Getting There Greener

The Guide to Your Lower-Carbon Vacation

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

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Union of Concerned Scientists

December 2008

The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.

The UCS Clean Vehicles Program develops and promotes strategies to reduce the adverse environmental impact of the U.S. transportation system.

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UCS Publications
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Design: Catalano Design

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Contributors & Acknowledgments

This report was made possible through the generous support of Foundation M, Oak Foundation, The Energy Foundation, The Pew Charitable Trusts, The William and Flora Hewlett Foundation, and Wallace Global Fund, with additional support from NoraLee and Jon Sedmak.

Scott Nathanson, Rich Hayes, and Jim Kliesch of the Union of Concerned Scientists (UCS) were instrumental in the conception and production of this report. Deborah Gordon, an independent transportation policy consultant, developed the initial draft, along with the core methodology used to compare fuel cycle carbon emissions from different vacation travel modes. UCS staff members David Friedman, Michelle Robinson, Patricia Monahan, and Don Anair provided additional review and suggestions.

The authors would like to thank Sandra Hackman for her efforts and skill in editing under a tight timeline, and Rob Catalano for his design and layout talents.

We would also like to thank several experts for reviewing specific topics and chapters and providing valuable input. John Davies of the U.S. Environmental Protection Agency commented on the methodology. John Putnam of Kaplan Kirsch & Rockwell, who chairs the Subcommittee on Aviation and Climate Change at the National Academies Transportation Research Board, and Anja Kollmuss, of the Stockholm Environment Institute, reviewed the chapter on air travel. Ross Capon and Matthew Melzer, National Association of Railroad Passengers, and Scott Leonard and Roy Deitchman, Amtrak, reviewed the chapter on rail travel. Dana Lowell of M.J. Bradley & Associates reviewed the information on intercity motor coaches. Stuart Cohen of TransForm (formerly the Transportation and Land Use Coalition) provided helpful guidance on the accounting of motor coach and rail emissions.

The opinions in this report do not reflect those of the individuals who reviewed and commented on it. UCS alone is responsible for the content.

EXECUTIVE SUMMARY

While the idea of "green" vacations has attracted recent attention, most information focuses on what to do when you get to your destination, not on how to get there. No definitive source has been available to guide travelers toward the greenest travel option—trains, planes, automobiles, or motor coach (a.k.a. buses)—for their particular vacation.

This report turns an analytical eye toward the environmental impact of domestic vacation travel, where global warming pollution—largely in the form of carbon dioxide (CO_2) emissions—can add up quickly. The results of our analysis may surprise you.

One Vacation Can Be Worse Than Commuting for a Year

Meet the Elsens, our eco-conscious family of four from the suburbs of Chicago. They've been trying to minimize their impact on the environment, especially when it comes to their commute. Dad drives a Chevy Malibu for his 10-mile round-trip travel to and from work. Mom recently switched from a Ford Explorer to a more efficient Ford Escape for her daily 25 miles of travel, which includes driving round-trip to work and carpooling the kids to and from after-school activities.

This year, with the holidays coming up, the Elsens decided to pull out all the stops for their first trip to Disney World and use frequent flyer miles to travel first-class. The available flight includes a layover in Houston, but the family figured that deluxe seats were worth the extra time. However, take a look at the resulting carbon footprint (see the figure to the right).

Yes, you're reading that right—the Elsens' one vacation splurge produces more than one and a half times the global warming pollution created by their *whole year* of weekday commuting. These stats are a sobering reminder that our carbon footprint is not merely a product of our daily habits, but of our vacation habits as well.

Fortunately, a number of travel options are greener than those the Elsens selected. This new guide gives Americans the tools they need to make sure they're *getting there greener*.

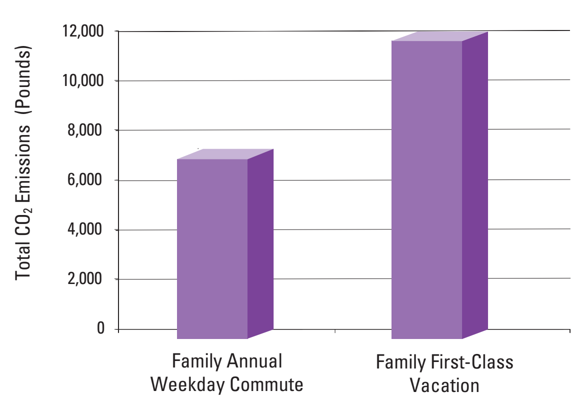
Your Guide to a Greener Vacation

How are you traveling? Where are you going? Who's tagging along?

This report provides the first comprehensive analysis—peer-reviewed by experts—of the highest-carbon and lowest-carbon options for vacation travel. In our matrix, three key factors determine the environmental impact of your travel: (1) the type of vehicle you are taking; (2) the distance you are traveling; and (3) the number of people traveling with you. Based on these factors, our analysis can tell you how environmentally sound—or perhaps unsound—your travel plans are.

Of course, Americans' travel is not a matter of absolutes, as different regions have access to different transportation options. As you plan your journey, the table on the next page can help you evaluate each option for solo, couple, or family travel. What you find might surprise you, as your best travel bet can shift significantly depending on the distance you travel and the size of your party.

Elsen Family Commute vs. First-Class Vacation



Notes: This comparison assumes that the Elsens' Chevy Malibu gets 25 miles per gallon, their two-wheel-drive Ford Escape gets 23 mpg, and the family takes four first-class round-trip flights from Chicago to Orlando via Houston. Weekday commuting represents 35 percent of the Elsens' average annual automobile travel. See Appendices B and C for emission factors of air and automobile travel used in this analysis.

Vacation Traveler Carbon Guide

For each grouping, travel options are listed from best to worst. Steer toward the greenest and try to avoid those in red!

Best Travel Options: Solo Traveler

	100 miles	500 miles	1,000+ miles
Best	Take motor coach	Take motor coach	Take motor coach
	Take train	Take train	Fly economy
	Fly economy	Fly economy	Take train
	Drive typical car	Drive typical car	Fly first-class
	Drive typical SUV	Fly first-class	Drive typical car
Worst	Fly first-class	Drive typical SUV	Drive typical SUV

Best Travel Options: Two Travelers

	100 miles	500 miles	1,000+ miles
Best	Take motor coach	Take motor coach	Take motor coach
	Take train	Take train	Fly economy
	Drive typical car	Drive typical car	Take train
	Drive typical SUV	Fly economy	Drive typical car
	Fly economy	Drive typical SUV	Drive typical SUV
Worst	Fly first-class	Fly first-class	Fly first-class

Best Travel Options: Family of Four

	100 miles	500 miles	1,000+ miles
Best	Take motor coach	Take motor coach	Take motor coach
	Drive typical car	Drive typical car	Drive typical car
	Drive typical SUV	Drive typical SUV	Drive typical SUV
	Take train	Take train	Fly economy
	Fly economy	Fly economy	Take train
Worst	Fly first-class	Fly first-class	Fly first-class

Notes: We based the color-coded ranking on the distribution of CO_2 emissions across modes. The analysis assumes typical car and typical SUV fuel economies of 23 mpg and 18 mpg, respectively. Train emissions reflect an average of electric and diesel operations. The analysis assumes use of turboprops for 100-mile flights, regional jets for 500-mile flights, and narrow-body jets for 1,000-mile flights, based on information from the Federal Aviation Administration. We assumed that all flights are nonstop. For more on the emission factors for each mode, see Appendices B, C, D, and E. To compare emissions across modes, see Appendix F.

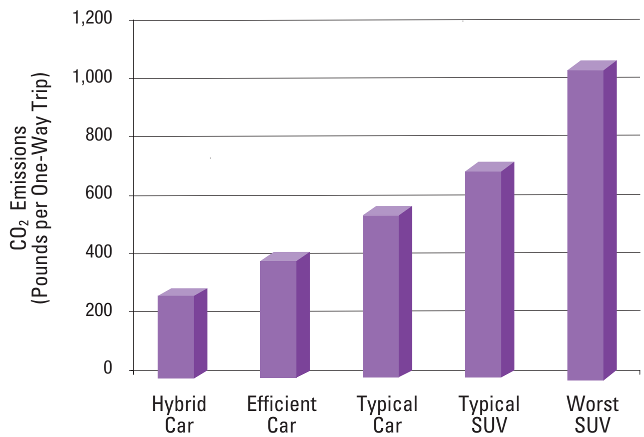
Top Five Rules of Thumb for Green Travel

The table to the left gives travelers an easy way to compare travel options to fit their needs. However, our *Getting There Greener* analysis also enabled us to create "rules of thumb" to help guide your initial travel choices, and to help you shrink your carbon footprint once you have made those choices. Let's start with the top travel tips, and then look more closely at each travel mode:

- **Motor coaches and trains are a carbon bargain.** Whether traveling with a family, with a partner, or alone, those seeking a carbon bargain should seriously consider rail and motor coach travel. Intercity bus options have been on the upswing, as numerous regional carriers now provide coaches with very comfortable seats. And Amtrak offers everything from high-speed rail service in the Northeast to "auto trains" that enable long-distance travel without the wear and tear on your automobile. From a carbon perspective, motor coaches and trains are among your lowest-emission options, especially on shorter (less than 500-mile) trips. Moreover, because motor coaches and trains are often underused, they may offer what amounts to a carbon "free ride."
- **Big SUVs and first-class flights usually have the largest carbon footprints.** Driving alone, driving inefficient SUVs (with or without other people), and flying first-class are the most polluting ways to go. To reduce your vacation's carbon footprint, consider other options.
- **For couples and solo travelers, a nonstop coach flight almost always beats an average car.** Carbon from cars and trucks adds up, especially when those vehicles travel long distances and are only partially occupied. If you're traveling alone or with one other person, you're usually better off flying direct in coach than getting behind the wheel of a passenger vehicle. This is especially true for trips of more than 500 miles.
- **To significantly reduce your carbon footprint behind the wheel, drive or rent a more efficient car.** If you don't own a fuel-efficient vehicle, think about renting one when driving on longer trips. The carbon emissions from a large, inefficient SUV are nearly *four times* those of a high-miles-per-gallon hybrid such as the Toyota Prius. If hybrids are not available, look into efficient conventional cars, which can ease the environmental harm while cutting your gasoline bill. Many car rental agencies now offer both hybrids and efficient conventional vehicles. Take advantage of them, and take some wear and tear off your car.

Carbon Emissions Depend on the Auto You Drive

Couple Traveling 500 Miles



Notes: Assumes a 46-mpg hybrid car, 32-mpg efficient car, 23-mpg typical car, 18-mpg typical SUV, and 12-mpg worst SUV. See Appendix C for details on automobile emission factors.

- **Avoid traveling during peak periods.** Congestion has a noticeable effect on your fuel consumption and carbon footprint. When a car or SUV is stuck in traffic, its fuel consumption rate can be double the rate it gets at steady cruising speeds. So think about getting a GPS unit for your car that can alert you to traffic hot spots in real time and suggest ways to avoid them. (Some sell for as little as $150.) And think about changing your vacation schedule to avoid peak travel periods that keep you stuck in traffic.

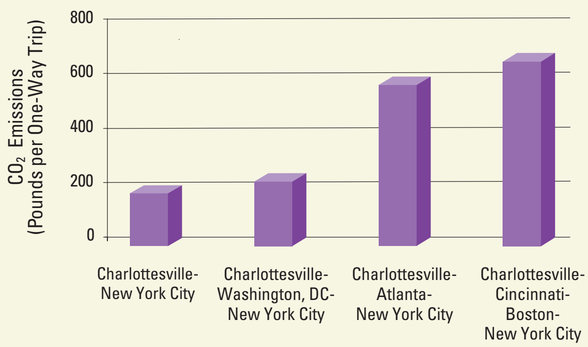
Now that you've decided whether to fly, drive, or take a train or motor coach, consider the following additional rules of thumb from our analysis of each travel mode, to shave your emissions even further.

Vacation Carbon Tips: Air Travel

- **Class matters—save money and save carbon.** When choosing seats, avoid first class. Because a first-class seat takes twice as much space as an economy seat, a first-class traveler on domestic flights is responsible for twice as much carbon as someone flying coach.[1]
- **Don't stop.** Choose nonstop flights over connecting flights, especially for shorter trips. Because takeoff, landing, and ground operations produce a lot of carbon, a 1,000-mile nonstop flight from New York City to Orlando can save nearly 35 percent compared with a two-connection flight down the eastern seaboard.
- **If you must stop, fly straight.** Travel websites and agents can show you exactly how many miles your flight will cover. If you can't get a nonstop flight, fly the most direct route possible to save carbon.
- **More seats = less carbon.** Make the market work. Choose airlines with all-economy seating when possible, as they have smaller per-passenger carbon footprints.

Carbon Emissions Depend on the Route You Take

Flying from Charlottesville, VA, to New York City



Note: This analysis is based on actual routes and the type of aircraft used on each, whether turboprop, regional jet, or narrow-body jet.

Vacation Carbon Tips: Automobile Travel

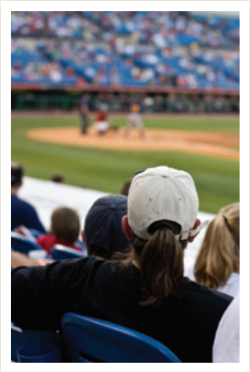
- **Solo and couples vacationing?** Keep it in the garage. Single travelers driving a typical car leave a large per-passenger footprint, while couples fare only a little better. Unless you're driving a vehicle that gets more than 45 mpg, look for other options, such as the bus, train, or even plane (economy seating, of course).
- **Keep the family road-trip tradition alive.** If you're planning on bringing the grandparents or the kids along for the ride, your per-person carbon footprint shrinks accordingly. This makes cars—especially efficient cars—a low-carbon option for larger groups traveling together.
- **Be car smart.** How you pack, how you drive, and how you maintain your vehicle can save significant carbon and cash.
- **Congestion guzzles excess gas.** Select travel times carefully and consider routes that allow you to avoid getting stuck in rush-hour traffic—especially if your trip takes you through congested areas.

Vacation Carbon Tips: Rail Travel

- **Ride the rails in the Northeast to cut carbon and congestion.** The Northeast Corridor is Amtrak's most highly developed segment, so you have more options, including high-speed Acela express trains between Washington, DC, and Boston. Because they run on electricity, Northeast Corridor trains are the cleanest rail option.
- **Even outside the Northeast, an Amtrak station might be closer than you think.** Check out your rail options even if you don't live near a train station. Amtrak's ThruWay bus service connects most cities to rail stations.
- **No rental required when training.** Unlike most airports, train stations are often right in city centers, so you don't have to hail a taxi or rent a car to get downtown, saving pollution as well as time. Amtrak also offers an "auto train" option that allows passengers to ride the train while bringing their cars along for the ride.

Take Me Out to the Ballgame

Here is one example of a chance to cut carbon emissions by taking the train. Vacationers traveling to Major League Baseball stadiums will find that many are located near train stations:



Ballpark (City)	Miles from airport	Miles from train station
Coors Field (Denver)	25.0	0.4
Dodger Stadium (Los Angeles)	20.0	1.8
Minute Maid Park (Houston)	18.6	1.1
Busch Stadium (St. Louis)	14.9	0.8
Camden Yards (Baltimore)	9.7	2.5

Vacation Carbon Tips: Motor Coach Travel

- **Motor coaches leave carbon in the dust.** A couple boarding a motor coach will cut their carbon nearly in half, compared with driving even a hybrid car. And if they take the motor coach rather than flying, they will cut their emissions by 55 to 75 percent, depending on the distance they travel.
- **Group tours = low carbon.** Interstate tour-bus travel has seen a major expansion over the past decade. So think about that group trip in a new, green way.
- **Not your daddy's Greyhound.** Today many companies have ditched their older buses and offer plush new coaches with everything from seat-back video to satellite radio to wireless Internet connections.
- **Search and ye shall find.** You can jump-start your low-carbon vacation with an Internet search. Bus travel—unlike air and rail travel—does not have a centralized reservations website (such as Orbitz, Expedia, Travelocity, or *amtrak.com*), but here are a few addresses to you get started: *www.gotobus.com*, *www.greyhound.com*, *www.peterpanbus.com*, *www.trailways.com/schedules.asp*. Happy trails!

Where you decide to go and how you get there is entirely up to you. It's your vacation. But prepped with rules of thumb and information about the carbon footprint of your travel options, perhaps next time you will choose to *get there greener*!

How We Created *Getting There Greener*

This analysis is based on energy consumption, ridership (passenger-miles), and carbon dioxide emissions data associated with each mode of travel. We used that information to compute average "in-use" carbon emissions for each mode, in pounds of CO_2 emitted per passenger-mile traveled. We then added upstream CO_2 emissions—those associated with extracting, refining, and transporting a given fuel—to yield total carbon dioxide emissions in pounds per passenger-mile. We estimated the amount of emissions accrued per trip by multiplying the resulting emission factors for each mode by distance traveled.

CHAPTER 1

RULES OF THE ROAD FOR A GREENER VACATION

Today's American Vacation Can Mean Big Carbon

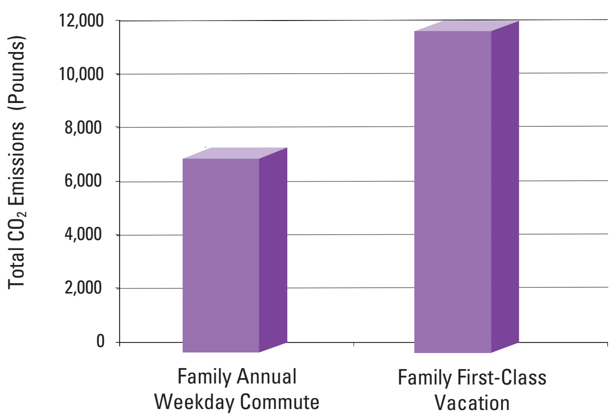
Meet the Elsen family—our amalgam of a typical American family. Greg and Ann Elsen, daughter Sarah, and son Joey live in the suburbs of Chicago, and have recently taken steps to reduce their carbon footprint and save money at the gas pump. Greg, for example, leaves his sports car in the garage and drives a Chevy Malibu on his 10-mile round-trip commute to work. Sarah, meanwhile, just traded in their old Ford Explorer for a more fuel-efficient Ford Escape, and is now getting about 23 miles per gallon for her 25 miles of daily work and errand travel.

Now Greg and Ann face another decision: how to travel on their vacation to Disney World during Sarah's upcoming spring break. Despite the expense of flying, they have saved enough credit card points to afford first-class seats for the entire family, and an upgrade on a rental car. But to fly free from Chicago to Orlando, they have to take a connecting flight through a hub city—either Houston or Cleveland. Finding the comfort (and novelty) of first class too good to pass up, the Elsens go for it, and decide to fly to Orlando through Houston.

What the Elsens don't realize is that global warming emissions from one vacation without a plan to get there greener can greatly exceed emissions produced during a year of weekday commuting. It turns out that the emissions from flying first-class and making a significantly out-of-the-way stopover really add up (Figure 1).

The Elsens' story is being retold by millions of Americans every year. Vacations account for more than half the trips of 100 miles or more that Americans make each year.[2] U.S. residents take almost 650 million trips of 50 miles or more every summer.[3] In 2006, some 124 million Americans took a vacation, traveling an average of 1,200 miles.[4]

Figure 1. Elsen Family Commute vs. First-Class Vacation



Note: The comparison assumes that the Elsens' Chevy Malibu gets 25 miles per gallon, their two-wheel-drive Ford Escape gets 23 mpg, and the family takes four first-class round-trip flights from Chicago to Orlando via Houston. Weekday commuting represents 35 percent of the Elsens' average annual automobile travel.

The family car is still the king of American vacation travel, with 82 percent of us hopping in a sedan, wagon, minivan, or sport utility vehicle (SUV) to get away, though generally at least one vacation trip per year is made by plane.[5] Conversely, travel on motor coaches (tour buses, intercity buses) and trains account for only 3 percent of all U.S. vacation travel.[6]

But these trends are not set in stone. Indeed, as the effects of climate change increasingly affect the way we live and travel, making carbon count as part of a vacation plan could, and should, spur Americans to rethink the way they travel.

This report turns an analytical eye toward this enormous transportation challenge, with the goal of helping consumers evaluate the carbon footprint of their vacation travel. Of course, we recognize that people also care about the cost, speed, and flexibility of their trips. With that in mind, this report gives Americans a new analytical tool for identifying greener ways to travel to their favorite vacation spots—in a way that makes sense for them.

We have mined information on energy consumption, ridership, and carbon dioxide emissions from government and other key sources to calculate carbon emissions from auto, train, bus, and airplane travel.

Travel Trends

The way we travel on vacation greatly affects our carbon footprint. According to recent figures, Americans take most vacations with their partner (62 percent), and the most popular destination is a big city (39 percent).[8]

As one might expect, we Americans tend to be weekend travelers. We favor Saturday or Sunday departures for trips of fewer than 500 miles, and Friday departures for trips of 500 to 1,000 miles. But these departure times—which vacationers can usually control—affect our carbon footprint, because we often hit traffic, especially on summer weekends. Given that more than half a billion days of vacation go unused in America every year,[9] U.S. vacationers could really get a win-win simply by extending their vacation so they can travel on less-congested days. (See Chapter 3 for more on the effect of congestion on carbon footprints.)

While travel mode and time affect our vacation carbon footprint, so does the distance we're traveling. Air travel has helped create a "smaller" America by expanding our vacation options. As vacation distances grow, travelers shift away from their autos: about two of three vacation travelers fly or use other modes for vacation distances of 1,000 to 1,500 miles (one-way). And fewer than 16 percent of us drive to our destinations when we take vacations of more than 1,500 miles.[10]

We have also analyzed how the number of people traveling together affects their carbon footprint. Combine that with figures on trip distance, and you have the first tool that can give you your best transportation option, depending on where you are, where you're going, and how many people are going with you.[7]

Time to Think Green

With this report, Americans can now begin to truly factor carbon into their vacation planning choices, no matter who is going with them and where they're headed. Let's take another look at the Elsens, and two other examples, to see how these choices might work in action.

Flying greener

The Elsens have discovered that flying first-class to Orlando through Houston would create a huge carbon footprint, so they have decided to revise their trip in two ways: they will fly coach and find a nonstop flight. Their new direct coach flight will cut their carbon emissions roughly 70 percent compared with their original flight plans. The Elsens have also decided to shave a little more carbon off their trip by using their upgrade to rent a 45-mpg Prius instead of a 19-mpg minivan. The result: a far cleaner vacation (Figure 2).

Motoring greener

Rita and Louie, who live in Santa Ana, CA, want to celebrate their fortieth wedding anniversary in Las Vegas this January. Instead of taking their Dodge Ram pickup, they've decided to travel in a luxury motor coach. The coach, which departs from nearby Anaheim and will drop them off on the Strip, will cost less than the drive, while cutting their carbon emissions from 460 pounds to just 90 pounds—a reduction of more than 80 percent.

All aboard greener

Harry wants to escape the Big Apple on the first day of spring for a little fly-fishing in Maine. He has decided to ditch the SUV rental this year and go by train. He will cut his carbon emissions 70 percent by making the switch. And Harry just found out he can save time, too, if he takes the higher-speed Acela electric train to Boston, and then continues on Amtrak's diesel-powered commuter rail to Portland.

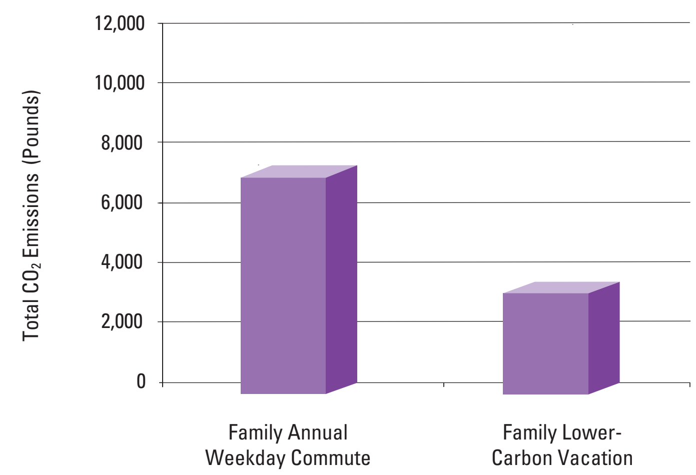
Curbing Global Warming

The U.S. transportation sector alone is responsible for some 40 percent[11] of our nation's fossil-fuel-related carbon dioxide (CO_2) emissions—the primary heat-trapping gas responsible for global warming. When released into the air, global warming pollution acts like a blanket, trapping heat in our atmosphere and altering weather patterns globally as well as here in the United States.[12] Global warming is well under way, and will have a wide range of consequences for our health and well-being.

Simply put, we need to significantly reduce these heat-trapping emissions to avoid the most harmful effects of global warming.

This report analyzes each travel mode—planes, trains, automobiles, and motor coaches—and offers rules of thumb on green vacation travel. The next four chapters take an in-depth look at your travel options and illustrate several opportunities for cutting carbon. As you will see, a little planning can go a long way when it comes to shrinking your vacation carbon footprint.

Figure 2. Elsen Family Commute vs. Lower-Carbon Vacation



Notes: The comparison assumes 250 days of weekday commuting in a Chevy Malibu getting 25 miles per gallon traveling 10 miles per day, and a two-wheel-drive Ford Escape getting 23 mpg traveling 25 miles per day. The family vacation includes four economy-class round-trip direct flights from Chicago to Orlando. Weekday commuting represents about one-third of the family's total annual automobile travel.

CHAPTER 2

AIR TRAVEL

U.S. air travel has doubled over the past two decades.[13] By 2015, the number of passengers carried by U.S. commercial airlines will likely hit the 1 billion mark.[14] This rise in air travel will continue to drive up U.S. carbon emissions, because planes leave a large carbon footprint owing to their enormous weight and the long distances they fly. Wide-body jets, for example, can emit 100 pounds of CO_2 for every mile they travel; a single cross-country flight can create 150 tons of global warming pollution.

On a more positive note, today's aircraft—wide-body and narrow-body jets, regional jets, and turboprop airplanes—travel relatively full, thereby reducing their per-passenger carbon emissions. In 2007, 80 percent of all seats were occupied.[15] Because of these high occupancy levels, a given seat is unlikely to go empty: if you don't take it, someone else probably will, or the airline will fill at least some of the void by adding commercial cargo.[16]

Still, your in-flight carbon footprint can vary widely, depending on a number of factors. With a little bit of forethought and a closer look at the information you have when you book your flight, you can shrink the emissions from your trip—and help convince the air travel industry to focus its resources on lower-carbon options.

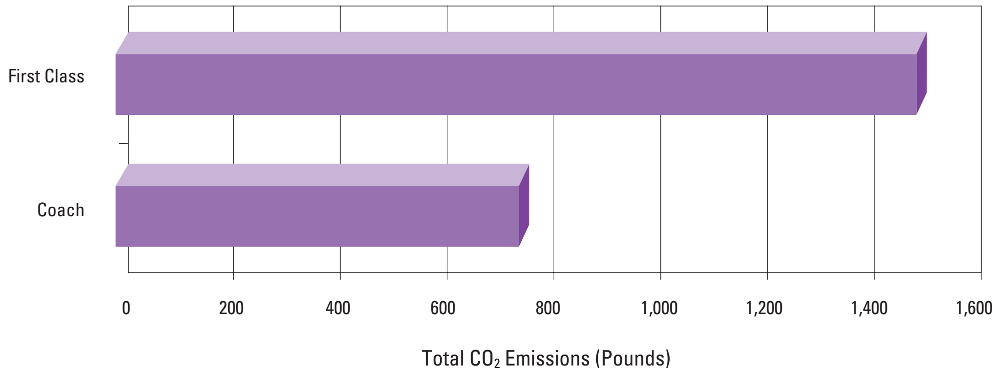
Based on our research, the top green travel tips for air travel are listed below.

Vacation Carbon Tips: Air Travel

- **Class matters—save money and save carbon.** When choosing seats, avoid first class. Because a first-class seat takes twice as much space as an economy seat, a first-class traveler on domestic flights is responsible for twice as much carbon as someone flying coach.[17]
- **Don't stop.** Choose nonstop flights over connecting flights, especially for shorter trips. Because takeoff, landing, and ground operations produce a lot of carbon, a 1,000-mile nonstop flight from New York City to Orlando can save nearly 35 percent compared with a two-connection flight down the eastern seaboard.
- **If you must stop, fly straight.** Travel websites and agents can show you exactly how many miles your flight will cover. If you can't get a nonstop flight, fly the most direct route possible to save carbon.
- **More seats = less carbon.** Make the market work. Choose airlines with all-economy seating when possible, as they have smaller per-passenger carbon footprints.
- **Know your plane.** Travel agents and travel sites can also tell you what kind of plane you will be riding. When options are available, choose the plane with the smallest average carbon footprint per seat.
- **Avoid airports with long delays.** Delays while you are on the plane, at the gate, and on the runway waste fuel and produce more carbon pollution. Less-congested airports often mean fewer headaches and fewer emissions.

Figure 3. Effect of Seat Class on Carbon Footprint

Solo Traveler Flying 2,000 Miles



Source: See Appendix B for seat calculation estimates, and for information from the Federal Aviation Administration on aircraft emissions.
Note: The figure assumes a nonstop flight on an average wide-body jet, and an occupancy rate of 80 percent—the 2007 industry average.

Class Matters—Save Money and Save Carbon

Flying in coach instead of first class is one way to curb your vacation carbon footprint. That is because first-class seats (and coach seats with more legroom, sometimes known as economy-plus) take up more space, reducing the number of passengers that a flight can carry.[18]

On domestic flights, a traveler in a typical first-class seat is responsible for twice as much carbon as someone in coach (Figure 3). On international flights, even higher carbon penalties for seating other than coach are likely, depending on how the airline configures the plane. The more expansive the layout—fully reclining first-class seats that convert into beds, the addition of business class, and extra space for flight attendants serving multiple classes—the fewer the passengers who can fit on the plane, translating into more emissions per seat.

Don't Stop

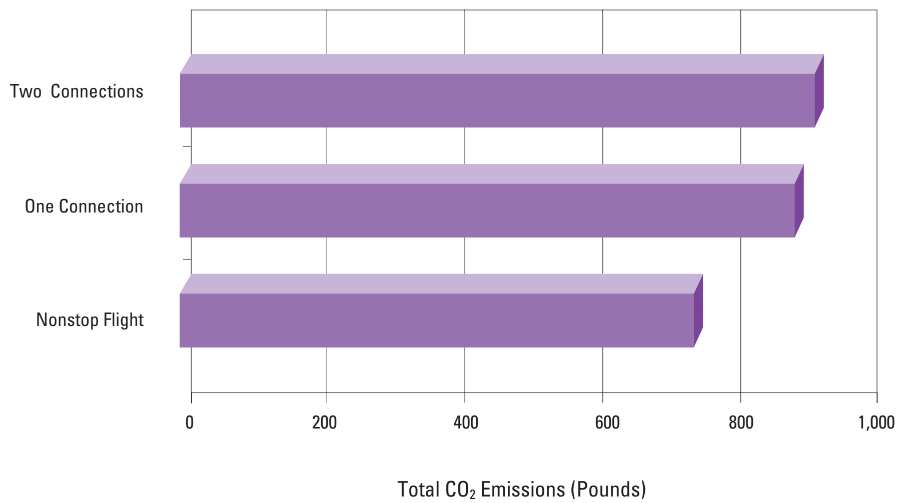
It takes a lot of fuel to propel a 65-ton jet 30,000 feet into the air, as well as to safely land it and bring it to a stop. Takeoff, landing, and ground operations produce sizable carbon emissions—as much as 10,000 pounds per plane for a wide-body jet—especially on shorter trips, where those operations account for a larger share of total emissions. Because connecting flights require two or more cycles of takeoff, landing, and ground operations, your carbon footprint is smaller when you choose a nonstop flight.

For example, as illustrated in Figure 4, you can cut roughly 20 percent of your carbon emissions by flying nonstop from Chicago to Los Angeles—a 2,000-mile trip—rather than taking connecting flights. That percentage will rise or fall depending on the length of the trip, as takeoff, landing, and "ground ops" account for a smaller fraction of emissions from a longer trip. For example, you can shave nearly 35 percent of the carbon off a 1,000-mile trip from New York City to Orlando by flying nonstop, but just about 10 percent off a 3,000-mile trip from San Francisco to Boston.

When families travel longer distances by air, it may make sense to drive up to 90 miles or even more to avoid connecting flights. As illustrated in Figure 5, a family can plan a trip that produces 25 percent less carbon by driving to a distant airport to fly nonstop, rather than making a single connection from a local airport. In this example, if the family avoids making two connections, they can reduce their carbon emissions by 35 percent.

Figure 4. Carbon Footprint of Nonstop vs. Connecting Flights

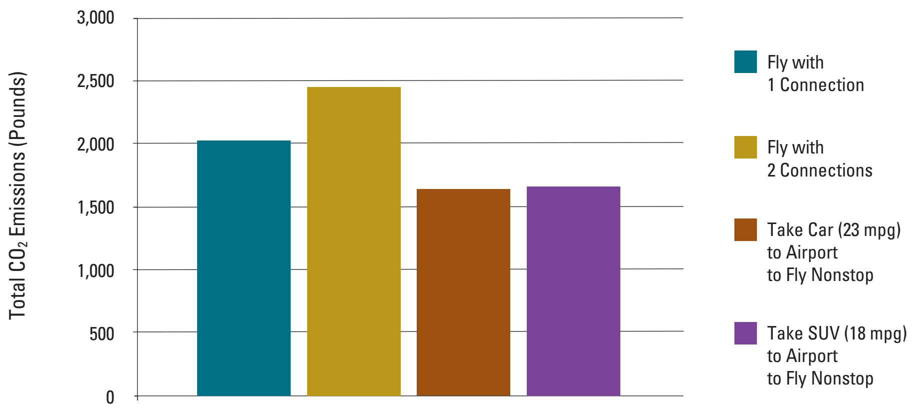
Solo Traveler Flying 2,000 Miles



Notes: The chart assumes that trips with two connections use two turboprop planes that fly 250 miles each and connect to a flight on a narrow-body jet. Trips with one connection use a regional jet traveling 400 miles and connect to a flight on a narrow-body jet. A nonstop flight uses a wide-body jet for the entire 2,000-mile trip. See Appendix B for more on emissions from different types of aircraft.

Figure 5. Carbon Footprint of Driving to Airport for Nonstop Flight vs. Taking Flight with Connections

Family of Four Flying 1,000 Miles, Driving 90 Miles



Note: The figure assumes plane types specified in Appendix B, and "typical car" and "typical SUV" fuel economies noted in Appendix C.

If You Must Stop, Fly Straight

You can't always avoid connecting flights, especially if you live in a smaller city with few nonstop options. But when your connecting flights take you in the opposite direction from your destination, your carbon footprint expands dramatically. The goal is to steer clear of multiple connections, and to make a single connection as direct as possible. If you do, you can cut your carbon emissions by a factor of two, three, or more.

Take, for example, a flight from Charlottesville, VA, to New York City. USAir offers a 310-mile direct flight. Passengers unable to make that flight have several options with connecting flights. For example, United can connect you through Dulles Airport in Washington, DC—a very direct route—for a total of 340 miles. Delta offers a flight connecting through Atlanta, which has you traveling southbound to reach your northbound destination, for a total of 1,190 miles. Delta also offers a 1,285-mile trip detouring through Cincinnati and then Boston. As illustrated in Figure 6, out-of-the-way layovers can double or even triple your trip's emissions.

More Seats = Less Carbon

Choose airlines that offer only coach class. Different airlines configure their airplanes differently, so each plane has its own carbon footprint per seat. In the end, the more seats an aircraft has, the less carbon-intensive the ride for everyone onboard.

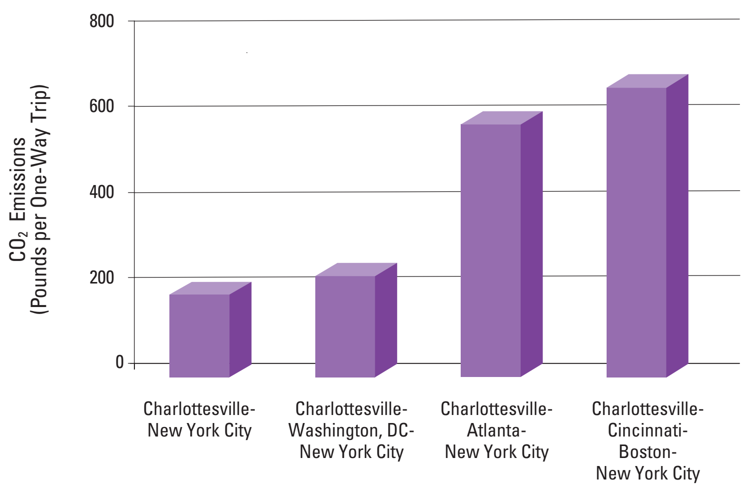
Some airlines remove first-class seats altogether and limit all seating to coach. This approach yields the lowest carbon emissions per passenger—carbon savings of about 10–15 percent, depending on how many seats the airline converts to coach. Travelers choosing airlines that offer only coach class encourage other airlines to do the same, sending a powerful signal to the market in support of cleaner air travel.

Let's look at a tale of two planes as an example. A Boeing 737-300 (733) operated by Southwest carries a total of 137 passengers in a single class: economy.[19] However, Continental configures the same plane with 124 seats, a dozen of which are in first class. Other options might include flights on United or USAir, which configure their 737s with 120 to 128 seats in a range of classes (Figure 7). In this case, the Southwest flight would reduce average per-passenger carbon emissions by as much as 12 percent compared with those of the other airlines.

Similarly, a Jet Blue Airbus 320 configured with 150 economy-class seats would reduce average per-passenger carbon emissions 8 percent compared with the same aircraft operated by United, which is configured with 12 first-class, 36 economy-plus, and 90 coach-class seats.

Figure 6. Carbon Emissions Depend on the Route You Take

Flying from Charlottesville, VA, to New York City

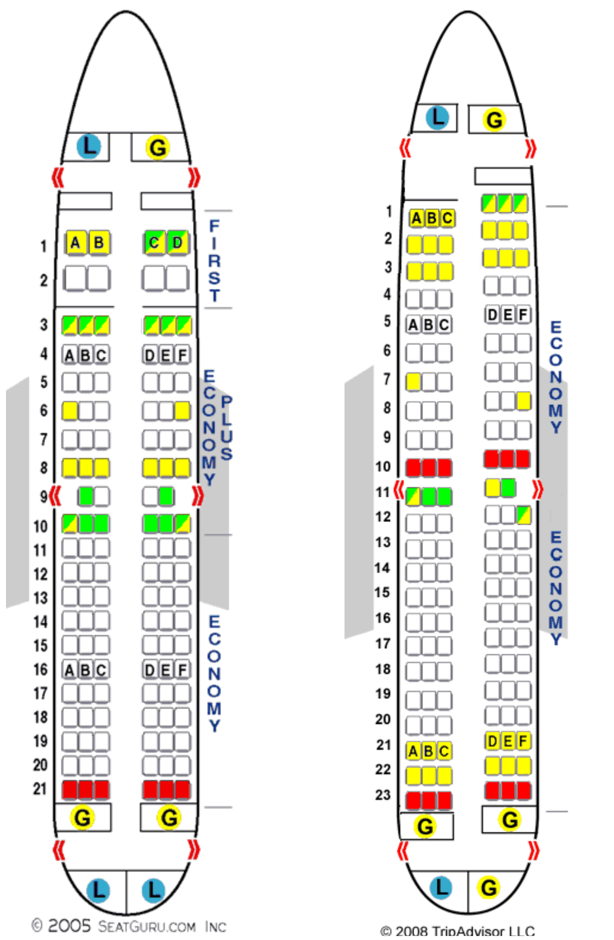


Note: This analysis is based on actual routes and the type of aircraft used on each, whether turboprop, regional jet, or narrow-body jet.

Figure 7. Seat Configurations in the Boeing 737-300 (733)

United "Version 1"
Total seats: 120
First class: 8 seats
Economy-plus: 46 seats
Economy: 66 seats

Southwest
Total seats: 137
Economy: 137 seats



Source: *www.seatguru.com* and *www.tripadvisor.com*.

Know Your Plane

Not all planes are created equal when it comes to carbon. Extensive data collected by the Federal Aviation Administration show that when planes fly at today's 80 percent average capacity, a wide-body jet's in-flight carbon footprint per seat is 7 percent smaller than that of a narrow-body jet. The in-flight carbon footprint of a turboprop and a regional jet is roughly 50 percent larger than that of a wide-body jet.

However, you can save even more carbon by avoiding flights on the highest-emitting aircraft in the fleet, which are often older. The most efficient wide-body jet produces 27 percent less carbon per seat than its least-efficient counterpart (Table 1). The most efficient narrow-body jet produces 32 percent less carbon than the least-efficient version, and the most efficient regional jet produces 36 percent less. The best- and worst-performing turboprops have the largest range: the former produces 56 percent less carbon than the latter.

Although average in-flight emissions for today's regional jets are comparable to those of turboprop planes, emissions during takeoff, landing, and ground operations are 50 percent higher. Again, these vary with the age and design of the aircraft. Older aircraft produce more carbon pollution during ground operations than newer, more efficient models (see Appendix B). If you want to fine-tune your vacation carbon profile, you can look for the type of aircraft when booking flights on the Internet.[20]

Table 1. Carbon Footprint of Air Travel, by Aircraft
Total Pounds of CO_2 per Trip for a Solo Traveler

	250 miles	500 miles	1,500 miles	2,500 miles
Best wide-body jet	--	--	490	**800**
Average wide-body jet	--	--	570	930
Worst wide-body jet	--	--	660	**1,090**
Best narrow-body jet	--	200	**540**	--
Avg. narrow-body jet	--	220	610	--
Worst narrow-body jet	--	290	**790**	--
Best regional jet	110	**210**	--	--
Average regional jet	170	300	--	--
Worst regional jet	190	**330**	--	--
Best turboprop	**110**	--	--	--
Average turboprop	160	--	--	--
Worst turboprop	**250**	--	--	--

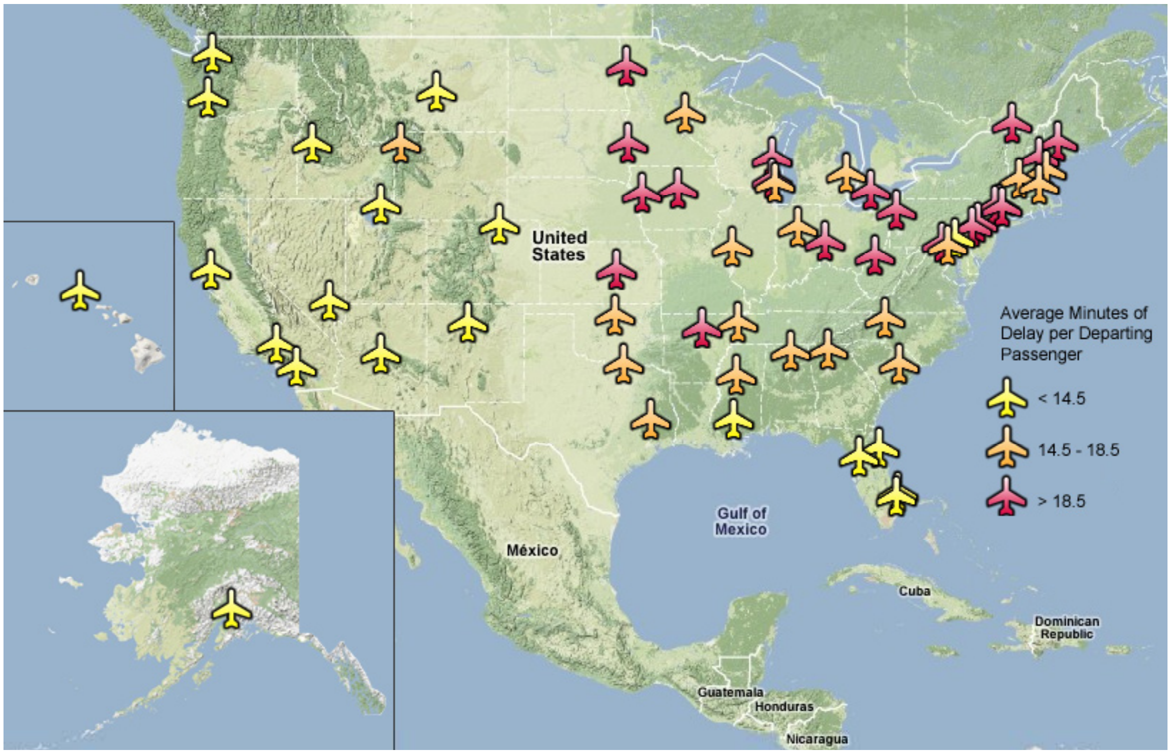
Source: See Appendix B.
Notes: Values in bold are those used for comparison in the text. Figures reflect a direct flight of the specified distance. Turboprops typically travel fewer than 250 miles, regional jets fewer than 1,000 miles, and narrow-body jets fewer than 2,000 miles. A trip that pieces together connecting flights on smaller-range aircraft will require more takeoffs, landings, and ground operations, and thus create more emissions.

Avoid Airports with Long Delays

Delays are costly in terms of carbon emissions. Planes waste fuel when they sit on the tarmac waiting to take off, and when they circle in the air waiting to land. The more congested the airport, the greater your chance of experiencing such delays. For every gallon of jet fuel a plane burns while stuck in traffic on the ground or in the air, it emits 25 pounds of carbon dioxide (including indirect emissions from the extraction, shipment, refining, and distribution of the fuel).[21] In 2007, planes emitted 8.5 million metric tons of CO_2 during airport delays, from both direct and indirect sources.[22] On average, this amounts to a 6 percent carbon penalty attributable to delays.[23]

Flights are delayed for many reasons—some of which, such as bad weather and mechanical problems, are beyond a traveler's control. Still, one of the best ways to actively combat delays is to avoid the most congested airports (Figure 8)—including New York City's Kennedy and LaGuardia airports, Chicago's O'Hare, Washington, DC's Dulles, and the Newark and Philadelphia airports—and choose secondary airports instead. This may mean driving to regional airports, preferably those from which economy airlines fly nonstop to your destination. Finally, keep in mind that where you're landing matters in avoiding delays, not just where you're departing.

Figure 8. U.S. Airports with the Longest Delays, 2007



Source: U.S. Senate Joint Economic Committee, 2008, *Your flight has been delayed again*, Figure 8.

CHAPTER 3

AUTOMOBILE TRAVEL

Loading up the car to go on vacation is an American tradition. Nine out of 10 Americans use a personal vehicle when traveling to summer vacation destinations less than 500 miles away.[24] And while Americans may prefer flying to reach vacation spots across the country, automobiles still often figure in their trip plans, whether for getting to the airport or driving around once they reach their destination.

However, automakers have not matched America's love of the road with a commitment to provide more efficient vehicle options. The average fuel economy of our nation's cars, minivans, SUVs, and pickups has essentially remained constant for more than two decades. While new federal fuel economy standards—complemented by state clean-car standards—will deliver more efficient options in coming years, today's traveler needs to do some serious thinking before hitting the road.

To calculate your carbon footprint, all you need is your vehicle's fuel economy rating. Roughly 25 pounds of carbon dioxide are emitted into the atmosphere for every gallon of gasoline burned—including the emissions from extracting, refining, and transporting the fuel.[25] Given its fuel economy, the cleanest hybrid vehicle sold today emits 0.54 pound of CO_2 per mile driven. If you drive another type of vehicle, your carbon footprint can expand by more than a factor of four, topping two pounds of CO_2 emitted for every mile you drive.

Given those findings, we compare automobiles with other transportation options and offer several recommendations.

Vacation Carbon Tips: Automobile Travel

- **Solo and couples vacationing? Keep it in the garage.** Single travelers driving a typical car leave a large per-passenger footprint, while couples fare only a little better. Unless you're driving a vehicle that gets more than 45 mpg, look for other options, such as the bus, train, or even plane (economy seating, of course).
- **Keep the family road-trip tradition alive.** If you're planning on bringing the grandparents or the kids along for the ride, your per-person carbon footprint shrinks accordingly. This makes cars—especially efficient cars—a low-carbon option for larger groups traveling together.
- **Be car smart.** How you pack, how you drive, and how you maintain your vehicle can save significant carbon and cash.
- **Congestion guzzles excess gas.** Select travel times carefully and consider routes that allow you to avoid getting stuck in rush-hour traffic—especially if your trip takes you through congested areas.
- **Banish the gas guzzler and rent more MPG.** While technologies exist to bring the fuel economy of SUVs up to that of cars, automakers have made most models gas-guzzling carbon emitters. Consider renting an efficient car or hybrid instead of taking a low-mpg car or SUV on vacation.

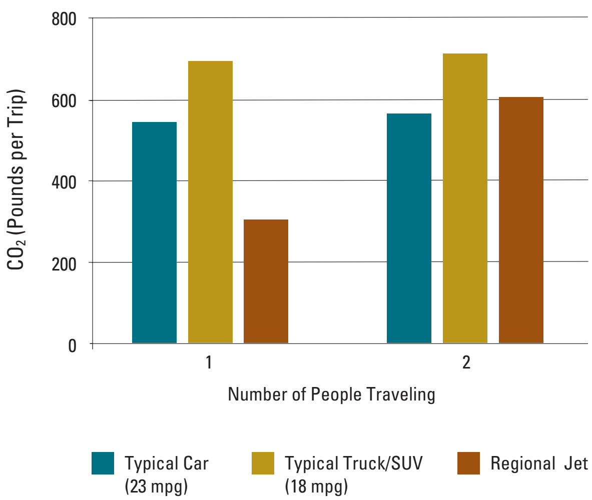
Solo and Couples Vacationing? Keep It in the Garage

When you travel alone in your car or SUV, you create a larger carbon footprint than in nearly any other mode of travel.[26] Indeed, in most cases, solo auto travel produces even more carbon than the "bad boy of air travel," regional jets. The situation improves slightly when two or more people travel together by car, with SUVs still the clear carbon loser (Figure 9).

Keep the Family Road-Trip Tradition Alive

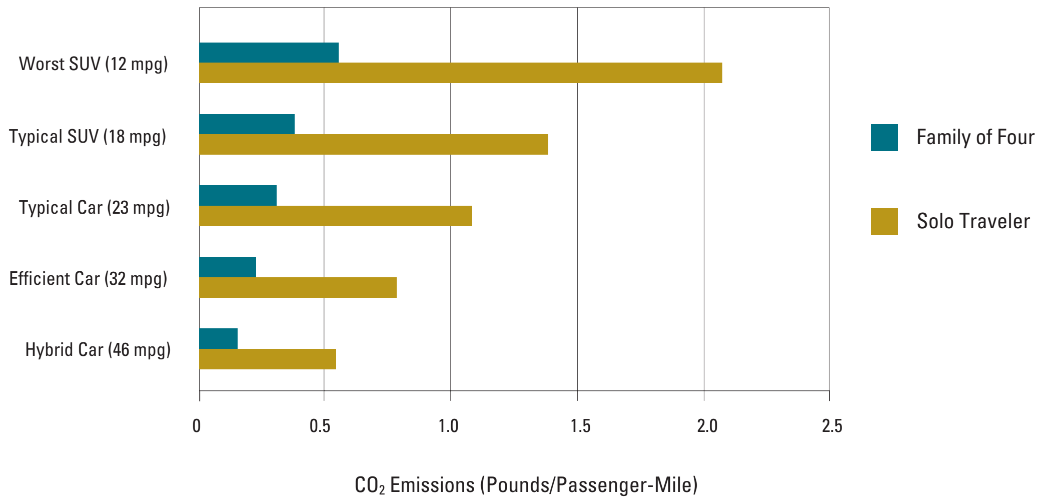
To travel greener, families should keep motoring together but use a more efficient vehicle. You may consume a bit more fuel loading up your car with more passengers and luggage, but the effect is small compared with the number of seats you occupy. A family of four that packs their luggage into an efficient car for a 100-mile trip will produce 89 pounds of global warming pollution—only about 13 percent more than someone traveling alone in the same vehicle to the same destination. Each person in the group is therefore responsible for emitting a little more than one-quarter as much pollution as a solo traveler. This makes efficient cars one of the greenest ways for families to travel together (Figure 10).

Figure 9. Total CO_2 Emissions, 500-Mile Trip



Note: For more on the emission factors used in this figure, see Appendices B and C.

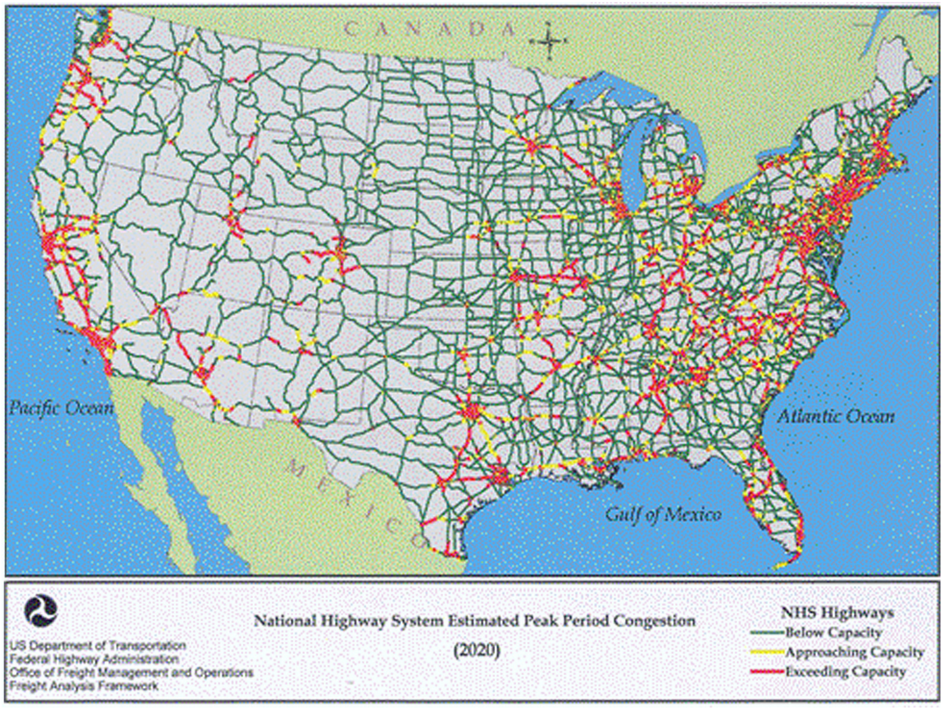
Figure 10. Auto Emission Factors, by Number of People Traveling Together



Source: See Appendix C.

Notes: All other graphs show emissions per trip. This graph highlights emissions per passenger-mile, to show how per-person pollution changes based on the number of people in a private vehicle. For more information, see Appendix A.

Figure 11. Projected U.S. Road Congestion, 2020



Source: Federal Highway Administration, 2005, T*raffic congestion and reliability: Trends and advanced strategies for congestion mitigation*, online at *www.ops.fhwa.dot.gov/congestion_report/chapter3.htm.*

Be Car Smart[27]

Preparation for a long trip is the perfect time to get the car into the best possible shape. A well-maintained vehicle is 4 percent more fuel efficient, on average, than a vehicle with problems. Replacing a car's very dirty air filter can save up to 10 percent on carbon emissions. And inflating your tires to the proper pressure, along with using the oil grade recommended specifically for your car, can shrink your carbon footprint another 5 percent.

A "lead foot" can diminish the benefits of an efficient car, however. Driving sensibly—avoiding aggressive acceleration and too much braking—can cut carbon 5–30 percent and save you money, too.[28] You can also cut carbon by obeying the speed limit. The rule of thumb is that each five miles per hour you drive over 60 mph is like paying an additional $0.25 to $0.30 per gallon for gas (when gasoline is $3.50–$4.00 per gallon). You can also shave a little carbon by using cruise control, and by avoiding idling whenever possible. You may also want to rethink that extra suitcase: adding 100 pounds can lower a vehicle's fuel economy by as much as 2 percent.

Congestion Guzzles Excess Gas

Getting stuck in traffic, especially on vacation, can be maddening as you waste precious time, money, energy, and carbon all at once. In fact, your decision on when to hit the road can be a big factor in just how long, and how much fuel, you need to get where you are going. This decision will become even more important as congestion on U.S. roads continues to rise in the coming years (Figure 11).

Most Americans who choose to drive to their vacation destination tend to leave on the weekend. Yet Friday, Saturday, and Sunday, especially in the summer, can be problematic in terms of traffic. It is worth considering off-peak departure times and days, such as nights or midday during the week.

Unless you're driving a hybrid that offers low-speed electric-only operation, crawling in stop-and-go traffic at an average of five miles per hour can more than quadruple your CO_2 emissions compared with smooth travel at 45–55 mph. Carbon emissions from congestion start to grow when speeds drop under 30 mph, and rise precipitously in traffic moving from 0–20 mph.[29] Shifting your vacation travel to off-peak times could therefore not only make your trip more pleasant but also shrink your carbon footprint.

Banish the Gas Guzzler and Rent More MPG

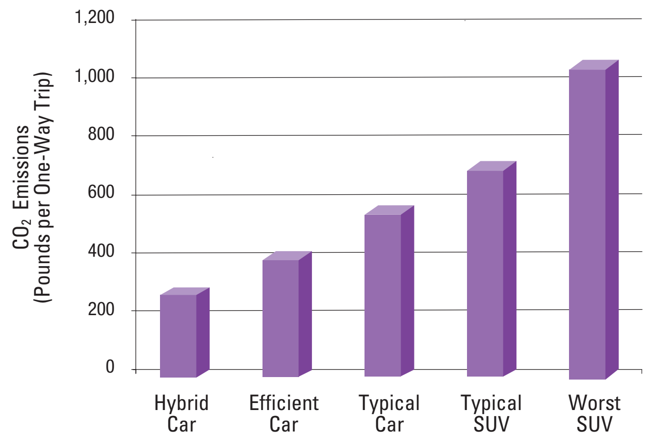
Unless you're comparing a Porsche 911 to a Ford Escape Hybrid, a car—rather than an SUV—is usually the greener way to go. Driving an SUV that accommodates a family of six or more can sometimes be comparable to taking two typical cars.[30] But if a family can fit in one car, it's a far better choice, because the average car emits roughly 25 percent less CO_2 than the average SUV.

The difference is even more striking when you compare very efficient and inefficient vehicles, such as a gas-sipping Toyota Prius and a Chevrolet Suburban (one of the most inefficient SUVs on the road). A family of four choosing the Suburban over the Prius would more than triple their carbon pollution (Figure 12). So choose an efficient or hybrid car if you have one, or rent one if you don't.

You may think driving an inefficient SUV that you already own is essentially free, but doing so actually costs you a bundle. Autos are expensive to operate: the average total cost of fuel, maintenance, and wear and tear ranges from 58.5 cents to 70.0 cents per mile, depending on fuel efficiency.[31] As fuel prices rise, driving your less-than-efficient large SUV or minivan on vacation becomes less economical. In fact, given high gas prices, you will save money by renting an efficient conventional or hybrid sedan instead of driving your SUV (Table 2).

Figure 12. Carbon Emissions Depend on the Auto You Drive

Couple Traveling 500 Miles



Notes: The figure assumes a 46-mpg hybrid car, a 32-mpg efficient car, a 23-mpg typical car, an 18-mpg typical SUV, and a 12-mpg worst SUV. For more on automobile emission factors, see Appendix C.

Table 2. Estimated Costs of Driving Different Vehicles

500-Mile Vacation

	Rented hybrid car (46 mpg)	Rented efficient car (32 mpg)	Rented typical car (23 mpg)	Owned typical SUV (18 mpg)	Owned worst SUV (12 mpg)
Gasoline	$38	$55	$76	$97	$146
Other costs*	--	--	--	$193	$193
Car rental	$120	$100	$110	--	--
Total cost	**$158**	**$155**	**$186**	**$290**	**$339**
Total carbon	**281 lbs.**	**406 lbs.**	**562 lbs.**	**712 lbs.**	**1,061 lbs.**

Notes: This table assumes two-person vacation travel over a long weekend; the use of a typical, efficient, or hybrid car at competitive rental rates; and gasoline at $3.50 per gallon.

*Other costs include tires and maintenance at a combined 6.3 cents per mile, and depreciation at an estimated 32.3 cents per mile, based on Oak Ridge National Laboratory, 2008, *Transportation energy data book*, Tables 10.12 and 10.13. For more information, see AAA, 2008, *Your driving costs 2008*, online at *www.aaaexchange.com/Assets/Files/20084141552360.DrivingCosts2008.pdf*. For more on emission factors, see Appendix C.

CHAPTER 4

RAIL TRAVEL

A century ago railroads were the only option for fast, reliable intercity travel. Traveling by train, once a romantic staple of U.S. destination travel, has waned dramatically over the years—from a high of 1.3 billion passengers annually in the 1920s to 26 million in 2007.[32] Despite intermittent surges in ridership during the post–World War II years and again after the oil crises of the 1970s, Amtrak's share of intercity passenger travel has shrunk to 1 percent as air travel has grown to 40 percent and auto ownership has exploded.[33]

Amtrak has remained in shaky financial condition since it was created during the Nixon administration, as growth in both population and consumer affluence boosted the popularity of highway and air travel. Public policy has also played a role, as federal and state governments have spent great sums on auto and airplane infrastructure since the 1950s through cost-sharing agreements for highways and airways. Rail infrastructure has no similar financing mechanism.[34]

Competing use of rail tracks is another challenge for passenger rail in America today. Roughly 97 percent of Amtrak's route-miles rely on tracks owned and maintained by freight railroads, which carry some 40 percent of the nation's goods.[35] This reliance on the freight network has exacerbated the economic challenges of passenger rail travel compared with other modes.

Given the high priority of air and auto travel among the country's transportation options, some Americans might assume that the passenger rail system simply "can't get you there." But, in fact, it can. You can board an Amtrak train in 46 states and throughout Canada. Amtrak's ThruWay bus service facilitates rail connections among 800 cities, including popular vacation spots such as Orlando, San Francisco, the Grand Canyon, Yosemite, Las Vegas, and the Big Apple. Amtrak also offers an "auto train" option, allowing passengers to ride the train while bringing their cars along. And unlike most air travel, Amtrak brings you

Vacation Carbon Tips: Rail Travel

- **Ride the rails in the Northeast to cut carbon and congestion.** The Northeast Corridor is Amtrak's most highly developed segment, so you have more options, including high-speed Acela express trains between Washington, DC, and Boston. Because they run on electricity, Northeast Corridor trains are the cleanest rail option.
- **See the cities, take the train, cut the carbon.** Even outside the Northeast, trains are a great way to take a family vacation. Families that take advantage of the routes and timetables can see more of America while cutting carbon.
- **An Amtrak station might be closer than you think.** Check out your rail options even if you don't live near a train station. Amtrak's ThruWay bus service connects most cities to rail stations.
- **No rental required when training.** Unlike most airports, train stations are often right in city centers, so you don't have to hail a taxi or rent a car to get downtown, saving pollution as well as time. Amtrak also offers an "auto train" option that allows passengers to ride the train while bringing their cars along for the ride.

right downtown, rather than depositing you miles from cities and transit.

Passenger trains produce an average of 0.43 pound of carbon dioxide emissions per passenger-mile. However, America has two distinct types of train service: that in the Northeast Corridor (from Washington, DC, to Boston), which runs on electricity, and the rest of the Amtrak network, which operates on diesel. Northeast Corridor trains average 0.37 pound of CO_2 emissions per passenger-mile while all other Amtrak trains average 0.45 pound—about 20 percent more.[36]

These emission rates are quite good compared with, say, a typical car with one passenger, which emits 1.08 pounds of CO_2 per passenger-mile. Perhaps even more important, however, is the fact that a train often offers what amounts to a carbon "free ride," as it is an underused travel mode in many areas of the country. (For more information, see Appendix A.)

Ride the Rails in the Northeast to Cut Carbon and Congestion

Trips along the eastern seaboard between Washington, DC, and Boston are best made on rail. Some of the nation's busiest roads and airports are located in this region, from Logan Airport in Boston to New York City's Kennedy and LaGuardia to Philadelphia Airport to Dulles outside Washington, DC. Congestion can mean that travel by car and plane gets plagued with delays.

Many features of the Northeast rail corridor make it an ideal travel option. Not only does the region have an electric rail system, but the proximity of a number of major metropolitan areas—not to mention coastal areas—allows you to keep your travel distance down while tapping an enormous variety of vacation options. It's a perfect example of merging travel mode and distance to curb your vacation carbon count.

See the Cities, Take the Train, Cut the Carbon

The Northeast Corridor is not the only place to take a multicity vacation by rail. Indeed, even if you fly to a different region of the country, you may still have the opportunity to take rail to see multiple sites (Figure 13). California, for example, offers intriguing possibilities. With service to nearly 200 California cities (with the aid of connecting bus service), Amtrak can transform vacation travel in the Golden State. Instead of enduring

Figure 13. Amtrak's U.S. Routes

Source: *www.amtrak.com.*

exhausting drives or being stuck in California's notorious traffic, Amtrak offers a coast-hugging ride with views of the Pacific Ocean.

Other states with extensive Amtrak service and connecting buses to numerous cities include Michigan (46 cities), Oregon (39), New York (32), Washington (31), Florida (30), and Texas (29).

An Amtrak Station Might Be Closer than You Think

No train track anywhere near home? Don't dismiss the train too quickly. Instead, head to *www.amtrak.com* and plug in where you want to start and end your trip. Amtrak's ThruWay bus connections offer extensive service beyond its 40 major rail station hubs. And given the extremely low emissions from motor coaches, travelers who use them to connect to trains can cut their carbon even further.

No Rental Required When Training

City limits can be 20 miles or more from major U.S. airports, and connecting highways are often congested with cars during rush hour and with trucks off peak. That isn't the case with rail. Stations are usually downtown, near hotels, subways, and tourist attractions (see Table 3 for one example). So when you ride the rails, you can often forgo the rental car or the long, often expensive cab ride to your vacation destination, saving money, carbon, and a lot of hassle. No parking challenges, no confusing airport traffic patterns, no parking tickets, no meters, and no gas stations.

Table 3. Take Me Out to the Ballgame

Vacationers traveling to Major League Baseball stadiums will find that many are located near train stations, eliminating the need for another leg of carbon-emitting travel:

Ballpark (City)	Miles from airport	Miles from train station
Coors Field (Denver)	25.0	0.4
Dodger Stadium (Los Angeles)	20.0	1.8
Minute Maid Park (Houston)	18.6	1.1
Busch Stadium (St. Louis)	14.9	0.8
Camden Yards (Baltimore)	9.7	2.5

CHAPTER 5

MOTOR COACH TRAVEL

The bus, a.k.a. motor coach, is perhaps America's best-kept travel secret. And slowly but surely, motor coaches are making a comeback. Fifty years ago, before the rise of air travel, cheap, rapid intercity bus service was the easiest way to travel in the United States. Soldiers heading to war, young couples honeymooning, families embarking on a new life, kids traveling to summer camp, retirees touring the country—pretty much everyone a generation ago spent some time in a bus terminal. "Go Greyhound and leave the driving to us" was coined in 1956, the same year Congress passed the first highway bill to finance America's new interstate system.

More recently, of course, Greyhound, Trailways, Peter Pan, and other traditional, depot-based, scheduled bus services have seen their customers dwindle. Still, buses have quietly remained a backbone of American travel, today holding one-third of the intercity passenger market. While the large companies have continued their service, enterprising smaller operators are entering the motor coach business in droves.[37] Offering everything from group tours to routes in niche-market corridors, these new operators have propelled the entire industry to a higher level of service. For example, Greyhound's Bolt service in the Northeast now provides low fares on new buses that even have wireless Internet connectivity.

This couldn't be better news for climate change. Even at today's average occupancy rates, your carbon footprint will be a mere 0.17 pound for every mile you travel on a motor coach—the smallest footprint of any mode for people traveling alone or with a companion. And as buses fill up, their per-passenger emissions will drop even further.[38]

And it has never been easier to board a bus. Services expanded greatly in recent years—more than 10 percent from 2006 to 2007 alone.[39] Entrepreneurial

Vacation Carbon Tips: Motor Coach Travel

- **Motor coaches leave carbon in the dust.** A couple boarding a motor coach will cut their carbon nearly in half, compared with driving even a hybrid car. And if they take the motor coach rather than flying, they will cut their emissions by 55 to 75 percent, depending on the distance they travel.
- **Group tours = low carbon.** Interstate tour-bus travel has seen a major expansion over the past decade. So think about that group trip in a new, green way.
- **Not your daddy's Greyhound.** Today many companies have ditched their older buses and offer plush new coaches with everything from seat-back video to satellite radio to wireless Internet connections.
- **Search and ye shall find.** You can jump-start your low-carbon vacation with an Internet search. Bus travel—unlike air and rail travel—does not have a centralized reservations website (such as Orbitz, Expedia, Travelocity, or *amtrak.com*), but here are a few addresses to you get started: *www.gotobus.com*, *www.greyhound.com*, *www.peterpanbus.com*, *www.trailways.com/schedules.asp*. Happy trails!

operators offer charter buses, tour buses, sightseeing buses, contract shuttles, commuter buses, and other special operations. And buses operate more freely than planes and trains because they don't require new infrastructure. New breeds of motor coaches even forgo conventional terminals, leaving from curbside locations or public-transit facilities. What's more, fares are very competitive compared with other travel options.

Ease, economics, and environmental benefits will combine to spur greater use of buses in coming years. Indeed, for those with extra time, they make it possible to truly see America.

Motor Coaches Leave Carbon in the Dust

It's plain and simple: buses are the low-carbon travel champ. On a per-passenger basis, buses emit less than one-sixth the carbon pollution of a typical car with one passenger. Put another way, every person who chooses motor coach travel instead of driving alone reduces his or her carbon dioxide emissions by an average of 85 percent. Moreover, each motor coach has the potential to remove as many as 55 autos from the highway, reducing congestion. So whether you're headed to the Hamptons, doing Disney, or seeing the Strip in Vegas, motor coaches should be front and center as you consider how to get there.

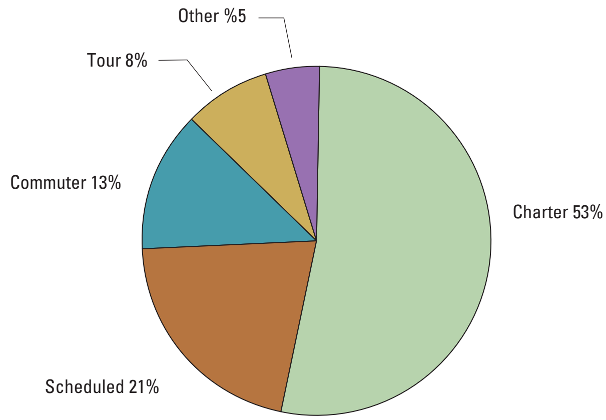
Group Tours = Low Carbon

Private operators such as Greyhound, Peter Pan, Bonanza Bus Lines, and Trailways used to dominate the bus industry. Today Greyhound accounts for less than 1 in 10 passenger-miles traveled on buses.[40] Now the lion's share of bus service falls into one of two categories: a host of operators that provide charter and tour buses for groups, and a small array of private bus operators that provide scheduled service between U.S. cities (Figure 14).

With the dynamic rise of luxury chartered motor coach service and its small carbon footprint, you have more reasons than ever to consider that group vacation. By helping to fill the bus with passengers, you will maximize the vehicle's carbon "efficiency," while also getting a chance to read, nap, chat with the person next to you, or just take in the scenery without worrying about the road.

Figure 14. U.S. Intercity Bus Service, 2005

Share of Passenger-Miles



Source: M.J. Bradley & Associates, 2007, *Comparison of energy use and CO_2 emissions from different transportation modes.*

Not Your Daddy's Greyhound

Motor coaches serve a wide array of travelers. For those on a tight budget, some carriers offer tickets for as little as one dollar for travel from New York City to Washington, DC. In fact, motor coach vacation travel is far easier on the wallet than any other option. And then there's the other end of the spectrum: those seeking a luxurious ride with seat-back video, XM satellite radio, laptop hookup, and a gourmet snack galley and cappuccino bar can often find a motor coach that fits the bill.

In metropolitan areas and a growing number of states, motor coach operators are sprouting up. Dozens of carriers operate a variety of services out of New York City, for example, with hundreds of daily departures to other U.S. cities and states. Low-cost bus lines there serve Boston; Washington, DC; Philadelphia; and St. Louis, as well as Michigan, Ohio, and Florida, among other destinations. Thousands of companies operate around the nation, including Megabus, which serves 31 cities in 15 states; CoachUSA, which operates in 450 cities in 18 states (300 cities in New York and New Jersey alone); Bolt Bus; and many others.

Search and Ye Shall Find

New motor coach operators continue to sprout up around the nation, especially in large cities. Today the industry is largely a network of some 4,000 small companies,[41] each running a small fleet of individually tailored motor coaches. And the good news is that ridership is growing. The bad news is that enterprising startup motor coach operators rely on word of mouth to publicize their services and do not publish timetables in Russell's Guide, a monthly subscription to bus schedules throughout the United States and Canada.[42] Over time they will advertise their services more widely.

The entrepreneurial, carbon-cutting traveler can usually find a motor coach with a little digging. One of the best places to start looking is *www.gotobus.com*, an Expedia.com-like site that includes routes for a number of smaller vendors around the country (not those of major carriers). Some services in regional corridors—such as the renowned "Chinatown Express," which runs from Washington, DC, to Philadelphia and on to New York City—are offered by a number of local carriers. And even larger carriers such as Greyhound have started subsidiaries such as Bolt Bus (*www.boltbus.com*), which operates new, luxury motor coaches serving niche markets. For the green traveler, these options are well worth an Internet search.

CHAPTER 6

THE GREENEST TRAVEL OPTION FOR YOU

The size of your vacation carbon footprint depends on three main factors: the distance you travel, the type of vehicle you select, and the size of your group. Once you know these basics, you can easily choose the best travel option for your trip.

As an example, let's compare the carbon footprints of different travel options between select cities for groups of various sizes. Figure 15 shows popular vacation origins and destinations for trips ranging from 100 to 2,500 miles. While of course you have many other vacation options, the map provides examples of the range of trips you could take if you stay within the country.

As illustrated in Table 4 and Figures 16 through 18, motor coaches are typically the greenest way to go. But if you don't find it convenient to take a motor coach on your next vacation, the next best way to travel will depend on your plans. When traveling alone or as a twosome, the train is the next-best option for trips up to about 750 miles. For longer solo trips, your carbon footprint is smaller if you fly coach, especially if the flight is nonstop.

If you travel as a family of four, things shape up differently. Again, motor coaches are worth a try if they fit your vacation plans. Apart from motor coaches, cars beat out trains in terms of carbon footprint, and the more efficient the car, the greater its advantage. SUVs (fully occupied) edge past trains if they have at least average fuel efficiency (18 mpg). Families traveling distances of 750 miles or more—and who don't have time to take a motor coach or passenger vehicle—can fly greener by choosing nonstop coach seats.

Figure 15. Selected Routes for U.S. Vacation Trips

For mileage and carbon footprints associated with each route, see the corresponding (color-coded) section of Table 4.

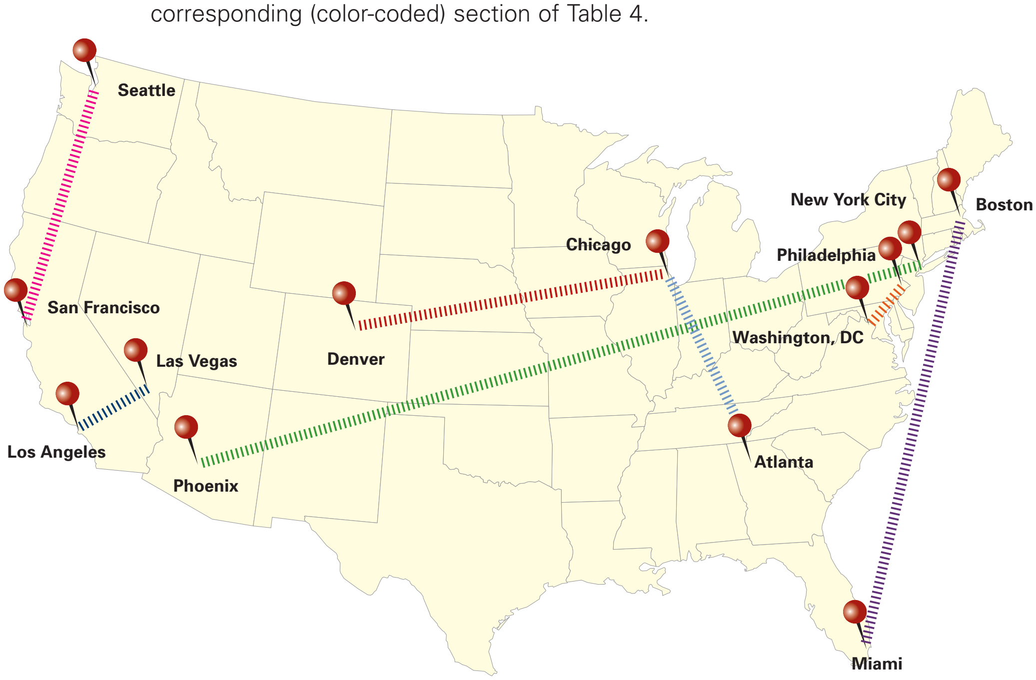


Table 4. Carbon Footprints by Vehicle and Travel Distance

Total Pounds of CO_2 per Trip

Trip (approx. mileage)	Motor Coach	Train	Car	SUV	Airplane
100	15	45	110	140	75
	35	85	110	140	150
	65	170	120	150	305
250	40	110	270	345	160
	85	215	280	355	315
	170	430	300	375	630
500	85	215	540	695	300
	170	430	565	710	605
	335	860	605	755	1,205
750	125	320	815	1,040	320
	250	645	840	1,070	640
	505	1,290	910	1,130	1,285
1,000	170	430	1,085	1,385	514
	335	860	1,125	1,145	835
	670	1,720	1,210	1,505	1,665
1,500	250	645	1,625	2,080	570
	505	1,290	1,685	2,135	1,135
	1,010	2,580	1,815	2,260	2,275
2,500	420	1,075	2,710	3,465	925
	840	2,150	2,810	3,560	1,855
	1,680	4,300	3,020	3,660	3,705

Solo Traveler (blue)

Couple (red)

Family of Four (green)

Source: See Appendices A through E for calculations for each vehicle.
Notes: Not every vehicle travels direct. Airplane data are for a nonstop coach flight. Car and SUV data reflect typical vehicle fuel economies of 23 mpg and 18 mpg, respectively. Train emissions reflect current use-weighted average of electric and diesel passenger trains.

Figure 16. Comparing Carbon Footprints: Solo Traveler

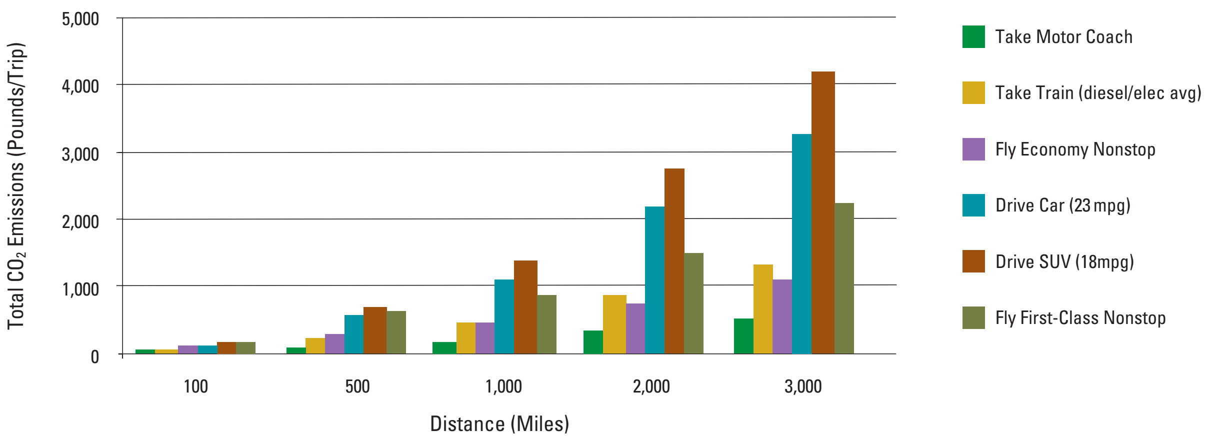


Figure 17. Comparing Carbon Footprints: Two Travelers

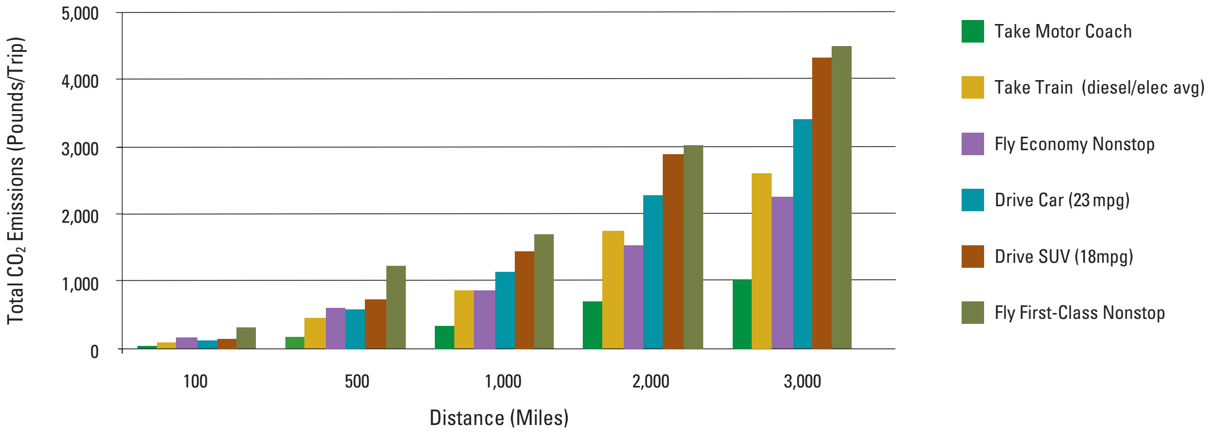
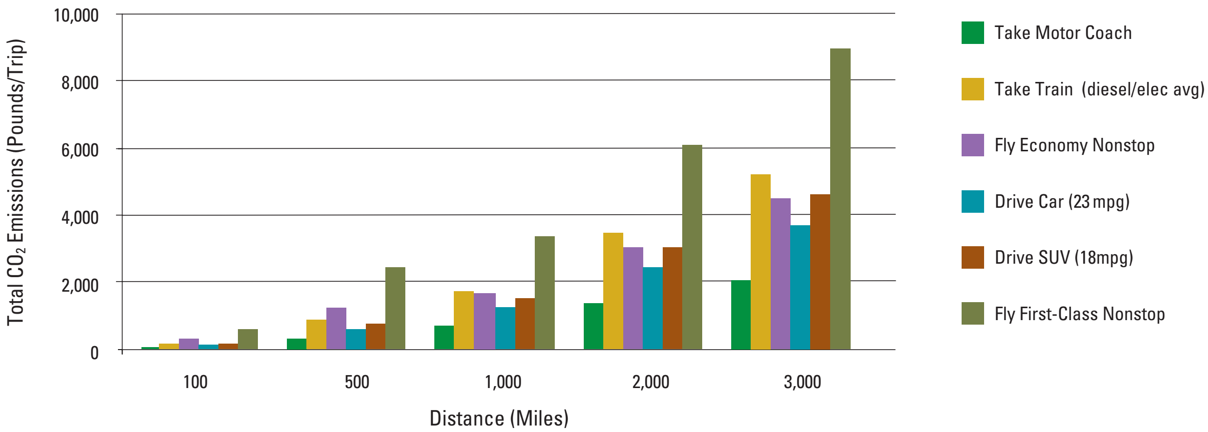


Figure 18. Comparing Carbon Footprints: Family of Four



Planning Greener Vacation Travel: Three Case Studies

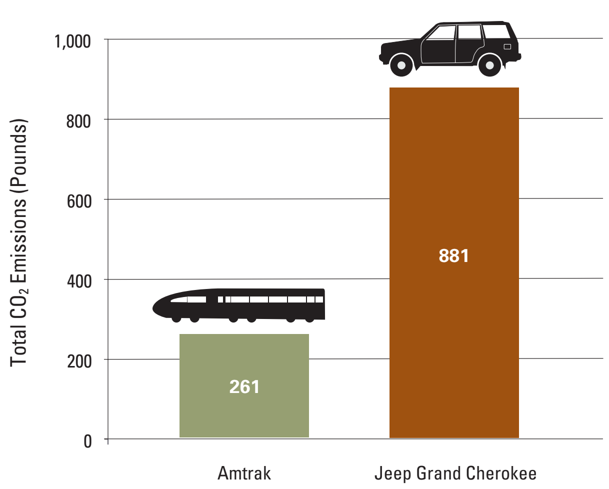
Which way to get away? The choice is yours, but keep in mind the environmental trade-offs. To highlight those choices, here are three case studies based on the rules of thumb from previous chapters. We will look at the solo traveler on a weekend jaunt, a couple traveling together, and a family of four working around conflicting schedules to take a long-planned vacation. These hypothetical scenarios illustrate real travel options in authentic vehicles to actual places. And as you'll see, the carbon these travelers trail along the way varies dramatically depending on how they get away.

Harry's heading out solo

All Harry does is work, work, work at his high-pressured investment job in New York City. He realizes that the best way to balance his life is to carve out time for R&R, and that means taking a vacation whenever he gets a chance. He's planning a long-weekend getaway to the Maine coast to fly-fish for striped bass, a passion he has shared with his dad since he was a kid. Harry does not keep a car in the city, so he is considering renting one for the trip north: a Jeep Grand Cherokee, just for fun, even with gas prices hovering around four dollars per gallon.

Figure 19. Harry's Heading Out Solo

New York City to Portland, ME, Round-Trip



Notes: The graph assumes 215 miles of travel by electric train, and 112 miles of travel by diesel train, each way. Travel by passenger vehicle is 318 miles each way. The fuel economy of the Jeep Grand Cherokee is 18 mpg. See Appendix D for emission factors for rail travel, and Appendix C for emission factors for automobile travel.

He could, of course, take Amtrak to Portland, ME. He would just need to switch trains in Boston while he stretches his legs and picks up a copy of the *Globe*. And if he caught the Acela high-speed train to Boston, he'd get there an hour sooner while shaving even more carbon.

So what does he do? Well, Harry is always a sucker for comfort and convenience. Taking Amtrak means he won't have to battle traffic out of the city on Friday evening. (That will shave carbon off his trip, too.) And he can talk to his dad about his fishing plans on his cell phone along the way, and plug his laptop into one of the outlets available in every row of seats. And there's another hook: a memo circulating around the firm notes that it is investing in carbon futures. Why not do his part and shrink his carbon footprint on vacation? He can brag about his whopping 70 percent carbon savings (Figure 19) when he gets back to the office the following Tuesday at 7 a.m. sharp.

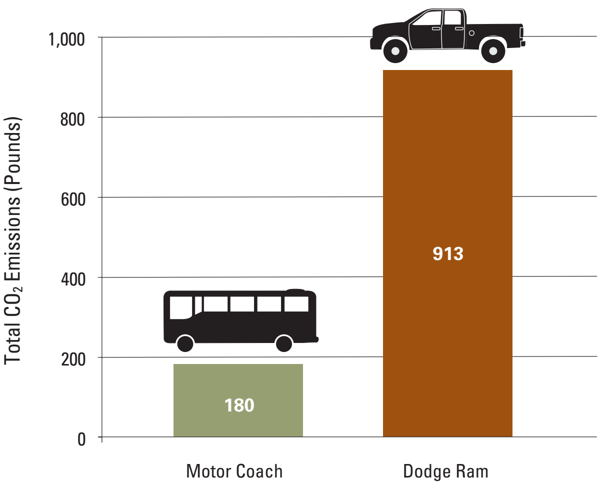
Rita and Louie head to Vegas, baby!

Couples need to get away and reconnect on vacations. It's no surprise that, now that they're retired, Rita and Louie look forward to their annual vacation in Las Vegas. Home is Santa Ana, CA, south of Los Angeles, with their two Welsh terriers. For the past six years, Rita and Louie have hopped in their Dodge Ram pickup and headed to the Strip, driving some 270 miles each way and trying different hotels each time. But this year, their 15-mile-per-gallon truck is pinching their budget, given a regional gas price of $4.50 a gallon. Driving their pickup will run them $160 each way, including $80 in gasoline alone—that's a lot of lost quarters for the slots![43] So they're thinking of leaving their gas guzzler (and the dogs) home and traveling to Vegas another way.

As it turns out, there is. An ad for the Lux Bus just ran in the couple's local paper. A motor coach departs nearby Anaheim daily, and offers plush reclining seats, free beverage service, and a movie along the way. What's more, this mode of travel is the biggest carbon winner compared with the pickup—and at $94 per round-trip senior ticket, it's a fiscal jackpot too. Rita can't believe she can cut carbon emissions by a factor of five (Figure 20) by switching from their truck to Lux Bus!

Figure 20. Rita and Louie Head to Vegas, Baby!

Santa Ana, CA, to Las Vegas, Round-Trip



Notes: The graph assumes 268 miles of travel each way. Fuel economy of the Dodge Ram is 15 mpg, minus a 0.4 mpg penalty for the weight of passengers and luggage. The emission factor for this vehicle with two occupants is 1.7 pounds of CO_2 per mile. See Appendix E for emission factors for motor coach travel.

The Elsens are going to Disney World

Greg and Ann Elsen are planning their long-awaited family vacation. Sarah and her younger brother Joey usually disagree about where to go. But not this year: it's unanimous. During Sarah's spring break, they will go to the fabled "House of Mouse" in Orlando, FL.

Ann has frequent-flyer miles for first-class upgrades, and figures she'll use them to take the family from Chicago to Orlando in style. The only rub is that to obtain free first-class seats, the family will have to make a connection in Houston. No worries, figures Ann: a more luxurious trip will be worth the extra time.

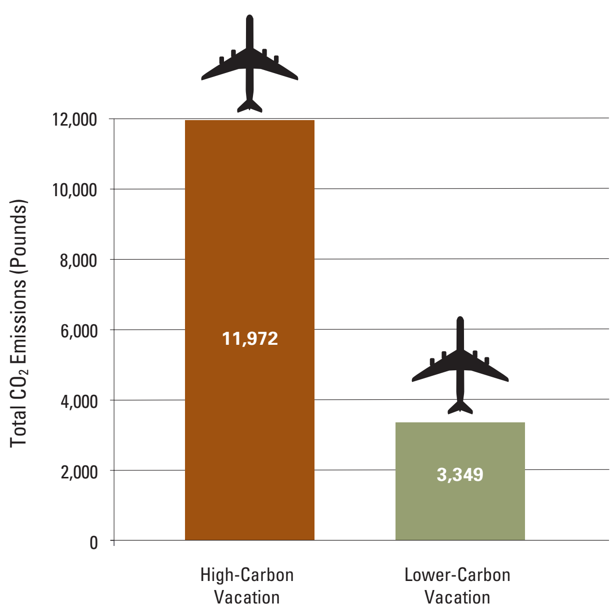
However, Sarah recently began talking about global warming, which she's been studying in science class. She thinks it would be better to make the trip as green as possible by shrinking her family's carbon footprint. So Ann and Sarah reviewed the family's options together, and decided on a nonstop flight with all-coach seating instead. That flight will reduce their one-way travel from about 1,800 to 1,000 miles—a drop of more than 40 percent. Sarah also learned in school that by opting for coach rather than first class, the family could cut their remaining emissions in half, as coach seats take up less room on the plane. All told, this simple change in flight plans will shrink the family's vacation travel footprint by roughly 70 percent (Figure 21).

Now when Sarah returns to school, she can talk to her class about how her family saved more than *four tons* of CO_2 getting there greener. She'll no doubt also rave about Space Mountain.

As Harry, Rita and Louie, and the Elsen family show, no single hard-and-fast rule applies to reducing global warming pollution on vacation. Carbon footprints depend largely on the vehicle you select, how many miles you are traveling, and how many people are going with you. Just follow the rules of thumb laid out in prior chapters and summarized in the next, concluding chapter to make the best choice.

Figure 21. The Elsens Are Going to Disney World

Chicago to Orlando, First-Class with Layover vs. Nonstop Coach



Notes: The high-carbon family vacation includes four first-class round-trip flights on narrow-body jets from Chicago to Orlando via Houston, totaling 1,778 miles each way (852 miles from Chicago to Houston, and 926 miles from Houston to Orlando). The lower-carbon family vacation includes four economy-class round-trip direct flights from Chicago to Orlando, totaling 1,005 miles each way. Emission factors are detailed in Appendix B.

CHAPTER 7

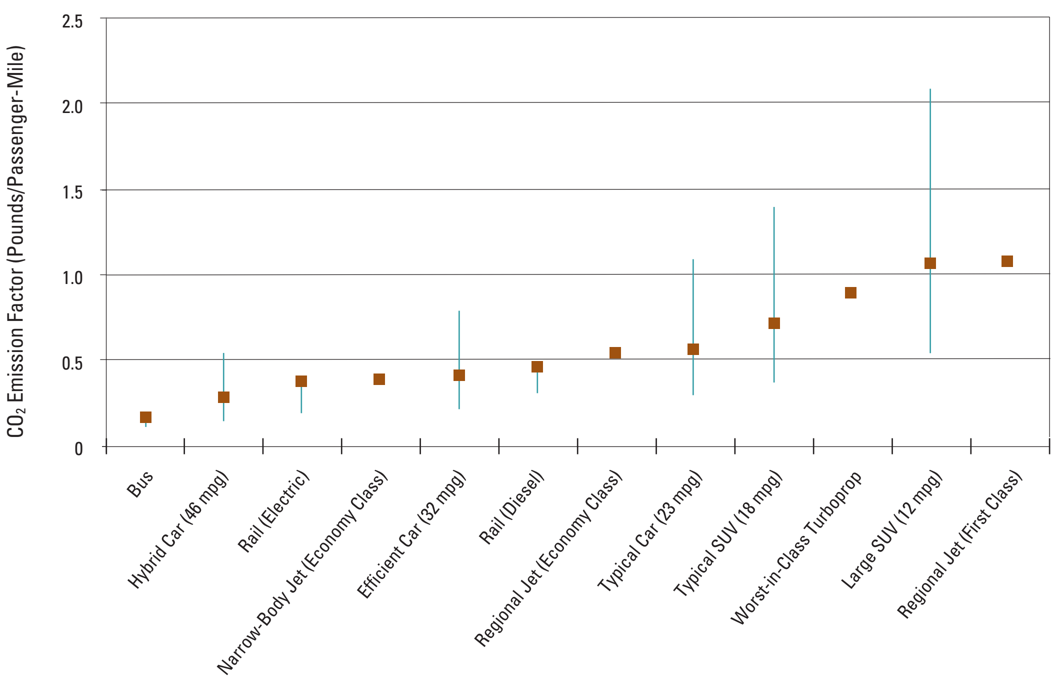
RULES OF THUMB FOR GETTING THERE GREENER

Knowing how to count carbon from vacation travel is important. Motor coaches, trains, the most efficient hybrid cars (which get 46 mpg), and coach seats on narrow-body jets have the smallest carbon footprints: less than one-half pound of CO_2 per mile (Figure 22). Medium carbon footprints result when travelers choose typical or efficient cars (23 to 32 mpg) or fly coach on regional jets. Travel by SUV or first-class jet produces the largest carbon footprint: more than one pound of CO_2 per mile.

Every vacationer's situation is unique. Some travelers may pursue vacations centered around a specific mode of travel, such as a passenger vehicle for a family road trip, or a train for a countryside rail vacation. Other vacationers may have more flexibility in their travel options but feel constrained by time or cost. Nevertheless, armed with information on the carbon emissions from different types of vacation travel, everyone can make better choices.

This chapter summarizes the major rules of thumb for low-carbon vacation travel. Together with the vacation carbon tips in earlier chapters, these guidelines can help you get there greener.

Figure 22. Carbon Footprints, by Vehicle



Notes: Dots represent average emission factors for each vehicle. The vertical lines for cars and SUVs represent single-occupant emissions (high end), two occupants (dot), and four occupants (low end). Vertical lines below other vehicles represent emissions at 80 percent occupancy.

Rules of Thumb

Motor coaches and trains are a carbon bargain

Whether traveling with a family, with a partner, or alone, vacationers seeking a carbon bargain should seriously consider rail and motor coach travel. Intercity bus options have been on the upswing, as numerous regional carriers now provide coaches with very comfortable seats. And Amtrak offers everything from high-speed rail service in the Northeast to "auto trains" that enable long-distance travel without the wear and tear on your automobile. From a carbon perspective, motor coaches and trains are among your lowest-emission options, especially on shorter (less than 500-mile) trips. Moreover, because motor coaches and trains are often underused, they may offer what amounts to a carbon "free ride."

Big SUVs and first-class flights usually have the largest carbon footprints

Driving alone, driving inefficient SUVs (with or without other people), and flying first-class are the most polluting ways to go. To shrink your vacation's carbon footprint, consider other options.

For couples and solo travelers, a nonstop coach flight almost always beats an average car

Carbon from cars and trucks adds up, especially when those vehicles travel long distances and are only partially occupied. If you're traveling alone or with one other person, you're usually better off flying direct in coach than getting behind the wheel of a passenger vehicle. This is especially true for trips of more than 500 miles.

To significantly reduce your carbon footprint behind the wheel, drive or rent a more efficient car

If you don't own a fuel-efficient vehicle, think about renting one when driving on longer trips. The carbon emissions from a large, inefficient SUV are nearly four times those of a high-mpg hybrid like the Toyota Prius. If hybrids are not available, look into efficient conventional cars, which can ease your environmental impact while cutting your gasoline bill. Many car rental agencies now offer both hybrids and efficient conventional vehicles. Take advantage of them, and take some wear and tear off your car.

Avoid traveling during peak periods

Congestion has a noticeable effect on your fuel consumption and carbon footprint. When a car or SUV is stuck in traffic, its fuel consumption rate can be double the rate it gets at steady cruising speeds. So think about getting a GPS unit for your car that can alert you to traffic hot spots in real time and suggest ways to avoid them. (Some sell for as little as $150.) And think about changing your vacation schedule to avoid peak travel periods that keep you stuck in traffic.

Carbon footprints are usually smaller on nonstop flights than on connecting flights

If you do need to fly, get to know your aircraft options. One important way to cut emissions is to fly nonstop, since doing so eliminates excess, out-of-the-way travel. And smaller planes have a bigger carbon footprint than larger ones, on average. Because connecting flights tend to use smaller planes on at least one leg, nonstop flights are usually the greener way to go.[44] Moreover, takeoff, landing, and ground operations produce a lot of carbon, and connecting flights require more of these high-carbon activities than nonstop flights. Finally, the carbon footprint of connecting flights can be even larger because you have a greater chance of encountering delays.

Conclusion

For years we have heard so much about the causes of climate change that we've often overlooked the fact that practical solutions can slow this growing problem now. Driving fuel-efficient vehicles, using renewable energy, and protecting threatened forests are the most important ways we can reduce global warming while saving money and creating new businesses and jobs. But because U.S. emissions of heat-trapping gases are so high, we each need to take every step we can to help curb global warming. You can boost your personal contribution to that effort and set an example for your friends, family, and neighbors by traveling green.

Appendix A: Methodology

As many environmentally conscious consumers are aware, driving a personal vehicle has a clearly defined global warming impact. Such a vehicle emits slightly more than 19 pounds of carbon dioxide for every gallon of gasoline it consumes; producing that fuel and transporting it from the wellhead to the pump releases another five to six pounds of carbon dioxide. In all, some 25 pounds of CO_2 enter the atmosphere for every gallon of gasoline our cars and trucks burn. Fuel-efficient vehicles, of course, are better for the environment when it comes to personal travel. However, as this report shows, other options are also available.

Large motor coaches and trains with low occupancy make excellent environmental choices for vacation travel, because your decision to ride those vehicles adds essentially no environmental impact. If a half-empty bus is already scheduled to travel from Baltimore to Knoxville, adding you to the passenger manifest won't require the company to send another bus. "On the margin," therefore, your decision to take that trip won't add carbon to the atmosphere.

In fact, however, the fuller a vehicle, the more environmentally friendly it is. On a per-passenger basis, a car is roughly four times as environmentally friendly with four seats occupied as when the driver travels alone. This same principle applies to other vehicles as well. Whether there are five people in a car, 50 people in a motor coach, or 500 people in a 747, the environment gets more travel "bang" for its carbon "buck" when those vehicles are fully occupied.

So what does this all mean for consumers trying to make environmentally friendly travel decisions? Fortunately, the answer is straightforward. Today, except in certain highly congested areas, most buses and trains run well under capacity. These travel modes are therefore usually your best environmental bet.

Of course, emissions *are* associated with *all* travel, and the best way to compare modes is on a per-passenger basis. The following sections explain the overall methodology we used in this report, and provide the emission factors for each mode. See Appendices B (aircraft), C (automobiles), D (rail), and E (intercity motor coaches) for more on the calculations and assumptions for individual modes.

Green Travel Methodology Overview

Our analysis is based on energy consumption, ridership (passenger-miles), and carbon dioxide emissions for each mode of travel. We obtained that information from a number of government and commercial sources for the most recent year available, usually 2004 or 2005.[45]

We then used standard metrics to convert energy consumption to CO_2 emissions, and divided by ridership, to arrive at average pounds of CO_2 emitted per passenger-mile traveled in each mode.

Finally, we added upstream CO_2 emissions—those associated with extracting, refining, and transporting a given fuel—to yield total pounds of carbon dioxide emitted per passenger-mile traveled in each mode.[46] We estimated per-trip emissions by multiplying the latter number by distance traveled. (See Appendices B through E for these values for each mode.)

Table 5 provides examples of distances for road and air travel between popular domestic locations.[47]

Why We Do Not Evaluate Travel on the Margin

In this report we developed and used average emission factors rather than attempting to estimate marginal emissions—that is, those associated with each additional passenger. We did this for several reasons. First and most important, the data we collected on fuel use and ridership for each travel mode are aggregated, and thus are not amenable to marginal calculations.

Moreover, even if such data *were* available, the resulting emission factors would depend heavily on the capacity of each vehicle. This would yield widely variable and sometimes extreme results that would impart little practical information to the typical vacation traveler.

Finally, passengers on planes, rail, and motor coaches rarely know ahead of time whether they are taking the last seat on a plane, or whether they are

Table 5. Distances between Popular Vacation Route Origins and Destinations, in Miles

Red = Flying   Blue = Driving

Destination		Origin: Boston	Chicago	Los Angeles	New York City	San Francisco
Atlanta	Driving	1,100	720	2,185	880	2,595
	Flying	950	605	1,950	760	2,140
Boston	Driving	-	985	2,980	215	3,110
	Flying	-	870	2,610	185	2,705
Chicago	Driving	985	-	2,015	790	2,130
	Flying	870	-	1,750	740	1,845
Denver	Driving	1,970	1,005	1,025	1,775	1,270
	Flying	1,755	890	860	1,620	965
Las Vegas	Driving	2,730	1,750	270	2,540	570
	Flying	2,380	1,515	240	2,240	410
Los Angeles	Driving	2,980	2,015	-	2,800	380
	Flying	2,610	1,750	-	2,460	335
Miami	Driving	1,505	1,415	2,740	1,290	3,095
	Flying	1,260	1,750	2,340	1,090	2,585
New York City	Driving	215	790	2,800	-	2,900
	Flying	185	740	2,460	-	2,580
Orlando	Driving	1,300	1,230	2,510	1,085	2,890
	Flying	1,120	1,005	2,215	945	2,445
Phoenix	Driving	2,700	1,915	370	2,460	750
	Flying	2,300	1,440	370	2,150	650
San Francisco	Driving	3,110	2,130	380	2,900	-
	Flying	2,705	1,845	335	2,580	-
Seattle	Driving	3,055	2,060	1,140	2,860	800
	Flying	2,495	1,720	955	2,410	680
Washington, DC	Driving	440	700	2,715	230	2,815
	Flying	415	590	2,290	220	2,420

Sources: Driving distances from city center to city center—*www.randmcnally.com*. Nonstop flying distances between major airports—Bureau of Transportation Statistics, *Inter-airport distance*, *http://www.transtats.bts.gov/distance.asp*. Rail distances vary from the driving and flying distances, depending on the route selected.

responsible for putting a new motor coach into operation. Without that information, travelers would lack the ability to ascertain their "place" along the marginal continuum.

Limitations of Our Assessment

Our methodology examines only carbon dioxide emissions. While other pollutants from these transportation modes have clear adverse environmental effects, limits on the available information prevented us from including these effects in our analysis. As more data on emissions other than CO_2 from various travel modes become available, we hope to factor that information into our analysis.

We also exclude "radiative forcing" of greenhouse gas emissions from airplanes at cruising altitudes (more than 3,000 feet) from our current methodology.[48] Scientists agree that greenhouse gas emissions at these high altitudes lead to radiative forcing, but the exact mechanism and associated multiplier are unclear. Similar uncertainty remains regarding the effects of the large quantity of water vapor (contrails) emitted in flight. As analysts begin to better understand the contribution (positive or negative) of contrails to climate change, we could also include those findings when updating our analysis.

Appendix B: Aircraft Data

We estimated carbon dioxide emissions from aircraft based on reported data for three categories of flight operations: (1) cruising (a function of distance flown); (2) ground operations; and (3) takeoff/landing and approach (TOL). The latter two categories occur once per flight (or, in the case of multi-leg trips, once per leg), and are not a function of distance flown.

The emission factors used in this report are average estimates for four different types of aircraft: wide-body jets, narrow-body jets, regional jets, and turboprops. However, many airline and travel websites now provide information on the specific type of aircraft used for a given flight—a useful tool for those seeking the lowest-carbon flight. (See Table 6 for emissions from the most commonly flown aircraft.)

Of course, 747s are not used commercially for 100-mile trips, and turboprops are not used for cross-country trips. Based on data from the Federal Aviation Administration, we assumed turboprop use for flight distances of 100 to 275 miles, regional jet use for flights of approximately 500 miles, narrow-body jets for flights of 750 to 1,500 miles, and wide-body jets for flights covering more than 2,000 miles.

Airlines today fly planes with occupancies that average 80 percent of their passenger capacity, and typically add freight to fill up available remaining weight capacity. We therefore used an 80 percent load factor when determining per-passenger emissions associated with air travel.

How Delays Affect Carbon Emissions

Air traffic delays force aircraft to burn more fuel, and thus produce more carbon emissions. Estimates show that delays resulted in 7.1 million metric tons of CO_2 emissions in 2007.[49] Given indirect emissions from the production and transport of the extra fuel, delays were responsible for a total of 8.5 million metric tons of CO_2 emissions.

The U.S. Environmental Protection Agency reports that domestic commercial aviation accounted for 144 million metric tons of CO_2 emissions in 2006.[50] Given the total emissions from delays noted above, that means they exacted a 6 percent CO_2 penalty on average. However, because delays do not occur system-wide, but rather depend on where and when you fly, this report does not account for carbon emissions associated with them.

Table 6. Average Aircraft Emission Factors, by Type

Aircraft	Manufacturer	Aircraft category (wide-body jet = WJ, narrow-body jet = NJ, regional jet = RJ, turboprop = TP)	Avg. miles per flight, by aircraft	Avg. in-flight emissions, by aircraft (lbs. CO_2/seat-mile)	Avg. TOL+ground emissions, by aircraft (lbs. CO_2/seat-flight)
B744	Boeing	WJ	3,587	0.36	25
MD11	McDonnell Douglas	WJ	2,925	0.40	27
B772	Boeing	WJ	2,661	0.35	37
B767	Boeing	WJ	2,336	0.31	34
B747	Boeing	WJ	2,225	0.42	28
B763	Boeing	WJ	2,112	0.35	36
Use-Weighted Average:		**WJ**		**0.36**	**31**
B757	Boeing	NJ	1,501	0.34	32
B753	Boeing	NJ	1,432	0.35	31
B752	Boeing	NJ	1,212	0.34	24
MD83	McDonnell Douglas	NJ	1,072	0.42	33
A320	Airbus	NJ	846	0.37	33
B737	Boeing	NJ	798	0.40	39
A319	Airbus	NJ	775	0.40	33
B733	Boeing	NJ	597	0.41	34
MD80	McDonnell Douglas	NJ	540	0.50	41
Use-Weighted Average:		**NJ**		**0.38**	**33**
CRJ7	Bombardier/Canadair	RJ	561	0.37	22
CRJ2	Bombardier/Canadair	RJ	465	0.57	30
CRJ1	Bombardier/Canadair	RJ	463	0.54	28
E145	Embraer	RJ	461	0.58	43
Use-Weighted Average:		**RJ**		**0.54**	**33**
AT72	Aerospatiale	TP	261	0.39	15
AT43	Aerospatiale	TP	219	0.41	17
SF34	Saab	TP	202	0.89	32
DH8A	De Havilland	TP	191	0.54	20
C208	Cessna	TP	144	0.57	31
Use-Weighted Average:		**TP**		**0.55**	**21**

Sources: Aircraft classifications—*www.pyramid.ch*, *Commercial aircraft encyclopedia*. Emission rates—Federal Aviation Administration, 2004, SAGE aircraft data.
Notes: Use-weighted averages apply to each aircraft class. Yellow = wide-body jets (2,000-mile or greater typical range). Blue = narrow-body jets (500–1,500-mile typical range). Orange = regional jets (500-mile typical range). Purple = turboprops (125–275-mile typical range). TOL = takeoff and landing.

Table 7. Aircraft CO_2 Emissions from Takeoff/Landing and Approach

As Reported by the Federal Aviation Administration (SAGE 2004)[51]

Aircraft	Number of economy-equiv. seats	Fraction of global use (%)	Distance (miles)	No. of flights	CO_2 emissions (kg)	CO_2 emissions per TOL (lbs./TOL)	Avg. per-seat CO_2 emissions (lbs./seat-flight)	Avg. CO_2 by aircraft category (lbs./seat-flight)	Aircraft category
B744	611	6.2%	9.7E+06	3.8E+05	1.4E+09	7,929	19.5	21	Wide-body jet
MD11	410	1.6%	2.9E+06	1.2E+05	2.7E+08	4,985	18.3		
B772	391	4.3%	7.9E+06	3.5E+05	1.1E+09	6,738	26.0		
B767	307	1.9%	7.5E+04	3.1E+03	5.7E+06	4,016	19.7		
B747	524	<0.1%	8.6E+04	1.1E+03	3.8E+06	7,421	21.3		
B763	274	5.0%	1.2E+07	5.2E+05	9.1E+08	3,888	21.4		
B757	228	0.4%	7.7E+04	3.4E+03	4.6E+06	3,054	20.2	22	Narrow-body jet
B753	227	0.4%	1.3E+06	5.7E+04	7.9E+07	3,041	20.2		
B752	218	5.7%	2.3E+07	1.0E+06	9.7E+08	2,113	14.6		
MD83	172	0.8%	3.9E+06	1.6E+05	1.8E+08	2,477	21.7		
A320	159	8.1%	4.8E+07	2.0E+06	2.4E+09	2,620	24.1		
B737	136	3.7%	2.2E+07	9.8E+05	9.9E+08	2,229	24.7		
A319	137	3.8%	2.4E+07	1.0E+06	9.7E+08	2,070	22.8		
B733	140	5.3%	4.2E+07	1.9E+06	1.6E+09	1,943	20.9		
MD80	145	2.6%	2.4E+07	9.8E+05	1.3E+09	2,910	30.2		
CRJ7	72	0.9%	7.9E+06	3.5E+05	9.2E+07	581	12.1	21	Regional jet
CRJ2	50	2.8%	2.8E+07	1.2E+06	3.2E+08	575	17.3		
CRJ1	50	2.5%	2.5E+07	1.1E+06	2.9E+08	581	17.5		
E145	50	3.1%	3.3E+07	1.4E+06	6.4E+08	1,019	30.7		
AT72	66	0.6%	7.9E+06	4.9E+05	8.8E+07	399	9.1	15	Turboprop
AT43	46	0.3%	4.4E+06	2.5E+05	3.4E+07	303	9.9		
SF34	34	0.7%	1.0E+07	7.1E+05	1.9E+08	593	26.3		
DH8A	37	0.3%	1.2E+07	6.7E+05	8.4E+07	278	11.3		
C208	12	0.2%	4.4E+06	2.5E+05	2.0E+07	180	22.6		
Total		**61.2%**							

Notes: These estimates apply to emissions from operations that occur on the ground or at altitudes lower than 3,000 feet. All aircraft calculations assume an average load factor of 80 percent. We add 20 percent to the totals for indirect emissions associated with the production and distribution of jet fuel. See Appendix A for sources and details. TOL = takeoff and landing.

Table 8. Aircraft CO_2 Emissions from Ground Operations

As Reported by the Federal Aviation Administration (SAGE 2004)[52]

Aircraft	Number of economy-equiv. seats	No. of flights	Fuel consumed (kg)	CO_2 (kg)	Fuel per flight (kg/flight)	CO_2 (kg/ground operation)	CO_2 (lbs./ground operation)	Total CO_2 emissions (lbs./seat-flight)	Avg. CO_2 by aircraft category (lbs./seat-flight)	Aircraft category
B744	611	3.8E+05	1.2E+08	3.9E+08	325	1,028	2,267	5.6	10	Wide-body jet
MD11	410	1.2E+05	4.1E+07	1.3E+08	346	1,088	2,399	8.8		
B772	391	3.5E+05	1.4E+08	4.4E+08	401	1,263	2,784	10.7		
B767	307	3.1E+03	1.3E+06	4.2E+06	423	1,332	2,936	14.4		
B747	524	1.1E+03	4.0E+05	1.3E+06	354	1,116	2,461	7.1		
B763	274	5.2E+05	2.0E+08	6.3E+08	384	1,211	2,670	14.7		
B757	228	3.4E+03	8.4E+05	2.6E+06	250	788	1,738	11.5	11	Narrow-body jet
B753	227	5.7E+04	1.4E+07	4.4E+07	244	773	1,704	11.3		
B752	218	1.0E+06	2.0E+08	6.3E+08	195	615	1,356	9.4		
MD83	172	1.6E+05	2.9E+07	9.0E+07	178	560	1,235	10.8		
A320	159	2.0E+06	3.0E+08	9.3E+08	145	459	1,011	9.3		
B737	136	9.8E+05	1.8E+08	5.6E+08	182	575	1,267	14.0		
A319	137	1.0E+06	1.4E+08	4.4E+08	136	426	940	10.3		
B733	140	1.9E+06	3.2E+08	1.0E+09	171	543	1,197	12.9		
MD80	145	9.8E+05	1.5E+08	4.7E+08	152	481	1,060	11.0		
CRJ7	72	3.5E+05	2.4E+07	7.6E+07	68	216	476	10.0	12	Regional jet
CRJ2	50	1.2E+06	7.4E+07	2.3E+08	60	189	416	12.5		
CRJ1	50	1.1E+06	5.6E+07	1.8E+08	51	160	353	10.6		
E145	50	1.4E+06	8.3E+07	2.6E+08	60	189	416	12.5		
AT72	66	4.9E+05	1.8E+07	5.8E+07	38	119	263	6.0	7	Turboprop
AT43	46	2.5E+05	7.1E+06	2.3E+07	29	91	201	6.6		
SF34	34	7.1E+05	1.2E+07	3.9E+07	17	54	119	5.3		
DH8A	37	6.7E+05	2.9E+08	6.5E+07	435	98	216	8.8		
C208	12	2.5E+05	2.5E+06	7.9E+06	10	32	70	8.7		

Table 9. Aircraft CO_2 Emissions from In-Flight Cruising (>3,000 ft.)

As Reported by the Federal Aviation Administration (SAGE 2004)[53]

Aircraft	Number of economy-equiv. seats	Miles per flight (avg.)	Distance (miles)	Number of flights	Fuel burn (kg)	CO_2 (kg)	Fuel per flight (kg/flight)	CO_2 (lbs./mile)	Total CO_2 (lbs./seat-mile)	Avg. CO_2 by aircraft category (lbs./seat-mile)	Aircraft category
B744	611	3,587	1.3E+09	3.8E+05	2.8E+10	8.9E+10	74,844	145	0.36	0.36	Wide-body jet
MD11	410	2,925	3.4E+08	1.2E+05	5.4E+09	1.7E+10	45,468	108	0.40		
B772	391	2,661	9.2E+08	3.5E+05	1.2E+10	3.8E+10	34,882	91	0.35		
B767	307	2,336	7.3E+06	3.1E+03	6.6E+07	2.1E+08	20,999	63	0.31		
B747	524	2,225	2.5E+06	1.1E+03	5.4E+07	1.7E+08	47,100	147	0.42		
B763	274	2,112	1.1E+09	5.2E+05	9.9E+09	3.1E+10	19,241	63	0.35		
B757	228	1,501	5.0E+06	3.4E+03	3.7E+07	1.2E+08	10,925	51	0.34	0.38	Narrow-body jet
B753	227	1,432	8.1E+07	5.7E+04	6.1E+08	1.9E+09	10,717	52	0.35		
B752	218	1,212	1.2E+09	1.0E+06	8.7E+09	2.7E+10	8,550	49	0.34		
MD83	172	1,072	1.7E+08	1.6E+05	1.2E+09	3.8E+09	7,449	48	0.42		
A320	159	846	1.7E+09	2.0E+06	9.9E+09	3.1E+10	4,867	40	0.37		
B737	136	798	7.8E+08	9.8E+05	4.1E+09	1.3E+10	4,178	36	0.40		
A319	137	775	8.0E+08	1.0E+06	4.2E+09	1.3E+10	4,051	36	0.40		
B733	140	597	1.1E+09	1.9E+06	6.0E+09	1.9E+10	3,235	38	0.41		
MD80	145	540	5.3E+08	9.8E+05	3.6E+09	1.2E+10	3,714	48	0.50		
CRJ7	72	561	2.0E+08	3.5E+05	5.0E+08	1.6E+09	1,425	18	0.37	0.54	Regional jet
CRJ2	50	465	5.7E+08	1.2E+06	1.6E+09	4.9E+09	1,264	19	0.57		
CRJ1	50	463	5.1E+08	1.1E+06	1.3E+09	4.2E+09	1,205	18	0.54		
E145	50	461	6.4E+08	1.4E+06	1.8E+09	5.6E+09	1,267	19	0.58		
AT72	66	261	1.3E+08	4.9E+05	3.1E+08	9.8E+08	639	17	0.39	0.55	Turboprop
AT43	46	219	5.4E+07	2.5E+05	9.9E+07	3.1E+08	399	13	0.41		
SF34	34	202	1.4E+08	7.1E+05	4.1E+08	1.3E+09	580	20	0.89		
DH8A	37	191	1.3E+08	6.7E+05	2.4E+08	7.7E+08	364	13	0.54		
C208	12	144	3.6E+07	2.5E+05	2.4E+07	7.4E+07	95	5	0.57		

Table 10. Calculations of Seat Area for Sample Aircraft

United A320								Avg. no. of seats per aircraft	Northwest A320							
Seat class	Pitch inches	No. seats across	% Overhead	"Area"	Economy seats displaced	Seats in class	Economy equivalent		Seat class	Pitch inches	No. seats across	% Overhead	"Area"	Economy seats displaced	Seats in class	Economy equivalent
Coach	31	6	25%	6.46	1.0	90	90		Coach	31	6	25%	6.46	1.0	132	132
Coach +	36	6	30%	7.80	1.2	36	43	**159**	Coach +	32	6	30%	6.93	1.1	0	0
First	38	4	40%	13.30	2.1	12	25		First	36	4	40%	12.60	2.0	16	31
Total							**158**		**Total**							**163**

United A319								Avg. no. of seats per aircraft	Northwest A319							
Seat class	Pitch inches	No. seats across	% Overhead	"Area"	Economy seats displaced	Seats in class	Economy equivalent		Seat class	Pitch inches	No. seats across	% Overhead	"Area"	Economy seats displaced	Seats in class	Economy equivalent
Coach	31	6	25%	6.46	1.0	72	72		Coach	31	6	25%	6.46	1.0	108	108
Coach +	35	6	30%	7.58	1.2	40	47	**137**	Coach +	32	6	30%	6.93	1.1	0	0
First	38	4	40%	13.30	2.1	8	16		First	35	4	40%	12.25	1.9	16	30
Total							**135**		**Total**							**138**

United B777-200								Avg. no. of seats per aircraft	Delta 777-200							
Seat class	Pitch inches	No. seats across	% Overhead	"Area"	Economy seats displaced	Seats in class	Economy equivalent		Seat class	Pitch inches	No. seats across	% Overhead	"Area"	Economy seats displaced	Seats in class	Economy equivalent
Coach	31	9	25%	4.31	1.0	223	223		Coach	31	9	25%	4.31	1.0	218	218
Coach +	35	9	30%	5.06	1.2	89	105	**391**	Coach +	35	9	30%	5.06	1.2	0	43
First	38	6	40%	8.87	2.1	36	74		First	60	6	40%	14.00	3.3	50	163
Total							**402**		**Total**							**381**

Sources: For computation methodology—Stuart Reddaway, 2007, *The carbon cost of business and first-class long-haul flying*, online at *www.tufts.edu/tie/carbonoffsets/aircalculator.htm*.
For airline configuration specifications—*www.seatguru.com*.
Note: For more information on seat configurations used by different carriers, see *www.united.com*, *www.nwa.com*, and *www.delta.com*.

Appendix C: Automobile Data

Per-trip emissions from automobiles are treated differently from those of airplanes, trains, and motor coaches. That's because—unlike in other modes—the traveler determines the number of passengers in a car, truck, or SUV. What's more, per-passenger carbon emissions from personal vehicles decline precipitously as the number of occupants rises. If a driver decides to travel alone, the vehicle's carbon emissions are fully attributed to that individual. If, on the other hand, the driver brings a spouse, a friend, or an entire family along, he or she incurs a small carbon penalty for the extra weight but per-person emissions fall by a factor of two, three, four, or more. In the case of airplanes, buses, and trains, we assume that those emission factors remain constant regardless of the number of passengers traveling.[54]

Per-trip emissions from automobiles vary dramatically with the type of vehicle. We estimated emissions for five different types of passenger vehicles: hybrid car, efficient conventional car, typical car, typical SUV, and large SUV. We evaluated each type of vehicle with one to five passengers, accounting for the modest drop in fuel economy that results from the additional people and their luggage.[55]

Table 11. Per-Vehicle CO_2 Emissions by Vehicle Type and Number of Occupants

	Occupants				
	1	2	3	4	5
	CO_2 emissions in lbs./vehicle-mile (direct and indirect emissions)				
Hybrid car (46 mpg)	0.54	0.56	0.58	0.60	0.63
Efficient car (32 mpg)	0.78	0.81	0.85	0.89	0.93
Typical car (23 mpg)	1.08	1.12	1.16	1.21	1.26
Typical SUV (18 mpg)	1.39	1.42	1.46	1.51	1.55
Large SUV (12 mpg)	2.08	2.12	2.17	2.21	2.26

Assumptions regarding average weight, in pounds:	
Passenger	150
Luggage (per-passenger)	50
Hybrid car	3,500
Efficient car	3,000
Average car	3,500
Average SUV	4,500
Worst SUV	6,000

Constants:
19.564 pounds of CO_2 per gallon of gasoline (direct emission factor)
27.5% (multiplier for indirect emissions)[56]

Sources: Fuel economies for different types of vehicles are based on assessments at *www.fueleconomy.gov* and in EPA, Office of Transportation and Air Quality, 2008, *Light-duty automotive technology and fuel economy trends: 1975–2008.*

Table 12. Per-Passenger CO_2 Emissions by Vehicle Type and Number of Occupants

	Occupants				
	1	2	3	4	5
	CO_2 emissions in lbs./passenger-mile				
Hybrid car (46 mpg)	0.54	0.28	0.19	0.15	0.13
Efficient car (32 mpg)	0.78	0.41	0.28	0.22	0.19
Typical car (23 mpg)	1.08	0.56	0.39	0.30	0.25
Typical SUV (18 mpg)	1.39	0.71	0.49	0.38	0.31
Large SUV (12 mpg)	2.08	1.06	0.72	0.55	0.45

Table 13. Total CO_2 Emissions from Automobiles by Number of Travelers and Distance

Pounds per Trip

Number of travelers		Distance traveled (miles)							
		100	250	500	750	1,000	2,000	2,500	3,000
1	Hybrid car	54	136	271	407	542	1,085	1,356	1,627
2		56	140	281	421	562	1,123	1,404	1,685
3		58	146	291	437	582	1,164	1,455	1,747
4		60	151	302	453	604	1,209	1,511	1,813
5		63	157	314	471	628	1,257	1,571	1,885
1	Efficient car	78	195	390	585	780	1,559	1,949	2,339
2		81	203	406	609	812	1,624	2,030	2,436
3		85	212	424	635	847	1,695	2,118	2,542
4		89	221	443	664	886	1,772	2,214	2,657
5		93	232	464	696	928	1,856	2,320	2,784
1	Typical car	108	271	542	813	1,085	2,169	2,711	3,254
2		112	281	562	842	1,123	2,246	2,808	3,369
3		116	291	582	873	1,164	2,329	2,911	3,493
4		121	302	604	907	1,209	2,418	3,022	3,627
5		126	314	628	943	1,257	2,514	3,142	3,771
1	Typical SUV	139	346	693	1,039	1,386	2,772	3,464	4,157
2		142	356	712	1,068	1,424	2,848	3,559	4,271
3		146	366	732	1,098	1,464	2,928	3,660	4,392
4		151	377	753	1,130	1,506	3,013	3,766	4,519
5		155	388	776	1,163	1,551	3,103	3,878	4,654
1	Large SUV	208	520	1,039	1,559	2,079	4,157	5,197	6,236
2		212	530	1,061	1,591	2,121	4,242	5,303	6,363
3		217	541	1,083	1,624	2,165	4,331	5,413	6,496
4		221	553	1,106	1,659	2,211	4,423	5,528	6,634
5		226	565	1,130	1,695	2,259	4,519	5,649	6,778

Appendix D: Rail Data

Train service in America falls into two distinct categories: the Northeast Corridor (from Washington, DC, to Boston), where trains run on electricity, and the rest of Amtrak's network, where trains run on diesel. Tables 14 and 15 provide our calculations for the emission factors from both types of trains, based on data from Amtrak and the federal government. We assumed that trains in the Northeast Corridor run on electricity, while those in all other regions run on diesel.

Amtrak claims that emission factors for electric and diesel service are similar. However, we came to a different conclusion. The electric locomotives that Amtrak uses in the Northeast Corridor are heavy and not very efficient, but they are still slightly cleaner than the diesel trains used elsewhere in the country. That is because the electricity grid serving the Northeast Corridor is relatively clean—it relies less on coal and more on natural gas and hydroelectricity than the grid in much of the rest of the country. And because of the pollution associated with extracting, refining, and distributing diesel fuel,[57] we found that when we accounted for both in-use and upstream carbon emissions, electric trains end up being roughly 20 percent cleaner than diesel trains.

Table 14. Estimate of Emission Factor for Diesel Rail, 2005

	Units	Source
65.5	Million gallons of diesel fuel consumed	(a)
22.38	Pounds of CO_2 per gallon of diesel (downstream only)	(b)
1,466	Million pounds of CO_2 from Amtrak diesel trains	computed
3,821	Estimated Amtrak non-electrified passenger-miles (millions)[58]	(c)
0.38	Pound of CO_2 per passenger-mile	computed
0.20	Indirect emission factor	(d)
0.45	**Pound of CO_2 per passenger-mile (includes upstream emissions)**	computed

(a) *www.amtrak.com.*
(b) *www.eia.doe.gov/oiaf/1605/coefficients.html.*
(c) Estimated value, confirmed by National Association of Railroad Passengers.
(d) EPA, Office of Transportation and Air Quality, 2006, *Greenhouse gas emissions from the U.S. transportation sector 1990–2003.*

Table 15. Estimate of Emission Factor for Electric Rail, 2005

	Units	Source
65.5	Million gallons of diesel	(a)
138,700	BTUs per gallon of diesel	(b)
9.08	Trillion BTUs of diesel use	computed
533	Million kWh of electricity consumed	(c)
10%	Electricity transmission losses (est.)	
593	Million kWh of electricity consumed (incl. transmission)	computed
5,381	Total Amtrak passenger-miles in 2005 (millions)	(d)
1,560	Million passenger-miles in Northeast Corridor (est.)[59]	(e)
0.908	Pound of CO_2 per kWh (Northeast avg., 2004)	(f)
538	Million pounds of CO_2 from Amtrak in Northeast Corridor	computed
0.34	Pound of CO_2 per passenger-mile	computed
0.075	Indirect emission factor	(g)
0.37	**Pound of CO_2 per passenger-mile (includes upstream emissions)**	computed

(a) *www.amtrak.com.*
(b) Oak Ridge National Laboratory (ORNL), 2008, *Transportation energy data book*, Table A.15.
(c) Computed based on total Amtrak energy use reported in ORNL, Table 9.10.
(d) ORNL, Table 9.10.
(e) *Amtrak monthly performance report*, November 2006, page A-1.3.
(f) *http://www.epa.gov/solar/documents/eGRID2006V2_1_Summary_Tables.pdf.*
(g) EPA, Office of Transportation and Air Quality, 2006, *Greenhouse gas emissions from the U.S. transportation sector 1990–2003.*

Table 16. Total CO_2 Emissions from Rail by Number of Travelers and Distance

Pounds per Trip

No. of travelers		Distance traveled (miles)							
		100	250	500	750	1,000	2,000	2,500	3,000
1	Diesel	45	114	227	341	454	908	1,135	1,362
2	Diesel	91	227	454	681	908	1,816	2,271	2,725
3	Diesel	136	341	681	1,022	1,362	2,725	3,406	4,087
4	Diesel	182	454	908	1,362	1,816	3,633	4,541	5,449
5	Diesel	227	568	1,135	1,703	2,271	4,541	5,676	6,812
1	Electric	37	93	185	n/a	n/a	n/a	n/a	n/a
2	Electric	74	185	371	n/a	n/a	n/a	n/a	n/a
3	Electric	111	278	556	n/a	n/a	n/a	n/a	n/a
4	Electric	148	371	741	n/a	n/a	n/a	n/a	n/a
5	Electric	185	463	927	n/a	n/a	n/a	n/a	n/a
1	Average	43	107	215	322	430	860	1,075	1,290
2	Average	86	215	430	645	860	1,720	2,150	2,580
3	Average	129	322	645	967	1,290	2,580	3,224	3,869
4	Average	172	430	860	1,290	1,720	3,439	4,299	5,159
5	Average	215	537	1,075	1,612	2,150	4,299	5,374	6,449

Note: "Average" estimates reflect average use-weighted emissions from diesel and electric rail combined (0.43 pound of CO_2 per passenger-mile).

Appendix E: Motor Coach Data

Because motor coaches encounter much less stop-and-go traffic than public-transit buses, they have notably lower carbon emissions, making them a very green way to travel. In fact, even when not filled to capacity, motor coaches have the smallest carbon emission factors of any major motorized vehicle.

We relied on several sources of information to develop emission factors for motor coaches (intercity buses). Without a way to evaluate which source had the most accurate information, we simply averaged the results from all the sources to develop the emission value used in this report.

We multiplied bus emission factors by the distance traveled and the number of people in the party to arrive at total carbon footprints.

Table 17. Estimates of Emission Factor for Motor Coaches

		Units	Source
American Bus Association	184	Passenger-miles per gallon of diesel	(a)
	22.38	Pounds of CO_2 per gallon of diesel	(b)
	0.12	**Pound of CO_2 per passenger-mile**	computed
Greyhound	184	Passenger-miles per gallon of diesel	(c)
	22.38	Pounds of CO_2 per gallon of diesel	(b)
	0.12	**Pound of CO_2 per passenger-mile**	computed
Congressional Research Service	953	BTUs per passenger-mile (1990)	(e)
	161.4	Pounds of CO_2 per million BTUs	(f)
	0.15	**Pound of CO_2 per passenger-mile**	computed
Oak Ridge National Laboratory	932	BTUs per passenger-mile (2000)	(g)
	161.4	Pounds of CO_2 per million BTUs	(h)
	0.15	**Pound of CO_2 per passenger-mile**	computed
Peter Pan	946	BTUs per passenger-mile (2006)	(i)
	161.4	Pounds of CO_2 per million BTUs	(j)
	0.15	**Pound of CO_2 per passenger-mile**	computed
Averages	0.14	Pound of CO_2 per passenger-mile	(k)
	0.20	Indirect emission factor	(l)
	0.17	**Pound of CO_2 per passenger-mile (includes upstream emissions)**	computed

(a) M.J. Bradley & Associates, American Bus Association, May 2007, Table 2.2.
(b) Energy Information Administration, *www.eia.doe.gov/oiaf/1605/coefficients.html.*
(c) *www.greyhound.com/home/en/About/FactsAndFigures.aspx.*
(d) Energy Information Administration, *www.eia.doe.gov/oiaf/1605/coefficients.html.*
(e) CRS, 1996, *Amtrak and energy conservation in intercity passenger transportation*, *www.ncseonline.org/NLE/CRSreports/energy/eng-11.cfm.*
(f) Energy Information Administration, *www.eia.doe.gov/oiaf/1605/factors.html.*
(g) Oak Ridge National Laboratory, 2008, *Transportation energy data book*, Table 2.13.
(h) Energy Information Administration, *www.eia.doe.gov/oiaf/1605/factors.html.*
(i) *www.peterpanbus.com/who-we-are/go-green.php.*
(j) Energy Information Administration, *www.eia.doe.gov/oiaf/1605/factors.html.*
(k) Computed average of five sources.
(l) EPA, Office of Transportation and Air Quality, 2006, *Greenhouse gas emissions from the U.S. transportation sector 1990–2003.*

Table 18. Total CO_2 Emissions from Motor Coaches by Number of Travelers and Distance

Pounds per Trip

	Distance traveled (miles)							
Number of travelers	100	250	500	750	1,000	2,000	2,500	3,000
1	17	42	84	126	168	336	420	504
2	34	84	168	252	336	672	840	1,008
3	50	126	252	378	504	1,008	1,260	1,512
4	67	168	336	504	672	1,344	1,680	2,016
5	84	210	420	630	840	1,680	2,100	2,520

Appendix F: Comparing Carbon Footprints for Each Travel Mode

The figures below compare carbon footprints across all major modes of travel for vacation parties of different sizes. To avoid complication, we averaged the results for specific types of vehicles within some travel modes in the body of the report.

Figure 23. Comparing Carbon Footprints across All Modes: Solo Traveler

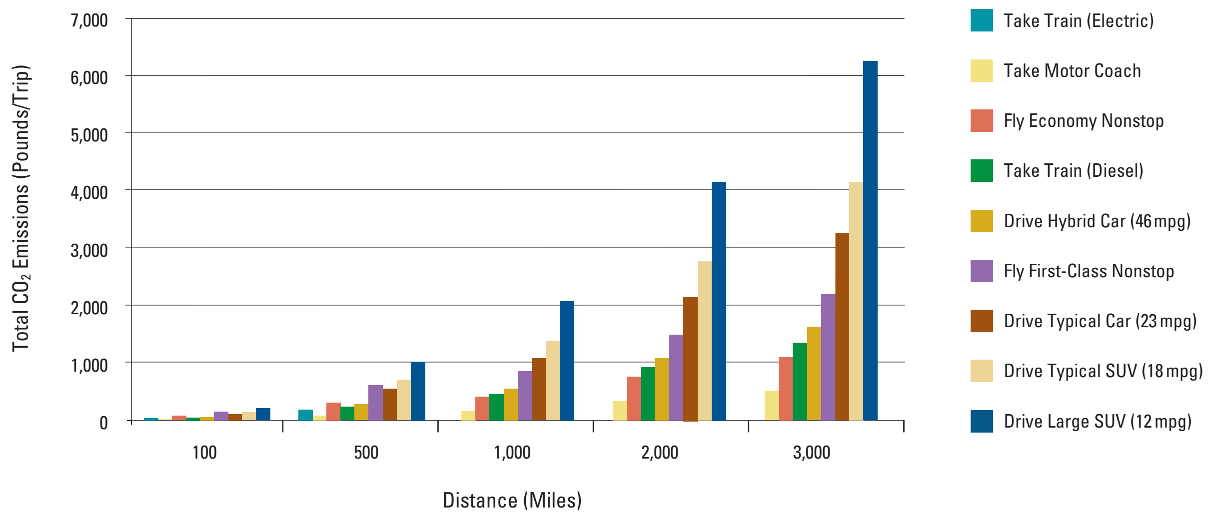


Figure 24. Comparing Carbon Footprints across All Modes: Two Travelers

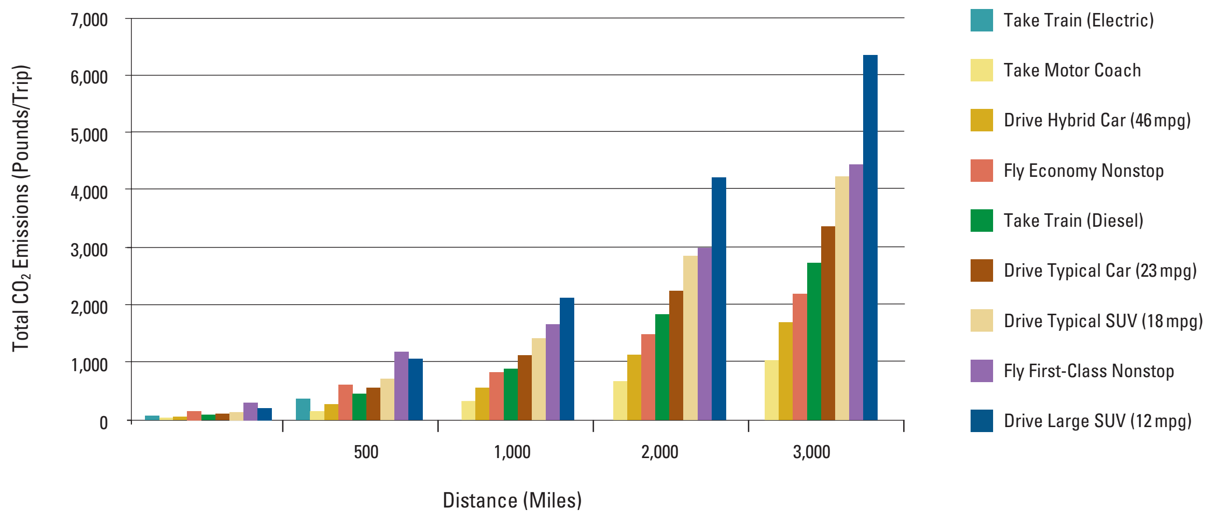
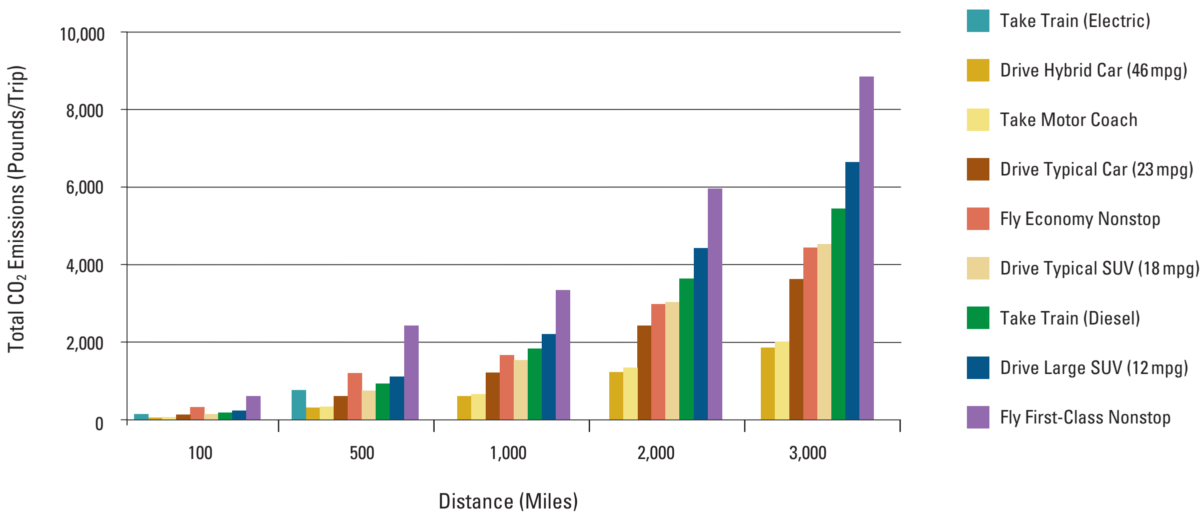


Figure 25. Comparing Carbon Footprints across All Modes: Family of Four



Endnotes

[1] Coach seats with more legroom—sometimes called "economy-plus"—are responsible for an average of 20 percent more carbon than standard coach seats.

[2] U.S. Department of Transportation. 1997. *1995 American travel survey*. Washington, DC. These statistics are the most recent available, as the department does not update them routinely.

[3] U.S. Department of Transportation. *National household travel survey: Summer travel quick facts, 2001–2002*. Washington, DC. Online at *www.bts.gov/programs/national_household_travel_survey/summer_travel.html.*

[4] Travel Industry Association (TIA). 2007. New study identifies travelers' ideal vacation trip. Washington, DC.

[5] TIA 2007.

[6] U.S. Department of Transportation 1997.

[7] See Appendices A through E for more on our research methods and how we calculated our results.

[8] TIA 2007.

[9] NBC News. 2007. Escape work: Get the most out of your vacations. Online at *http://today.msnbc.msn.com/id/18897063/.*

[10] U.S. Department of Transportation. *National household travel survey: Summer travel quick facts, 2001–2002.*

[11] This calculation is based on: U.S. Environmental Protection Agency (EPA). 2006. *Greenhouse gas emissions from the U.S. transportation sector: 1990–2003*. And: Energy Information Administration. 2007. *Emissions of greenhouse gases in the United States, 2006*. The 40 percent figure includes "upstream" emissions associated with extracting, refining, and transporting fuel from the wellhead to the fuel pump.

[12] For more information, see *www.ucsusa.org/global_warming/global_warming_101/.*

[13] Oak Ridge National Laboratory (ORNL). 2008. *Transportation energy data book*, 27th edition, Table 9.2. Oak Ridge, TN.

[14] Federal Aviation Administration (FAA). March 15, 2007. Press release no. AOC-8-07. Washington, DC.

[15] U.S. Department of Transportation, Bureau of Transportation Statistics, Research and Innovation Technology Administration (RITA). 2008. Transtats database. Online at *www.transtats.bts.gov.* Washington, DC.

[16] Although the aircraft and its fuel account for most of the weight on a flight, the "payload" (crew, supplies, passengers, luggage, and air freight) does affect the flight's carbon footprint. The industry attributes 100 kilograms (220 pounds) to each passenger and their luggage, although experts now believe this estimate is too low. Because most large airlines accrue additional revenues from carrying cargo, they add air freight to an underoccupied plane whenever possible. The emission factors used in this report do not consider air freight. Instead, all emissions stem from an assumed passenger load of 80 percent (the industry average). See Appendix B for more details.

[17] See endnote 1.

[18] For aircraft with multiple classes of seats, we calculated the area that each seat class occupies by dividing the pitch (in inches) by the number of seats across the aircraft, multiplied by the percent of overhead space devoted to each class. We then converted this area to an economy-equivalent number of seats. The same aircraft can have different seat configurations, and thus varying numbers of economy-equivalent seats. For example, Delta configures its Boeing 777s with 381 economy-equivalent seats, while United's 777s have 402 economy-equivalent seats.

[19] See *www.seatguru.com* for seating configurations for the planes each airline has in service.

[20] The type of engine in an aircraft does affect its carbon emissions. If a manufacturer decides to use different engines in various aircraft of the same model, estimates of carbon emissions for that model will be less accurate.

[21] Direct emissions alone are 21 pounds of CO_2 per gallon of jet fuel. See: Energy Information Administration. 2007. Voluntary reporting of greenhouse gases. Online at *www.eia.doe.gov/oiaf/1605/coefficients.html*. Indirect emissions add 20 percent to this amount. See: EPA 2006, Appendix B.

[22] U.S. Senate Joint Economic Committee. 2008. *Your flight has been delayed again*. Figure 2. This number includes indirect emissions, as estimated in EPA 2006.

[23] Domestic commercial air operations are responsible for emitting a total of 144 million metric tons of CO_2 according to: EPA. Forthcoming. *Greenhouse gas emissions from U.S. transportation and other mobile sources*. Washington, DC. This figure includes both direct and indirect carbon emissions.

[24] Bureau of Transportation Statistics. 2004. *National household travel survey*. Online at *www.bts.gov/programs/national_household_travel_survey/summer_travel.html.*

[25] Throughout this report we use fuel cycle emission factors. That is, we include emissions from the extraction, shipment, refining, and distribution of fuel, in addition to the direct emissions from each vehicle's tailpipe. See: EPA 2006. For up-to-date fuel economy ratings for any vehicle, see *www.fueleconomy.gov.*

[26] The sole exception is first-class air travel covering distances of 500 miles or fewer, which has a slightly larger carbon footprint than driving a typical (23 mpg) car that distance.

[27] All data in this section are from U.S. Department of Energy (DOE). *Driving more efficiently*. Washington, DC. Online at *www.fueleconomy.gov.*

[28] We all recognize aggressive driving when someone else is doing it. Such driving can include relying on "jackrabbit" starts, accelerating to a stop, making an excessive number of lane changes, tailgating with rapid flutters on the gas pedal, and more.

[29] Driving at speeds in excess of the speed limit also increases carbon emissions. For more information on speed and fuel economy, see ORNL 2008, Table 4.22.

[30] This depends on the fuel economy of the respective vehicles. Six passengers in a 12 mpg SUV are responsible for about the same amount of carbon dioxide as three occupants in each of two 23 mpg cars.

[31] The figure of 70.0 cents per mile is from ORNL 2008, Table 10.12. The figure of 58.5 cents per mile is the Internal Revenue Service's reimbursement rate, effective July 1, 2008. Gasoline and oil represent 14.3 percent of the total cost of driving a car, according to ORNL 2008.

[32] The data in this paragraph are from *www.amtrak.com* and Congressional Research Service (CRS). 2004. *Amtrak: The political and social aspects of federal intercity passenger rail policy*. Washington, DC.

[33] Eno Transportation Foundation. 2007. *Transportation in America.* Washington, DC.

[34] CRS 2004.

[35] Ibid.

[36] See Appendix D for data and calculations.

[37] Eno Transportation Foundation 2007, 45.

[38] When families of four or more travel together, per-passenger emissions are lower if they drive a 46 mpg hybrid car than if they take a bus.

[39] Schweiterman, J., et al. 2007. *The return of the intercity bus: The decline and recovery of scheduled service to American cities, 1960–2007.* Chicago: DePaul University.

[40] M.J. Bradley & Associates. 2007. *Comparison of energy use and CO_2 emissions from different transportation modes*. Concord, MA.

[41] American Bus Association. 2003. *Motor coaches: Partners in the community.* Washington, DC.

[42] Motor coaches remain the principal form of passenger transportation between cities in Canada, according to Transport Canada, the country's transportation ministry. See American Bus Association 2003.

[43] These costs use the Internal Revenue Service's mileage reimbursement rate of $0.585 per mile, and assume a one-way distance of 270 miles.

[44] This rule of thumb holds as long as analysts continue to concur that "radiative forcing" at altitudes higher than 3,000 feet—where long-distance jets tend to fly—does not undermine their carbon advantage over short-distance aircraft. The concept of radiative forcing addresses the fact that CO_2 emissions at higher altitudes have a larger impact than those at lower altitudes.

[45] See Appendices B through E for specific sources for each mode. They include the Federal Aviation Administration for aircraft; Amtrak for electric and diesel rail; the American Bus Association, Greyhound, Congressional Research Service, Oak Ridge National Laboratory, and Peter Pan for intercity buses; and the EPA for cars and SUVs.

[46] For upstream emissions from various transportation modes, see EPA 2006.

[47] Travel distances for rail must be estimated, but they are closer to driving distances than to flying distances.

[48] See endnote 44 for an explanation of radiative forcing.

[49] U.S. Senate Joint Economic Committee 2008.

[50] See: EPA. Forthcoming. *Greenhouse gas emissions from U.S. transportation and other mobile sources*. Washington, DC.

[51] SAGE is a computer model used by the Federal Aviation Administration to predict fuel burn and emissions for all commercial flights in a given year. The EPA reports that total CO_2 emissions from domestic commercial aviation were relatively stable in 2004 (the data used above) and 2006. This implies that the SAGE data used in this report are still current. See: EPA. Forthcoming. *Greenhouse gas emissions from U.S. transportation and other mobile sources*. Washington, DC.

[52] See endnote 51.

[53] See endnote 51.

[54] Adding one more passenger to any vehicle will cut per-passenger emissions, but this decline is small in travel modes that carry large numbers of passengers, such as planes, trains, and motor coaches. Adding occupants to cars, SUVs, and minivans, in contrast, can decrease per-passenger emissions by as much as a factor of five.

[55] DOE. 2006. Driving technology: A transition strategy to enhance energy security. Online at *www1.eere.energy.gov/vehiclesandfuels/pdfs/program/tsp_paper_final.pdf.*

[56] EPA 2006.

[57] Ibid.

[58] Total Amtrak passenger-miles minus passenger-miles in Northeast Corridor. See Table 15.

[59] Operations in the Northeast Corridor account for about 29 percent of Amtrak's total passenger-miles. In personal communication with the authors, Amtrak estimated its Northeast Corridor passenger-miles at 1.5 billion, which is consistent with our estimate.

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Getting There Greener

The Guide to Your Lower-Carbon Vacation

While the idea of "green" vacations has attracted recent attention, most information focuses on what to do when you get to your destination, not on how to get there. No definitive source has been available to guide travelers toward the transportation option—train, plane, automobile, or motor coach (a.k.a. bus)—that will produce the least global warming pollution during a particular vacation. Until now.

In *Getting There Greener*, the Union of Concerned Scientists presents the first comprehensive analysis—peer-reviewed by experts—of the highest-carbon and lowest-carbon options for vacation travel.

This analysis shows that three key factors determine the environmental impact of your travel: (1) the type of vehicle you are taking; (2) the distance you are traveling; and (3) the number of people traveling with you. Based on these factors, this guide can tell you how environmentally sound (or perhaps unsound) your travel plans are.

Where you decide to go and how you get there is entirely up to you. It's your vacation. But with our rules of thumb and the information we provide about the carbon footprint of your travel options, you'll have the tools you need to *get there greener*!

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Union of Concerned Scientists

National Headquarters
Two Brattle Square
Cambridge, MA 02238-9105
Phone: (617) 547-5552
Fax: (617) 864-9405

Washington, DC, Office
1825 K St. NW, Suite 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

West Coast Office
2397 Shattuck Ave., Suite 203
Berkeley, CA 94704-1567
Phone: (510) 843-1872
Fax: (510) 843-3785