternatives have major hurdles, such as cost to employ or non-availability of transport options. However, there are great financial and non-financial benefits for adopting most alternative commuting strategies when possible. These benefits may include decreased stress, increased productivity, and tax incentives.

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Organizational emissions tied to employee commuting can represent a very large or a very small part of an organization's overall carbon footprint, depending on a great number of factors. Factors may include facility location, organizational culture, and industry sector. However, the carbon emissions associated with employee commuting can represent a significant portion of the organization's overall carbon footprint size. By reducing commuting-related emissions, an organization can reduce its overall carbon footprint, sometimes dramatically.

The majority of commuter emissions in the U.S. are a result of transportation in single-occupant vehicles; 77 percent of commuters travel by this mode (Walls and Nelson, 2004). In addition to contributing to large employer carbon footprints, high levels of single-occupant vehicle commuting result in congested roads and traffic jams, heavy burdens on transportation infrastructure, and pollution. Additionally, commuters stuck in rush hour traffic expend 4.8 percent of annual fuel consumption in the U.S. (Lubber, 2008).

By encouraging employees to adopt alternatives to single-occupant vehicle commuting, an organization can reduce its overall carbon footprint. Additionally, these alternatives may have other positive financial and non-financial benefits for employees and the organization.

Alternatives to single-occupant commuting discussed in this white paper include bus transit, subway/light rail transit, carpooling and vanpooling, bicycling, and telecommuting. Each strategy is evaluated using the following format:

1. First, each transit strategy is introduced and its positive and negative aspects evaluated.
2. Second, financial incentives supporting alternative transit modes are examined,
3. Finally, the potential carbon-emissions reduction for each strategy is illustrated based on different levels of adoption by employees.

Baseline

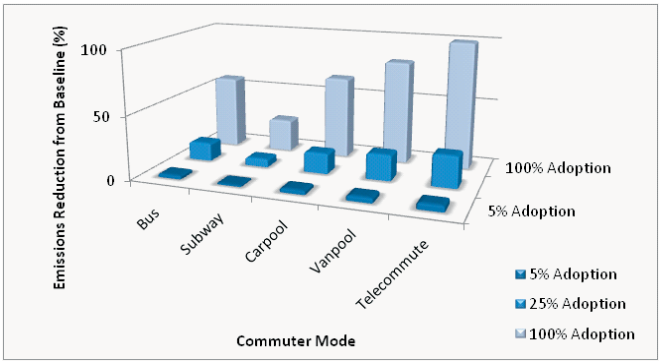
Before each strategy is discussed, a baseline commuter carbon footprint is calculated for three hypothetical small business where employees use single-occupant vehicles as their sole mode of transportation.

Using a number of assumptions, outlined in Appendix A, the carbon dioxide emissions—in pounds per passenger per mile—was calculated to be 0.7095 for a hypothetical commuter traveling to and from work a single-occupant vehicle. Using this figure, daily and annual approximations were tallied for the hypothetical businesses. The results are summarized in the Table 1 below.

Business Size	Baseline Emissions (lbs CO_2/day) from Employee Commuting	Baseline Emissions (lbs CO_2/Year) from Employee Commuting
50 employees	1,064.3	266,085.7
250 employees	5,321.7	1,330,428.7
1,000 employees	21,286.8	5,321,715.0

Emissions Reduction Summary

The white paper includes summary tables for each transit mode showing emissions-reduction potential from three levels of employee adoption. These results can best be summarized in the figure below. It is interesting to note that while all the alternative transit modes reduce carbon emissions from baseline levels, some are more effective than others. Subway/light rail has the lowest reduction potential, while telecommuting has the greatest reduction potential.



The pounds of carbon emissions per commuter mile for each alternative commuter mode are displayed in Table 2 below, as well as their respective percentage reduction from the single-occupant baseline.

Mode	Pounds (lbs) of CO_2 Emitted per Passenger Mile	Reduction from Single Occupancy Baseline (%)
Bus	0.2994	58
Subway/ light rail	0.5282	26
Carpool	0.1774	75
Vanpool	0.1232	83
Telecommuting/ biking	0.0000	100

Bus Transit

Bus transit has the potential to significantly reduce commuter carbon emissions. Bus transit reduces the carbon emissions per passenger mile 58 percent from single-occupant vehicle commuting, to 0.2994 pounds per passenger mile (Bureau of Transportation Statistics, 2002). Secondary benefits of bus transit include reducing the number of single occupant vehicles that need to be parked at the work facility, reducing the demand for parking space and its associated maintenance. Employees who commute on buses may find their commute more relaxing, as they are able to focus time on leisure activities such as reading or listening to music instead of struggling through rush hour traffic.

The government incentive program available for bus transit is the same as that for subway/light rail transit and vanpooling. This program is called the Qualified Transportation Fringe Benefit program, a U.S. federal law that allows workers to receive up to $230 per month in employer paid, tax-free transit costs. Alternatively, employees can choose to take up to $230 per month in tax-sheltered payroll deductions to put towards transit costs. If the employer purchases and distributes transit passes as part of its employee benefits program, these costs may be deducted as a regular business expense.

Subway/Light Rail Transit

Subway and light rail lines do not have to contend with traffic and run on a fixed route. Subway/light rail transit reduces the carbon emissions per passenger mile 26 percent from single-occupant vehicle commuting, to 0.5282 pounds per passenger

mile. Secondary benefits of this commuter mode include reduced time spent in rush hour traffic and the ability to multitask or use commuter time for leisure activities. However, the use of subway/light rail commuting will only be feasible for employees who live within close proximity to a subway/light rail station. This option may not be feasible for employees if the workplace facilities are not within proximity to a subway/light rail station.

The government incentive available for this commuter mode is the Qualified Transportation Fringe Benefit program, outlined in the bus transit section.

Carpooling and Vanpooling

Carpooling is extremely easy to implement, as employees usually have their own vehicles already. Carpooling requires some organization of ride sharing between employees but no capital investment. Carpooling reduces the carbon emissions per passenger mile 75 percent from single-occupant vehicle commuting, to 0.1774 pounds per passenger mile.

Vanpooling requires a larger capital investment and organizational effort by a company in order to rent vans, coordinate routes, and purchase insurance. Vanpooling reduces the carbon emissions per passenger mile 83 percent from single-occupant vehicle commuting, to 0.1232 pounds per passenger mile.

Secondary benefits of these commuter modes include: reduced stress related to single occupant vehicle commuting and the ability to multitask or use commuter time for leisure activities. There is no government incentive available for carpooling, but vanpooling is part of the Qualified Transportation Fringe Benefit program, outlined in the bus transit section.

Bicycling

Bicycling is carbon neutral and can be proposed as an alternative to all employees living within 10 miles of the office, providing that road and weather conditions make it a feasible option. Bicycling reduces the carbon emissions per passenger mile 100 percent from single-occupant vehicle commuting, to zero pounds per passenger mile. A secondary benefit of cycling is healthier employees.

The incentive available to subsidize bike commuting is the Bike Commuter Benefit program. This program allows employers to provide employees who commute primarily by bike a tax-free benefit of up to $20 per month. Employers have the added advantage of being able to defer up to 9.5 percent of their FICA contribution on each $20 payment using this incentive.

Telecommuting

Telecommuting allows employees to work from their home offices through the use of telephone, computer and Internet technologies. By enabling an employee to perform their duties from a remote location, telecommuting eliminates the travel time and carbon footprint associated with commuting for that employee.

Like bicycling, telecommuting is carbon neutral and reduces the carbon emissions per passenger mile 100 percent from single-occupant vehicle commuting, to zero pounds per passenger mile.

Secondary benefits of telecommuting include cost savings associated with commuting for employees, time savings from reduced time spent in rush hour traffic, increased employee productivity, increased business agility, and increased employee satisfaction and retention.

There are no federally sponsored incentive programs for telecommuting currently available. However, many state programs are available that subsidize the majority of start up costs associated with telecommuting.

Conclusions

Although there are a number of alternatives to single occupancy vehicle commuting, not all options may be feasible for your organization. Depending on the transportation infrastructure available in your area it may be most cost effective to promote a bus transit program among your employees. Telecommuting represents the most effective method for reducing carbon emissions, but this mode of commuting requires the largest amount of planning and organizational changes in order to successfully operate. Your organization must carefully consider the costs and benefits associated with each transit mode before making a decision. Commonly, a mix of multiple commuter alternatives is used to achieve a reduce commuter carbon footprint. There is no 'one size fits all' solution, you must use the information and decide what is right for you.

Introduction

On-road vehicles account for approximately 44 percent of all CO_2 emissions, 33 percent of all NO_x emissions, and 25 percent of volatile organic compound (VOC) emissions in the U.S. (Commuter Check, 2010). In 2002, emissions from U.S. commuter cars and trucks alone totaled 314 million metric tons of carbon dioxide, or 5.4 percent of the nation's total CO_2 emissions (EPA, 2010). Every year, 2.9 billion gallons of gasoline—or 4.8 percent of the total annual fuel consumption of cars and light trucks is burned while American commuters are idling in traffic. That is the equivalent of the contents of 58 supertankers (Lubber, 2008; Best Workplaces for Commuters, 2007).

Commuter traffic creates congestion, releases millions of tons of pollution, and requires expensive investments in road infrastructure and maintenance. According to a commuter study, 77 percent of American workers commute to work in single occupancy vehicles (Walls and Nelson, 2004). Additionally, the emissions released by commuters are directly attributable to their employers' carbon footprint. That is, if an employee drives 100 miles each day in an SUV, the emissions released through the commute must be a part of the data used to calculate the carbon footprint of the business itself. Therefore, by encouraging employees to adopt alternatives to single-occupant vehicle commuting, an organization can reduce its overall carbon footprint. Additionally, these alternatives may have other positive effects on employees and the organization.

As emphasis on environmental performance increases and as large businesses, such as Walmart, begin to request that their supply chains complete carbon footprint reporting and reduction measures, organizations should look to commuter emissions reduction strategies to reduce their carbon footprints.

Alternatives to single-occupant commuting discussed in this white paper include bus transit, subway/light rail transit, carpooling and vanpooling, bicycling, and telecommuting. Each strategy is evaluated using the following format:

1. First, each transit strategy is introduced and its positive and negative aspects evaluated.
2. Second, financial incentives supporting alternative transit modes are examined.
3. Finally, the potential carbon-emissions reduction for each strategy is illustrated based on different levels of adoption by employees.

Promoting and investing in alternative forms of commuter transportation including bus transit, subway/light rail transit, carpooling, vanpooling, biking and telecommuting represent significant opportunities for organizations to reduce their carbon footprints while increasing employee morale and productivity.

Carbon Footprint of Commuting Baseline

In order to calculate an approximate baseline carbon footprint associated with small business commuter travel in the U.S., a number of assumptions were made based on a variety of research findings. These assumptions are summarized below:

- A majority of commuters travel in single-occupant vehicles (77 percent) (Walls and Nelson, 2004; The United States Environmental Protection Agency (EPA), 2008; Transportation Alternatives, 2008).
- Average commuter distance travelled is approximately 30 miles round trip per day (Transportation Alternatives, 2008; Undress For Success: The Telework Research Network, 2009b).
- Average fuel efficiency of a commuter vehicle is 19.49 miles per gallon (Transportation Alternatives, 2008).
- The combustion of one gallon of gasoline typically produces 19.4 pounds of emitted carbon dioxide (EPA, 2010).

Using this data, the pounds of CO_2 emitted per passenger mile for a commuter traveling in a single-occupant vehicle are calculated to be 0.7095. Specific calculations surrounding the carbon footprint of commuting baseline can be found in Appendix A.

Using the data, a daily baseline was then calculated for hypothetical businesses employing 50, 250, and 1,000 people; a yearly baseline was also calculated assuming a 250-day work year. Baseline data is presented in Table 3, below.

Business Size	Baseline Emissions (lbs CO_2/day) from Employee Commuting	Baseline Emissions (lbs CO_2/Year) from Employee Commuting
50 employees	1,064.3	266,085.7
250 employees	5,321.7	1,330,428.7
1,000 employees	21,286.8	5,321,715.0

Considering that many businesses already have employees who commute using alternative transportation modes, this baseline data represents the ultimate ”worst case scenario” where every employee is commuting using single-occupant vehicles. Most organizations will not have a carbon footprint of this size depending on factors such as commuting distance, car type, and use of alternative transit modes; however, for purposes of illustration, this information will serve as the baseline approximation in this white paper.

Alternative Transit Modes

Bus Transit

Encouraging employees to use public transit in the form of buses represents an excellent opportunity to reduce commuter related carbon emissions. By sharing a vehicle that runs on a scheduled route with a number of other commuters, the carbon dioxide emissions are reduced. In fact, bus transit reduces the carbon emissions per passenger mile 58 percent from single-occupant vehicle commuting, to 0.2994 pounds per passenger mile (Bureau of Transportation Statistics, 2002).

Positive and negative aspects

Encouraging employees to ride the bus has the added benefit to the organization of reducing the number of single occupant vehicles that need to be parked at the work facility and reducing the demand for parking surface and its associated maintenance. Also, employees who commute on buses may find their commute more relaxing, as they will now be able to focus time on leisure activities such as reading or listening to music instead of struggling through rush hour traffic. Reduced stress related to commuting may allow these employees to arrive at work with higher morale, resulting in increased productivity (Federal Transit Administration and Environmental Protection Agency, 2003).

There are a number of situations where using bus transit may not be feasible for employees. If the employee's home is not located within close proximity—further than two miles—to a convenient bus route, it is not likely that they will

be willing to adopt this transit mode. Similarly, if the work facility is not located within a mile or two from a convenient bus route or transit hub, the organization should not pressure employees to use bus transportation. This transportation alternative is most viable in cities with well-developed public transportation infrastructure and may not be possible in suburban and rural areas.

Incentives

U.S. federal law now allows workers to receive up to $230 per month in employer paid, tax-free transit costs. Alternatively, employees can choose to take up to $230 per month in tax-sheltered payroll deductions put towards transit costs. This incentive is offered for all public transit modes, as well as vanpool initiatives operated by small businesses. Employees are not required to pay federal income or payroll taxes on transit commuter benefits as long as they do not exceed $230 per month (American Public Transit Association, 2009).

If the employer purchases and distributes transit passes as part of its employee benefits program, these costs may be deducted as a regular business

expense. In addition, federal payroll taxes are not paid on transit commuter benefits. In most cases, these factors combine to entirely offset the cost of administering a public transit program (American Public Transit Association, 2009).

This program makes excellent financial sense, and it is strongly recommended that businesses take full advantage, if implementing a public transit-commuting program is feasible. According to Kiplinger's Personal Finance Magazine, "Rarely does an employee benefit save both the employee and employer money. But through a great twist of the tax code, you may be able to commute with tax dollars, and save your boss tax dollars too" (American Public Transit Association, 2009).

The financial and non-financial benefits of implementing a bus transit program in the workplace are outlined in Table 4 below.

Financial Benefits	Non-financial Benefits
Federal tax incentives provide $230 to each employee in employer paid tax-free transit costs (American Public Transit Association, 2009).	Reduced emissions of CO_2, NOx, and VOCs associated with employee commuting.
Employees save an average of $400 per month on direct commuting costs such as fuel and vehicle repairs (Commute Solutions, 2004).	Less stressful mode of commuter transportation allows employees to arrive at work happy and productive.
Reduced demand for on-site parking and associate parking maintenance costs.	Allows commuter multitasking and increased productivity during travel to and from work.

Carbon Emissions Reductions

In order to determine the potential for carbon emissions reduction associated with adoption of bus transit by employees, three levels of adoption were investigated—five percent, 25 percent and 100 percent. These three levels were investigated for each of the three hypothetical businesses—50, 250, and 1,000 employees—and bus transit emissions were compared to baseline calculations to determine emissions reduction potential. Calculations surrounding bus transit emissions can be found in Appendix A, emissions reduction potential is displayed in Table 5 below.

	Emissions Reduction from Baseline (lbs CO_2/year) and % Reduction from Baseline		
Business Size	5% Adoption	25% Adoption	100% Adoption
50 employees	7,772 [2.9%]	38,517 [14.5%]	153,811 [57.8%]
250 employees	38,623 [2.9%]	192,398 [14.5%]	769,054 [57.8%]
1,000 employees	154,015 [2.9%]	769,215 [14.5%]	3,076,215 [57.8%]

As expected, an increased adoption of bus transit by employees will result in significant reductions in commuter carbon emissions. In fact, by adopting bus transit at a rate of just 25 percent, an organization can reduce its commuter-related carbon emissions by 14.5 percent.

Subway/Light Rail Transit

There are many similarities between encouraging employees to use public bus transportation and subway/light rail transportation. The use of a fixed track system for commuter purposes reduces the per-rider carbon emissions significantly from other transportation modes. Subway/light rail transit has

the added benefit of not needing to contend with other vehicles during its route, adding efficiency of reduced starting and stopping. The estimated per-rider carbon emissions of a subway/light rail system are 0.5282 pounds per passenger mile (Bureau of Transportation Statistics, 2002; SSC Carbon Calculator, 2010). This value may vary quite significantly between subway/light rail systems depending on the power sources being utilized, for example a system run entirely on coal will have much higher emissions than a system operating using hydroelectric or nuclear power.

Positive and Negative Aspects

Commuters traveling by subway/light rail will experience the benefit of reduced travel time spent in rush hour traffic, and the ability to multitask or use commuter time for leisure activities. However, the use of subway/light rail commuting will only be feasible for employees who live within close proximity to a subway/light rail station. This option may not be feasible for a business if its facilities are not within proximity to a subway/light rail station. Businesses operating within large metropolitan areas will experience greater success from this commuter alternative, as these areas will have significantly more developed subway/light rail systems.

Subway/light rail transit has similar employee and employer benefits as bus transit options.

Incentives

The same incentive available for bus transportation is available to commuters using subway/light rail transit. This federal tax incentive allows workers to receive up to $230 per month in employer paid, tax free transit costs, or $230 per month in tax-sheltered payroll deductions put towards transit costs. Employees are not required to pay federal income or payroll taxes on transit commuter benefits as long as they do not exceed $230 per month (American Public Transit Association, 2009).

This incentive program is an excellent opportunity to provide employees with an economically viable, environmentally friendly commuting opportunity; boosting employee morale while reducing the carbon footprint of operations.

The financial and non-financial benefits of implementing a subway/light rail transit program in the workplace are outlined in the Table 6 below.

Financial Benefits	Non-financial Benefits
Federal tax incentives provide $230 to each employee in employer paid tax-free transit costs (American Public Transit Association, 2009).	Reduced emissions of CO_2, NOx, and VOCs associated with employee commuting.
Employees save an average of $400 per month on direct commuting costs such as fuel and vehicle repairs (Commute Solutions, 2004).	Less stressful mode of commuter transportation allows employees to arrive at work happy and productive.
Reduced demand for on-site parking and associate parking maintenance costs.	Allows commuter multitasking and increased productivity during travel to and from work.

Carbon Emissions Reductions

Although it is unlikely to see adoption rates for subway/light rail commuting as high as 100 percent within a company, the potential emissions reductions were calculated for five percent, 25 and 100 percent adoption rates in a 50, 250, and 1,000-employee business. Calculations surrounding subway/light rail transit emissions can be found in Appendix A, while a summary of reductions can be found in Table 7 below.

	Emissions Reduction from Baseline (lbs CO_2/year) and % Reduction from Baseline		
Business Size	5% Adoption	25% Adoption	100% Adoption
50 employees	3,482 [1.3%]	17,067 [6.4%]	68,011 [25.6%]
250 employees	17,173 [1.3%]	85,148 [6.4%]	340,054 [25.6%]
1,000 employees	154,015 [1.3%]	340,215 [6.4%]	1,360,215 [25.6%]

As illustrated in Table 7, the carbon emissions reductions over baseline single occupant commuter vehicles are significant. The energy efficiency and low emissions associated with subway/light rail transit mean that a 25 percent adoption of this alternative transportation mode results in a 6.4 percent reduction in the carbon emissions associated with commuter travel. As energy technologies become cleaner, subway/light rail systems will be able to operate with even lower carbon emissions, and commuter carbon emissions will be further reduced.

Questions for Evaluating Feasibility of a Bus or Subway/Light Rail Transit Program

Use your regional transit provider's website to determine which bus or subway/light rail routes pass within close proximity to the office. Ask yourself the following questions to determine the feasibility of adopting or promoting the alternative commuter transit mode to your employees.

1. Are there routes near your office? Which ones?
2. If there are no routes near to the office, is it possible to relocate your office to be in closer proximity?
3. If relocation of your facility is not feasible, could you operate a shuttle program for employees to reach mass transit hubs?
4. How frequently do buses/trains operate? Do they match with work hours? Can work hours be adjusted?

If you were able to answer yes to any one of the first four questions, take stock of interest in the program using employee e-mail surveys. If employees are interested, work with payroll to take advantage of the Qualified Transportation Fringe Benefit program and purchase each employee who can use these forms of transit a pass. This will result in a savings of $230 per month per employee in federal income and payroll taxes. Then, develop a communications plan to help promote the program and its financial and environmental benefits. Monitor the success of the program through employee surveys to determine the number of employees using the transit program, and their feelings about it. Use this feedback to address employee concerns and modify the program accordingly.

Carpooling and Vanpooling

Due to the fact that many businesses operate in regions where public transportation alternatives including subway/light rail and bus routes are not available, ridesharing programs can be viable option for a commuter emissions reduction strategy. Ridesharing programs require careful coordination between employees who live in relative proximity to one another, but can result in a significant savings of carbon emissions over single occupant vehicles.

Carpooling reduces the carbon emissions per passenger mile 75 percent from single-occupant vehicle commuting, to 0.1774 pounds per passenger mile.

In order to establish a carpooling program in a workplace, employers can either post sign-up lists where interested employees write their home address information and determine on their own who in their area would be convenient to carpool with, or employers can match employees based on zip codes to maximize fuel efficiency while minimizing added distance to a commuter trip. Many municipalities offer rideshare organization services online for free, these include programs such as San Francisco's RideMatch program (Metropolitan Transportation Commission, 2010). Vanpooling programs require a greater investment of time and money by an employer in order to initiate. This is because, as opposed to carpooling, employees likely do not own

Virginia Telework Day

On June 10, 2009 the governor of Virginia Timothy Kaine gave an executive order to 'green' Virginia. This specifically called for reductions in energy consumption and increases in energy efficiency both in government and statewide (Telework Exchange, 2009). As a component of this, a telework day was scheduled and executed on August 3, 2009. The information surrounding opinions, outcomes, and emissions reductions were summarized in a report.

There was widespread participation in Telework Day, with 4,267 employees teleworking – many for their first time. This resulted in a calculated personal savings for Virginians of approximately $113,000. In addition, data collected from participants illustrated a large reduction in carbon emissions – participants avoided driving a total of 155,782 miles, reducing emissions by 82.77 tons (Telework Exchange, 2009). Additional calculations showed that if all interested teleworkers with suitable job types in the state of Virginia were to telecommute one day per week they would collectively save $807,000,000 in commuting costs, reduce vehicle miles by 602,000,000 and reduce vehicular emissions by 360,800 tons (Telework Exchange, 2009).

When participants were asked to share their experiences from Telework Day the majority (69 percent) stated that they were more productive teleworking than they were in a normal day at the office (Telework Exchange, 2009). Many participants had no previous exposure to teleworking, but as a result of Telework Day 91 percent stated that they would likely telework in the future as a result of this experience.

Virginia Governor Tim Kaine said, "Telework is a family-friendly, business-friendly public policy that promotes workplace efficiency, reduces strain on transportation infrastructure, and provides an opportunity to 'green' Virginia."

8-12 person capacity cargo vans. In order to operate a successful vanpool program, employers must organize the rental or purchase of several cargo vans, and coordinate a gathering point for employees who live in close proximity to one another. Drivers may be selected for each van; it is suggested that multiple drivers be assigned for each vehicle so that turns may be taken driving.

Vanpooling reduces the carbon emissions per passenger mile 83 percent from single-occupant vehicle commuting, to 0.1232 pounds per passenger mile.

Positive and Negative Aspects

Employees may experience benefits of carpool and vanpool programs that include reduced fuel costs associated with commuting and decreased stress associated with single commuter driving. They may also experience reduced commute time because they can travel in high occupancy vehicle lanes, where available, helping them avoid rush hour congestion. Employers may consider providing preferred parking for carpool employees in the form of parking closer to facility entrances. Another incentive that can be offered to employees is reduced cost or free parking for those who choose to participate in carpooling programs.

Incentives

A Qualified Transportation Fringe Benefit program is now offered by the federal government to provide a tax incentive for both employers and employees who participate in a commuting program such as vanpooling. As long as the van in question is a vehicle qualified for highway travel and has a minimum occupancy of seven passengers, the employer can claim up to $230 per month per employee as a normal business expense exempt from federal payroll taxes (Community Transportation Association, 2009). This incentive generally would more than cover the monthly costs of leasing and operating an appropriately sized vehicle for vanpooling. It is recommended that a professional tax accountant is consulted to create a cost analysis for implementation of a vanpool program and to ensure the organization accounts for expenses such as vehicle rental, insurance, and fuel costs, and savings from tax incentives.

The financial and non-financial benefits of implementing a vanpooling or carpooling program in the workpace are outlined in Table 8 below.

Financial Benefits	Non-financial Benefits
Federal tax incentives provide $230 to each employee in employer paid tax-free transit costs (American Public Transit Association, 2009).	Reduced emissions of CO_2, NOx, and VOCs associated with employee commuting.
Employees save an average of $100 per month on direct commuting costs such as fuel and vehicle repairs (Commute Solutions, 2004).	Less stressful mode of commuter transportation allows employees to arrive at work happy and productive.
Reduced demand for on-site parking and associate parking maintenance costs.	Allows commuter multitasking and increased productivity during travel to and from work.

Carbon Emissions Reductions

Carpooling

In order to calculate the carbon emissions of a carpooling initiative, the total emissions of a medium-sized sedan were divided by four, creating an estimate of the per person emissions of the vehicle. This assumes that a carpooling program will be able to match a minimum of four employees

based on proximity of residences, and may not be a realistic assumption in all cases.

Calculations surrounding carpooling emissions can be found in Appendix A, while a summary of reductions can be found in Table 9 below.

	Emissions Reduction from Baseline (lbs CO_2/year) and % Reduction from Baseline		
Business Size	5% Adoption	25% Adoption	100% Adoption
50 employees	8,720 [3.3%]	43,257 [16.3%]	172,769 [64.9%]
250 employees	43,362 [3.3%]	216,095 [16.3%]	863,843 [64.9%]
1,000 employees	172,973 [3.3%]	864,005 [16.3%]	3,455,373 [64.9%]

A 25 percent adoption of carpooling will result in an approximately 16 percent reduction in carbon footprint associated with commuter activities. Considering the minimal financial and infrastructure-related investment required to put a carpooling program in place, the emissions reduction is a significant reward.

Vanpooling

The fuel efficiency of an eight-person cargo van was estimated by using EPA fuel consumption data for a GMC Savannah 1500RWD, adjusted to real-world fuel efficiency conditions by the application of a mathematical correction (General Motors, 2010; Transportation Alternatives, 2008)). In order to determine a per person emissions level, fuel consumption was divided by eight. Again, this assumes that the vanpooling program will be able to match a minimum of eight employees based on proximity of residences, and may not be a realistic assumption in all cases.

6 Steps to Start a Vanpool

Create awareness and support – advertise your vanpool program on company intranet, via e-mail, and on office memo-boards.

Determine interest – make sign-up sheets available on memo-boards, via office intranet and e-mail. Make sure to include a column for zip code or address, so that participants can be matched by proximity of residence.

Create van groups – place interested employees into groups of 7 to 10 based upon proximity of residence. These employees will become van mates.

Plan drivers, routes, and pick-up points – from each van group select three employees interested in and qualified to drive. Multiple drivers are needed in case one is absent and can reduce the workload by sharing the task. Select an optimal route that reduces travel time, while balancing proximity of pick-up points to employee residences. Commonly used pick-up points include carpool parking lots, malls, churches, or employee homes.

Lease or purchase vans – your organization may choose to rent a van from a vehicle rental provider. This has the added advantages of included maintenance and insurance. Alternatively, your company may purchase or lease a van.

Claim your tax incentive – you are now eligible for the Federal Qualified Transportation Fringe Benefit, and can claim up to $230 per month as a business expense for each employee in your vanpool.

Calculations surrounding vanpooling emissions can be found in Appendix A, while a summary of reductions can be found in Table 10 below.

	Emissions Reduction from Baseline (lbs CO_2/year) and % Reduction from Baseline		
Business Size	5% Adoption	25% Adoption	100% Adoption
50 employees	10,904 [4.1%]	54,178 [20.4%]	216,453 [81.3%]
250 employees	54,283 [4.1%]	270,701 [20.4%]	1,082,267 [81.3%]
1,000 employees	216,658 [4.1%]	1,082,428 [20.4%]	4,329.067 [81.3%]

The commuter emissions from a 25 percent adoption of vanpooling initiatives would be approximately 20 percent lower than that of the single occupant vehicle baseline. Emissions reductions could be further improved if 12- to 15-person vans were used in vanpooling programs. However, it was uncertain whether employees would feel comfortable operating such large vehicles or whether proximity of residence would accommodate filling them.

Bicycling

Bicycle commuting not only completely eliminates the carbon emissions related to an employee's work travel, it has the additional benefit of allowing employees to integrate exercise into their workday. Depending on the level of athleticism of employees, and the availability of bike lane and trail infrastructure, employees may choose to cycle to work from as far as 20 miles away. Biking, like walking, is a commuter alternative that results in zero carbon emissions; integrating a bike to work program into office culture is an excellent opportunity to reduce emissions.

Bike to Work: The Route

In order to make your route as safe and enjoyable as possible, don't think like a motorist, think like a cyclist. Use websites such as Google Earth (http://www.google.com/earth/index.html) and Bikely (www.bikely.com) to research a route that avoids major automobile traffic, difficult ascents and harrowing descents. Experiment with your route until you find one that lets you arrive to work relaxed and refreshed.

Positive and Negative Aspects

Generally, bike commuters get exercise and are generally healthier than those using other transit modes. However, setting up an effective cycle

Five Useful Incentives to Promote Bike Commuting

- **Flexible work hours for employees who bike** – leeway of 15-20 minutes on scheduled work time.
- **Fitness Club Memberships** – if you cannot offer on-site shower facilities, make bike-commuting employees members at clubs nearby so they can access showers and change rooms.
- **Bike Commuter "Starter Kits"** – new bike commuters receive a water bottle, tire patch kit, helmet, and reflective bike stickers. Safety first!
- **Subsidized Bike Tune-ups** – at local bike shops for participating employees.
- **Cash Back** – for cyclists who do not use company parking spaces.

Bike to Work: The Bike

Make your bike commute as safe and ergonomic as possible by following these simple tips to outfit your ride:

- **Frame** – any bike frame will be sufficient, however hybrid style bike frames provide a more upright posture and will allow for greater awareness of your surroundings.
- **Tires** – commuters will find that street tires with a dimension of 700x35C (70 cm diameter and 3.5 cm width) will provide excellent stability and reduced friction compared to knobby mountain bike tires.
- **Mirrors** – a good mirror is essential for bike commuting, as it allows you to avoid potential accidents. The most common version mounts to the end of your handlebars.
- **Seat** – a comfortable seat will make your ride much more enjoyable. Seat design is based on personal preference, much like choosing a mattress.
- **Lights** – this is a safety essential for night riding. White headlights will show you where you are going, while a red blinking LED alerts traffic to your presence. By wrapping your bike in reflective tape and wearing a reflective safety vest, you will make yourself even more visible.
- **Bell** – this safety feature helps you to communicate your intentions to slow moving bikes and pedestrians and can be purchased at a bike or hardware store for approximately $5. To communicate with cars invest in an air horn that can be charged using a bike pump.
- **Helmet** – an affordable and essential safety feature, bike helmets are commonly made of Styrofoam and should be replaced after any impact or accident.
- **Cargo** – the best solution for carrying laptops, files, and other work related items on your bike is to invest in a rear rack and panniers. Waterproof versions are available in case you get caught in the rain.

culture can take some investment. In order to adopt a bike to work program, it is important to install infrastructure at the work facility to support employees who bike to work. Aspects of this infrastructure include shower, locker and changing room facilities for both sexes, and a secure bike storage area that is sheltered from the elements. Without these amenities in place to accommodate bike commuters, it is unlikely that the program will be well received (Mintzer, 2008).

Proximity to the workplace is a major consideration when attempting to persuade employees to bike; those who do not live within a reasonable proximity will not adopt this transportation method. In addition, the availability of dedicated bicycle lanes and bike paths on route may be a factor for employees considering bike commuting. This is because there is a stigma surrounding this transit mode that it is dangerous to share the road with rush hour vehicle commuters (Mintzer, 2008).

Incentives

As a part of the Federal Commuter Tax Benefit Program, a Bike Commuter Benefit program came into effect on January 1, 2009. This program allows employers to provide employees who commute primarily by bike a tax-free benefit of up to $20

per month. Employers have the added advantage of being able to defer up to 9.5 percent of their FICA contribution when giving the $20 bike commuter benefit (San Francisco Bicycle Coalition, 2009). In order to further incentivize bike commuting for employees, an employer may consider offering gift cards to dedicated bike commuters. For example, a Washington D.C. company, Toole Design Group, rewards bike commuting employees with a $200 REI, Amazon, or iTunes gift card for every six months that they ride to work (Simon, 2010).

The financial and non-financial benefits of implementing an employee bike commuter program in the workplace are summarized in Table 11.

Financial Benefits	Non-financial Benefits
Employees receive tax-free benefit of $20 per month for bike commuting. Employers can defer up to 9.5 percent of their FICA contribution through this program (San Francisco Bicycle Coalition, 2009).	Reduced emissions of CO_2, NOx, and VOCs associated with employee commuting.
Employees save an average of $400 per month on direct commuting costs such as fuel and vehicle repairs (Commute Solutions, 2004).	Less stressful mode of commuter transportation allows employees to arrive at work happy and productive.
Reduced demand for on-site parking and associate parking maintenance costs.	Bike commuters get exercise and are generally healthier than those using other transit modes.

Carbon Emissions Reductions

The carbon emissions associated with bicycle commuting are zero because commuters are moving under their own physical power, unassisted by fossil fuels. The figures in Table 12 below reflect a 1:1 adoption to emissions reduction ratio; meaning that a 25 percent adoption rate of a bicycle commuter program will result in a 25 percent decrease in commuter emissions.

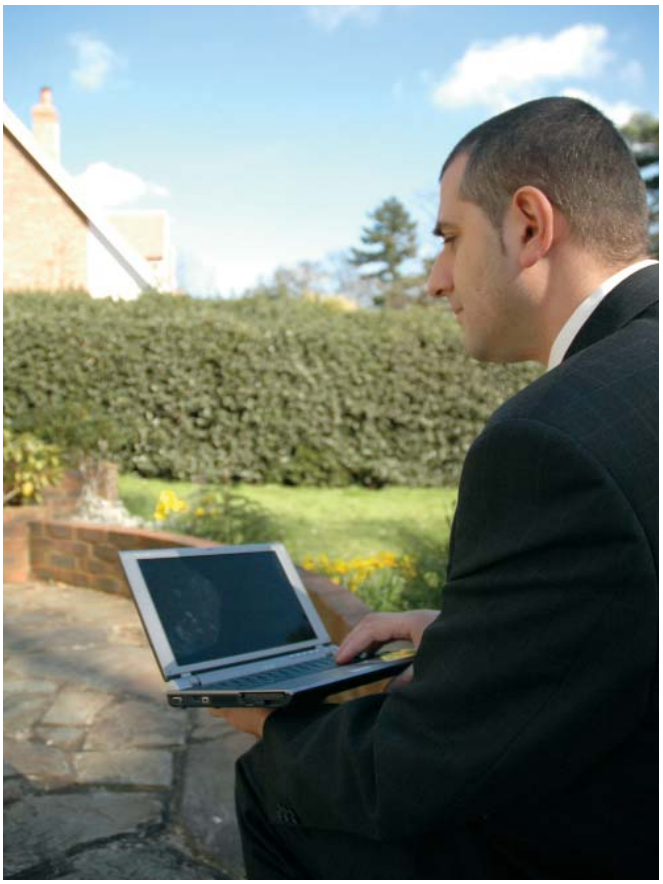
	Emissions Reduction from Baseline (lbs CO_2/year) and % Reduction from Baseline		
Business Size	5% Adoption	25% Adoption	100% Adoption
50 employees	13,386 [5%]	66,586 [25%]	266,086 [100%]
250 employees	66,691 [5%]	332,741 [25%]	1,330,429 [100%]
1,000 employees	266,290 [5%]	1,330,590 [25%]	5,321,715 [100%]

Telecommuting

What is Telecommuting?

AT&T CEO Randall Stephenson said, "Work is an activity, not a place" (The Carbon Disclosure Project, 2010). This statement summarizes the driving force behind telecommuting, also called teleworking. In order to eliminate the carbon emissions associated with an employee's commute, a business can adopt telecommuting. Traditional telecommuting allows employees to work from their home offices through the use of telephone, computer and Internet technologies. By enabling an employee to perform their duties from a remote location, telecommuting eliminates the travel time and carbon footprint associated with commuting for that employee. Considerations must be made for the technology an employee will require to perform their duties from a satellite location, as well as the appropriate occupations that may be performed remotely.

Another method to reduce commuter carbon emissions is the integration of telecenter use



into business operations. This is very similar to telecommuting, but employees perform their daily work at a centralized facility equipped to accommodate the needs of office work. In this situation, employees reduce their commuter related emissions because the telecenter is closer to their home than the company's work facilities. In addition, they are provided with shared tools that they require to perform their duties, including computers, fax machines, copiers, printers and dedicated technical assistance.

Calculating the emissions reduction for telecenters is not as straightforward as calculating the emissions reductions for traditional telecommuting. The primary unknown variable with regard to commuting that affects telecenter calculations is new facility location in relation to employee residences.

Because there is insufficient average data available on telecenters, due to telecenters not being widely adopted, the emissions reductions for telecenters will not be discussed further in this white paper.

Telepresence, a third type of telecommuting, encompasses the use of specialized, dedicated conference rooms within a workplace to substitute face-to-face business meetings that would otherwise require air travel. The carbon emissions associated with air travel are quite significant. With the installation of high-definition television screens, audio equipment, and video recording devices on dedicated internet connections, many of these regular interactions can be accomplished using telepresence. This form of interaction would not substitute initial new client interactions and major business deals, but could rapidly take the place of regular client meetings or interaction with remote branches of a company.

Calculating the emissions reduction for telepresence is more complex than calculating the reduction for traditional telecommuting and telecenters. Telepresence itself may reduce overall organizational emissions based on travel-related emissions, but may have no effect on day-to-day commuter emissions. Because telepresence data is unique to each individual organization and averages cannot be assumed, the emissions reductions for telepresence will not be discussed further in this white paper.

Positive and Negative Aspects of Traditional Telecommuting

Besides the carbon emissions reductions created by traditional telecommuting, there are number of secondary benefits of adopting this work mode both for employers and businesses. Employees who telecommute 50 percent of the time experience

a savings of $2,000 to $6,000 annually in costs associated with transportation to the workplace, including fuel and vehicle maintenance costs (Lubber, 2008) and spend between 100 and 400 fewer hours per year stuck in rush-hour traffic. Many employees (70.5 percent) are willing to reinvest this saved time into work activities, contributing a significant benefit back to the business (Green Business Network, 2005). Other employees spend the excess time with families or attending to personal obligations that traditional commuter schedules would not normally allow.

Having control over more time results in increased morale and translates to more effective work performance. Several studies have shown that telecommuters experience a 20 to 40 percent increase in productivity over their commuting counterparts (Montero, 2009; Green Business Network 2005; Undress For Success: The Telework Research Network, 2009).

Telecommuting offers an additional benefit to employers of allowing for greater business agility. Telecommuting stations can be used by workers to limit unexpected absences due to illness while limiting contact with other employees; this has the benefit of reducing lost revenue due to sick days (U.S. Office of Personnel Management, 2008). Telecommuting also provides an avenue to slow the

Virginia Telework Day

On June 10, 2009 the governor of Virginia Timothy Kaine gave an executive order to 'green' Virginia. This specifically called for reductions in energy consumption and increases in energy efficiency both in government and statewide (Telework Exchange, 2009). As a component of this, a telework day was scheduled and executed on August 3, 2009. The information surrounding opinions, outcomes, and emissions reductions were summarized in a report.

There was widespread participation in Telework Day, with 4,267 employees teleworking – many for their first time. This resulted in a calculated personal savings for Virginians of approximately $113,000. In addition, data collected from participants illustrated a large reduction in carbon emissions – participants avoided driving a total of 155,782 miles, reducing emissions by 82.77 tons (Telework Exchange, 2009). Additional calculations showed that if all interested teleworkers with suitable job types in the state of Virginia were to telecommute one day per week they would collectively save $807,000,000 in commuting costs, reduce vehicle miles by 602,000,000 and reduce vehicular emissions by 360,800 tons (Telework Exchange, 2009).

When participants were asked to share their experiences from Telework Day the majority (69 percent) stated that they were more productive teleworking than they were in a normal day at the office (Telework Exchange, 2009). Many participants had no previous exposure to teleworking, but as a result of Telework Day 91 percent stated that they would likely telework in the future as a result of this experience.

Virginia Governor Tim Kaine said, "Telework is a family-friendly, business-friendly public policy that promotes workplace efficiency, reduces strain on transportation infrastructure, and provides an opportunity to 'green' Virginia."

loss of experience and talent felt as employees retire. By allowing retiring employees to transition slowly, work in reduced schedules, and work from home, they can expertise on an as-needed basis, without the additional stress of commuting and long work hours. This can extend their work lives by two to three years (The American Telecommuting Association, 2008).

Employers may see additional financial savings through a reduced need to rent, maintain, clean, and equip traditional office buildings. Also, employers may find that they no longer need to maintain, provide, or subsidize as much parking space on-site.

Additionally, businesses benefit from the ability to select employees from a much wider talent pool, regardless of geographic location. Having the ability to telecommute instantly from any region of the world means that proximity to work and willingness to relocate are no longer relevant selection criteria for new hires (U.S. Office of Personnel, 2008). Finally, working remotely can allow employees to continue to work during events that would normally cause major work disruptions including terrorist threats, pandemic alerts, or severe weather warnings (Montero, 2009).

However, implementing a telecommuting program isn't without its hurdles. Employers must invest adequate time planning, preparing, and equipping for the transition to telecommuting.

In order to initiate a successful telecommuting program the employer must first identify which employees and jobs are well suited to remote telecommuting. These jobs are typically tasks where information can be accessed from an online database and employees can work well independently with minimal guidance. Positions not well suited to telecommuting are those that require access to physical records or sensitive data that cannot be placed in an online database. Positions requiring frequent team interaction can be performed remotely, but this is generally not advisable due to risk of miscommunication.

By examining the types of tasks performed during a workweek, and the time attributed to each task, many employees have found that approximately 20 percent of their work can be performed from a remote location with ease. This translates to one day per week that each employee could telecommute and work from home. If this is the case company-wide, there is great potential to institute a policy where one work day per week is spent telecommuting.

When instituting a telecommuting program it is important that employees who are selected to work remotely are given all of the necessary tools to perform their tasks from home and remain connected to the workplace. This generally encompasses the installation of a business phone, a high speed Internet connection, and necessary computer equipment. In addition, it is extremely important that employees be given proper training and technical support to perform effectively and feel that they are still a part of the office (Montero, 2009). Depending on the organization, the financial investment may not make telecommuting an attractive option, despite all of the positive benefits.

An additional hurdle to employers is ensuring managers are equipped to maintain a high-level employer-employee relationship in a new telecommuting environment. In order to ensure a strong employer-employee relationship is maintained with telecommuting staff, it is crucial to train staff

Sun Microsystems

The 40,000-person organization, Sun Microsystems, has adopted an extensive telework program in which 56 percent of employees participate. In 2007, this program allowed Sun Microsystems to reduce its carbon emissions by 52,000 metric tons (Sun Microsystems, 2008). The Sun telecommuting program works using software installed both on employees' work and home computers, allowing them to access their work computers remotely from home.

Sun released the findings of its study, *The Open Work Energy Measurement Project* (Sun Microsystems, 2008), which followed 100 employees engaged in the telework program in order to comprehensively track their carbon footprints. A goal of the study was the comparison of energy consumption of the home office and workplace in order to determine whether telecommuters where actually decreasing their overall energy consumption or just shifting the location of its use. This found that home office equipment uses approximately half of the power consumed in conventional offices. Furthermore, more than 98 percent of the carbon footprint of traditional office work is attributed to commuting activities, and office equipment contributes a negligible 1.7 percent of emissions (Sun Microsystems, 2008).

In addition, employees saved approximately $1,700 per year in reduced vehicle maintenance and fuel costs from telecommuting just two days per week. Employees who participated in Sun's telework program saved approximately 2.5 weeks worth of commuting travel time by working from home just two days per week (Sun Microsystems, 2008).

and establish ground rules associated with this new work arrangement. Telecommuting candidates should be selected primarily on a volunteer basis, because people with some personality types may feel that they have been dislocated from the office culture and will not be able to work effectively in their home environment. The opportunity to telecommute can also be treated as an incentive offered to employees with excellent performance. Establishing a strong vision for a telecommuting program and communicating this openly and transparently with employees will help to guarantee its success (Montero, 2009).

The employer must follow a number of ground rules to ensure that telecommuters are happy and efficient. First, employers must respect the business hours established in a telecommuting agreement; just because an employee can now be contacted at all hours via Smartphone and e-mail does not make it okay. Employees can begin to resent constant work pressure from an overzealous supervisor, or may burn out rapidly due to constant blending of work and personal hours (Montero, 2009). Employers must also adhere to a schedule of meetings, feedback and contact with telecommuting staff so that they remain a part of corporate culture and remain productive. Both parties must always remember that telecommuting is a privilege that can be removed from employees who are not performing effectively (Montero, 2009).

Calculating and Tracking Your Commuter Emissions

Your organization will find it useful to calculate the baseline carbon emissions associated with commuter activities. This will help to quantify the challenge you face with respect to reducing commuter emissions. In order to create an accurate picture of your emissions you will need to undergo a carbon footprint analysis, conducted by a sustainability consulting organization, which is tailored specifically to you and integrates employee-specific data. However, to create a rough baseline and track improvements you can use the Carbon Calculator Table below. The values are a result of national averages and assumptions drawn from the calculations performed in each section of the white paper.

Commuter Mode Calculation	Baseline (lbs of CO_2/year)	Initiatives Adopted (lbs of CO_2/year)
Single Occupant Vehicle – multiply the number of employees using this mode by 5322.		
Bus – multiply the number of employees using this mode by 2246.		
Subway/light rail – multiply the number of employees using this mode by 3962.		
Bike – multiply the number of employees using this mode by 0. This mode is carbon neutral.		
Carpool – multiply the number of employees using this mode by 1866.		
Vanpool – multiply the number of employees using this mode by 993.		
Telecommuting – multiply the number of employees using this mode by 0. This mode is carbon neutral.		
TOTAL (sum of column)		

Incentives for Traditional Telecommuting

The U.S. does not currently have a federal tax incentive program for telecommuting. However, the Telework Tax Incentive Act was introduced in the Senate in December 2009. The proposed legislation amends the Internal Revenue Code allowing an employer or employee a tax credit of up to $1,000 per year for telecommuting related expenses, given that the employee telecommutes for a minimum of 75 days per year (OpenCongress, 2010). In addition, a number of states offer incentives for both employers and employees to participate in telecommuting programs. These states include Georgia, California, Illinois, Virginia, Arizona, New York, Washington, Texas, Connecticut, Maryland and New Jersey (SuiteCommute, 2010).

Although state regulations differ, the programs generally offer tax incentives to businesses or employees who telecommute. For example, the State of Virginia offers up to $35,000 in reimbursements and tax incentives, including teleworker computer equipment and peripherals, broadband Internet, and technical consultant services, for companies investing in the initial stages of a telework program. Georgia offers $20,000 worth of incentives for the same items, and the State of Maryland offers a 25 percent tax credit for program start-up costs (SuiteCommute, 2010).

For specific state-by-state incentives, it is recommended that a tax professional be consulted.

The financial and non-financial benefits of implementing an employee telecommuter program in the workplace are summarized in Table 13.

Financial Benefits	Non-financial Benefits
State specific reimbursement programs for start-up costs. These include up to $20,000 in Georgia, and a 25 percent tax credit in Maryland.	Reduced emissions of CO_2, NOx, and VOCs associated with employee commuting.
Employees who telecommute 50 percent of the time save approximately $2000 to $6000 per year on commuter related costs (Lubber, 2008)	Employees who telecommute half of the time save 100 to 400 hours not spent in rush hour traffic (Green Business Network, 2005).
Reduced demand for on-site parking and associate parking maintenance costs.	Greater business agility—fewer work hours lost.
Reduced need for office space, and lower cleaning, electricity, and maintenance costs for an organization (Sun Microsystems, 2008).	Telecommuters are 20-40 percent more productive than conventional office workers (Montero, 2009).

Carbon Emissions Reduction of Traditional Telecommuting

When examining the carbon emissions reduction achieved by traditional telecommuting, it is found that the emissions attributed to commuting are reduced to zero. This is because no vehicle traffic is required to arrive at the workplace. Calculations surrounding telecommuting emissions can be found in Appendix A and are summarized in Table 14.

	Emissions Reduction from Baseline (lbs CO_2/year) and % Reduction from Baseline		
Business Size	5% Adoption	25% Adoption	100% Adoption
50 employees	13,386 [5%]	66,586 [25%]	266,086 [100%]
250 employees	66,691 [5%]	332,741 [25%]	1,330,429 [100%]
1,000 employees	266,290 [5%]	1,330,590 [25%]	5,321,715 [100%]

When the difference in energy consumption between office and home work is accounted for, it is found that telecommuting even further reduces emissions. A summary provided by Sun Microsystems as a part of their *Open Work Energy Project* (Sun Microsystems, 2009), shows that the average power consumption of a home office is 65 watts per person per hour, while consumption in the workplace is 135 watts per person per hour.

Top Five Tools for Teleworking

Task:	Security – Hardware Firewall
Description:	The primary line of defense against network attacks. Security is an important aspect of telework. Requires purchase of router.
Sample tool:	Linksys routers (http://home.cisco.com/en-us/wireless/linksys/)
Task:	Security – Software Firewall
Description:	Monitors programs that are operating and creates a second line of defense for your system. Requires annual license fee.
Sample tool:	Norton Security (http://us.norton.com/360)
Task:	Web Conferencing
Description:	An interactive web conferencing program allowing up to 15 participants to share their screens and conduct meetings. Features include speech, highlighting options, and the ability to share mouse and keyboard control. This creates an effective meeting experience.
Sample tool:	GoToMeeting (http://www.gotomeeting.com/fec/online_meeting)
Task:	Document Sharing/Collaboration
Description:	In order for teams to work on a single project in collaboration they may require simultaneous access to the most updated version of a document from remote locations.
Sample tool:	GoogleDocs (http://docs.google.com/demo/edit?id=scACJ95oeiO6_Ab0JtChXLUqJ&dt=document&pli=1#document)
Task:	Instant Messaging and VOIP
Description:	To create an environment of constant communication, take advantage of instant messaging, voice chat, and video chat programs.
Sample tool:	Skype (http://www.skype.com/intl/en-us/home)

Conclusion

There are many options available for reducing the significant carbon emissions attributed to commuter activities. These range from basic modal choices such as subway/light rail and bus transportation, which produce significantly less carbon emissions per passenger mile than conventional transportation, to more drastic lifestyle changes such as biking to work—a carbon neutral transportation mode.

Businesses outside of metropolitan areas where public transportation is not widely available or practical may choose to implement carpooling and vanpooling programs. While carpooling and vanpooling programs are slightly more difficult, time consuming, and expensive than other commuter options to implement, they are very effective at reducing carbon emissions. Also, the start-up and operating costs of these programs can be heavily offset by taking advantage of federal tax incentives.

Telecommuting represents a lucrative opportunity to eliminate most of a business' commuter carbon by allowing employees to work remotely. In addition, a number of secondary benefits such as increased productivity and employee morale have been attributed to telecommuting.

By observing the figure presented below it can be seen that the most effective methods for reducing carbon emissions, regardless of percent adoption, are telecommuting and bike commuting. The least effective methods of carbon reduction that have been investigated are bus and subway transit. Regardless of method, it is important to note that all alternative transportation modes represent significant opportunities to reduce emissions below baseline.

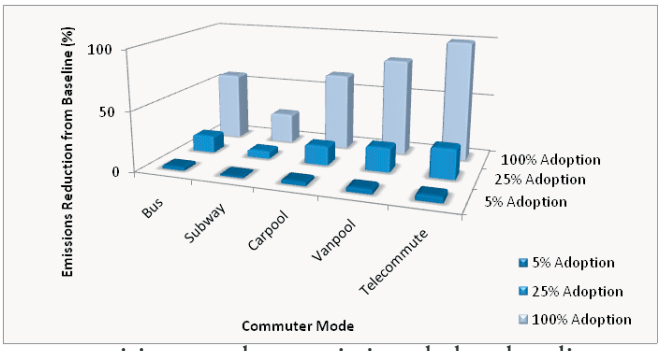


Figure 1. A comparison of the emissions reductions from baseline of three different levels of adoption (5 percent, 25 percent, 100 percent) of a variety of commuter modes.

By outlining the benefits and costs of each initiative, detailing the available incentives, and illustrating potential carbon emissions reductions, this white paper provides an overview of the most common and impactful ways organizations can reduce commuter carbon emissions. It is important to note that telecenters, telepresence, ferry travel, commuter train travel, and other modes of commuter transport were not addressed in this white paper. To get a specific and detailed picture of an organization's carbon footprint, it is recommended that a professional consultant be hired to do a complete carbon footprint analysis.

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Appendix A: Detailed Carbon Emissions Reduction Calculations

Single Occupancy Vehicle Baseline

Assumptions

assuming all employees travel by single occupancy vehicle			
Days worked/year	250		
Miles travelled	30		
Pounds CO2/Passenger mile	0.709562		
Employees	50	250	1,000
Total emission baseline(LBs CO2/day)	1064.343	5321.715	21286.86
Total emission baseline (LBs CO2/year)	266085.75	1330428.75	5321715

Bus Transit Emissions Calculations

Assumptions

Work Days/year	250		
Miles travelled	30		
Fuel ef ciency (mpg)	3.2		
CO2 emitted (lbs/passenger mile)	0.2994		
Employees	50	250	1,000
Employee Participation (fraction of 1)	**0.05**	**0.25**	**1**
Result - 50 employee business			
Emissions (Lbs CO2/day)	1033.255	910.275	449.1
Emissions (Lbs CO2/year)	258313.75	227568.75	112275
Savings over baseline (Lbs CO2/year)	7772	38517	153810.75
Percent reduction from baseline	2.920862917	14.47540877	57.80495573
Result - 250 employee business			
Emissions (Lbs CO2/day)	5167.225	4552.125	2245.5
Emissions (Lbs CO2/year)	1291806.25	1138031.25	561375
Savings over baseline (Lbs CO2/year)	38622.5	192397.5	769053.75
Percent reduction from baseline	2.903011529	14.46131557	57.80495573
Result - 1,000 employee business			
Emissions (Lbs CO2/day)	20670.8	18210	8982
Emissions (Lbs CO2/year)	5167700	4552500	2245500
Savings over baseline (Lbs CO2/year)	154015	769215	3076215
Percent reduction from baseline	2.894085835	14.45426897	57.80495573

Subway/Light rail Transit Emissions Calculations

Assumptions			
Work Days/year	250		
Miles travelled	30		
CO2 emitted (lbs/passenger mile)	0.5282		
Employees	50	250	1,000
Employee Participation (fraction of 1)	**0.05**	**0.25**	**1**
Result - 50 employee business			
Emissions (Lbs CO2/day)	1050.415	996.075	792.3
Emissions (Lbs CO2/year)	262603.75	249018.75	198075
Savings over baseline (Lbs CO2/year)	3482	17067	68010.75
Percent reduction from baseline	1.308600705	6.414097711	25.55971148
Result - 250 employee business			
Emissions (Lbs CO2/day)	5253.025	4981.125	3961.5
Emissions (Lbs CO2/year)	1313256.25	1245281.25	990375
Savings over baseline (Lbs CO2/year)	17172.5	85147.5	340053.75
Percent reduction from baseline	1.290749317	6.40000451	25.55971148
Result - 1,000 employee business			
Emissions (Lbs CO2/day)	21014	19926	15846
Emissions (Lbs CO2/year)	5253500	4981500	3961500
Savings over baseline (Lbs CO2/year)	68215	340215	1360215
Percent reduction from baseline	1.281823623	6.392957909	25.55971148

Carpooling Emissions Calculations

Assumptions			
Days worked/year	250		
Miles travelled	30		
Fuel ef ciency (mpg)	19.49		
Pounds CO2 emitted/Gallon	19.4		
Lbs CO2 emitted/Gallon/person	4.85		
Employees	50	250	1,000
Employee Participation (fraction of 1)	**0.05**	**0.25**	**1**
Result - 50 employee business			
Emissions (Lbs CO2/day)	1029.463417	891.3170857	373.2683427
Emissions (Lbs CO2/year)	257365.8543	222829.2714	93317.08568
Savings over baseline (Lbs CO2/year)	8719.895716	43256.47858	172768.6643
Percent reduction from baseline	3.277099851	16.25659344	64.9296944
Result - 250 employee business			
Emissions (Lbs CO2/day)	5148.267086	4457.335428	1866.341714
Emissions (Lbs CO2/year)	1287066.771	1114333.857	466585.4284
Savings over baseline (Lbs CO2/year)	43361.97858	216094.8929	863843.3216
Percent reduction from baseline	3.259248462	16.24250024	64.9296944
Result - 1,000 employee business			
Emissions (Lbs CO2/day)	20594.96834	17830.84171	7465.366855
Emissions (Lbs CO2/year)	5148742.086	4457710.428	1866341.714
Savings over baseline (Lbs CO2/year)	172972.9143	864004.5716	3455373.286
Percent reduction from baseline	3.250322768	16.23545364	64.9296944

Vanpooling Emissions Calculations

Assumptions			
Days worked/year	250		
Miles travelled	30		
Fuel ef ciency (mpg)	18.3222		
Pounds CO2 emitted/Gallon	19.4		
Lbs CO2 emitted/Gallon/person	2.425		
Employees	50	250	1,000
Employee Participation (fraction of 1)	**0.05**	**0.25**	**1**
Result - 50 employee business			
Emissions (Lbs CO2/day)	1020.726483	847.6324131	198.5296526
Emissions (Lbs CO2/year)	255181.6207	211908.1033	49632.41314
Savings over baseline (Lbs CO2/year)	10904.12934	54177.64672	216453.3369
Percent reduction from baseline	4.097975688	20.36097262	81.34721114
Result - 250 employee business			
Emissions (Lbs CO2/day)	5104.582413	4238.912066	992.6482628
Emissions (Lbs CO2/year)	1276145.603	1059728.016	248162.0657
Savings over baseline (Lbs CO2/year)	54283.14672	270700.7336	1082266.684
Percent reduction from baseline	4.080124299	20.34687942	81.34721114
Result - 1,000 employee business			
Emissions (Lbs CO2/day)	20420.22965	16957.14826	3970.593051
Emissions (Lbs CO2/year)	5105057.413	4239287.066	992648.2628
Savings over baseline (Lbs CO2/year)	216657.5869	1082427.934	4329066.737
Percent reduction from baseline	4.071198605	20.33983282	81.34721114
Adjusting Fuel Economy			
EPA Value mpg (city/highway)	15/17		
Assumed city/highway mix	67%/33%		
Combined, unadjusted economy	15.66		
Adjusted for real world conditions	18.3222		

Telecommuting Emissions Calculations

Assumptions			
Miles travelled	0		
Fuel ef ciency (mpg)	0		
CO2 emitted/Gallon	0		
Travel time	0		
Capital Cost			
Energy Use/day			
Employees	50	250	1,000
Percentage of Participation	5	25	100
Result - 50 employee business			
Emissions (Lbs CO2/day)	1010.8	798	0
Emissions (Lbs CO2/year)	252700	199500	0
Savings over baseline (Lbs CO2/year)	13385.75	66585.75	266085.75
Percent reduction from baseline	5.030615131	25.02416984	100
Result - 250 employee business			
Emissions (Lbs CO2/day)	5054.95	3990.75	0
Emissions (Lbs CO2/year)	1263737.5	997687.5	0
Savings over baseline (Lbs CO2/year)	66691.25	332741.25	1330428.75
Percent reduction from baseline	5.012763743	25.01007664	100
Result - 1,000 employee business			
Emissions (Lbs CO2/day)	20221.7	15964.5	0
Emissions (Lbs CO2/year)	5055425	3991125	0
Savings over baseline (Lbs CO2/year)	266290	1330590	5321715
Percent reduction from baseline	5.003838048	25.00303004	100