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Driving vs. Walking: Cows, Climate Change, and Choice

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Summary

Could walking be worse for the planet than driving? This startling idea has recently received coverage in *New York Times* blogs[1] and beyond. In the following, we look at the numbers behind this comparison to determine whether the life-cycle[2] greenhouse gas (GHG) emissions of food needed to replace the calories burned in walking a certain distance could exceed the life-cycle emissions of the fuel needed to drive a car the same distance. Our conclusion: it depends on the assumptions.[3] Driving turns out to be better only if you compare it to a very greenhouse-gas-intensive food, such as beef. When we consider an average American diet, which is still energy-intensive compared to diets in other countries, walking is better for the planet. While we commend growing efforts to understand the complex implications our purchases, choices, and activities have on the climate, we caution against making hasty behavioral changes based on analyses and comparisons that may be faulty or rely on unrealistic assumptions.

Introduction

From "paper versus plastic" to "cotton diapers versus disposable diapers," the environmental impacts of our daily choices have been debated for years. Similarly, the question of whether walking (or bicycling) is better or worse than driving has been discussed for more than two decades.[4] The "drive vs. walk" question goes something like this: you're at home and need to go to a store three-quarters of a mile away (1.5 miles roundtrip).[5] Concerned about your potential contribution to climate change and conscious that the production and transportation of the calories you'll burn in walking or bicycling can be very carbon-intensive, you wonder if driving to the store would release fewer greenhouse gases.

In his book, *How to Live a Low-Carbon Life*,[6] Chris Goodall answers the question this way: "It makes more sense to drive than walk, if walking means you need to eat more to replace the energy lost."[7] Goodall—a proponent of reducing GHG emissions—comments that his intent is not to encourage driving, but rather, "to draw attention to the carbon intensity of modern food production, particularly of meat."[8]

The media have already repeated Goodall's claims, with limited or no critical analysis. The *Times* (U.K.) stated: "Walking does more than driving to cause global warming, a leading environmentalist has calculated."[9] In February 2008, John Tierney posted a *New York Times* blog essentially repeating Goodall's driving vs. walking claim, writing:

> If you walk 1.5 miles, Mr. Goodall calculates, and replace those calories by drinking about a cup of milk, the greenhouse emissions connected with that milk (like methane from the dairy farm and carbon dioxide from the delivery truck) are just about equal to the emissions from a typical car making the same trip.[10]

Are such claims warranted? Do the assumptions behind Goodall's findings withstand scrutiny? Let's look at the numbers.

The All-Beef Diet

Walking 1.5 miles at a moderately fast 3.0 mph pace requires about 120 calories,[11] equivalent to the amount of calories in 67 g (2.4 oz) of top sirloin.[12] To estimate the life-cycle GHG emissions of beef, Goodall refers to an article on beef production in Japan.[13] Using the estimates from this article, the calories burned by walking the 1.5 miles would be equivalent to 1.9 kg of CO_2-equivalent emissions, if replaced by top sirloin.[14] Of course, estimating life-cycle GHG emissions for beef cattle production and transportation is much more complex than, say, measuring the caloric value of a given quantity of beef. A variety of factors affect GHG emissions, including the source and means of producing cattle feed (petroleum-based fertilizers, for example, can greatly increase total emissions); the type of feed (methane produced by cow's digestion contributes to total GHG);[15] and the source of electricity used for processing and storing the meat (e.g. burning coal generates more GHG than does hydropower or wind). Given these variable factors, it is not surprising that a British-based estimate of GHG emissions from beef cattle production is only about half that of the Japanese study used by Goodall.[16] Using the numbers from the Japanese and British studies, we can estimate that between 1.3 and 2.4 kg of CO_2-equivalent emissions are produced to raise, process, store, and transport the top sirloin that powers this 1.5-mile walk.

Table 1. Carbon Emissions Estimates, by Calorie Source

		CO_2-equivalent (g)	
	calories	low	high
top sirloin,[17] 67 g	123	1,300	2,400
ground beef,[18] 40 g	123	790	1,500
2% milk,[19] 8.1 oz	123	230	660
nonfat milk,[20] 11.2 oz	123	330	970
apple,[21] lg (237 g)	123	7	170

	avg. daily caloric intake	CO_2-equivalent (g)	
typical US diet	2,693		5,100
vegan diet	2,693	1,000	

Sources: Caloric values of foods[22]; CO2-e of Beef,[23] Milk,[24] and Apples[25]; Daily caloric intake.[26]

Car GHG Emissions

How do the GHG emissions associated with the calories burned by walking compare to those linked to driving? Goodall states that the typical car in the United Kingdom emits 0.29 kg CO_2-equivalent/mile.[27] Using EPA estimates of GHG emissions/gallon of gasoline,[28] this works out to an average fuel economy of 30.3 mpg—50% higher than the average U.S. vehicle.[29] Gas mileage depends on several factors. For instance, engine temperature can greatly affect gas mileage, as short trips with cold engines can burn twice as much fuel as the same car would once warmed up.[30] Applying this to Tierney's example of a 24-mpg car could yield an actual fuel economy of only 12 mpg over the 1.5-mile trip if the engine is cold. In recognition of these factors, we generously assume the car in this assessment gets 17.1 mpg,[31] considerably higher than the typical U.S. vehicle in these conditions. Incorporating a well-to-pump analysis that found extracting, refining, and transporting fuel effectively consumes 20% of the gasoline before it reaches the pump,[32] and discounting the life-cycle GHG emissions generated by the manufacture and maintenance of the car,[33] the car trip would generate slightly more than 1 kg of CO_2-equivalent at 17.1 mpg over the

1.5-mile distance. After accounting for such factors as well-to-pump fuel losses, the lower fuel economy of U.S. cars in general, and the additional decrease in fuel economy associated with cold starts and short city trips, a more appropriate vehicle GHG emission for this 1.5-mile trip would be double that of Goodall's example.

But a car doesn't drive itself, and so we must also consider the calories consumed by the person driving the car during the trip. Estimates of this energy vary, but report that driving requires more energy than simply sitting idly. Research suggests that driving a car in moderate-to-heavy traffic requires around 150 calories/hour,[34] increasing CO_2-equivalent emissions for the steak-eating driver to almost 1.2 kg. However, this drive vs. walk comparison only looks at the emissions during the 1.5-mile trip itself. A true comparison would be based on emissions over time, rather than over distance.[35]

Under these particular assumptions, Goodall's numbers pan out: using the Japanese study's estimates, a person who exclusively ate top sirloin would generate double the GHG by walking compared to driving the 1.5 miles. A person who exclusively ate ground beef would generate 30% more emissions by walking than by driving. Even using the lower British beef study's GHG estimates, the top-sirloin-eater would generate 16% more GHG emissions by walking than by driving.

The All-Milk Diet

But in Tierney's article, it is assumed the walker's calories come from milk, rather than beef. It turns out that these numbers do not hold up as well as Tierney or Goodall claims, though again, it depends on the assumptions (such as the speed of the walker, milk's GHG emissions, and the car's fuel efficiency). An eight-ounce glass of reduced fat (2%) milk contains about 120 calories, roughly equivalent to the energy used to walk the 1.5 miles. Estimates of GHG emissions per kg of milk generally range from 0.92 - 1.5 kg CO_2-equivalent/kg milk.[36] Goodall uses a much higher emission rate of about 2.7 kg CO_2-equivalent/kg milk.[37] Yet even using this higher rate, the GHG emissions of the milk needed to replace the energy expended by walking would be about 38% less than those generated by driving the same distance. To make a different comparison, nonfat milk has about 68% of the calories in reduced fat (2%) milk, so, assuming that life-cycle GHG emissions are the same per volume of milk, a walker drinking nonfat milk would emit about 11% fewer GHG than if that person drove the same distance, using the highest GHG estimates. Using the low end of the GHG estimates, a walker drinking nonfat milk would be responsible for only 32% of the emissions of the driver. Thus, the comparison of GHG emissions between walking and driving is very dependent on the assumptions used, as shown in Table 2.

The Average American Diet

Of course, it is not very realistic to assume all replacement calories for walking or driving come exclusively from beef or milk. In the typical American diet, beef and pork contribute about 10% of total daily caloric intake; dairy products as a whole contribute about 7%.[38] A recent study provides a more comprehensive estimate of the GHG emissions of a typical U.S. diet, as well as those of a vegan diet.[39] As shown in Table 2, a typical person walking 1.5 miles in the U.S. would generate less than 25% of the GHG that would be generated if that person drove the same distance. This is a very different story from that offered by Goodall and Tierney. The chief reason for the difference is the underlying assumption of the source of the calories, assumptions regarding vehicle GHG emissions, and the range of GHG emissions of these different calorie sources. If we assume that the walker's replacement calories come exclusively from top sirloin—the highest GHG emitter we evaluate here—then driving has less impact on the planet. However, the GHG emissions of milk used to fuel the walk, even using the very high rate offered by Goodall, are lower than driving. And the most realistic comparison—one that assumes a typical diet—shows walking is the better choice by a factor of four.

Table 2. Total GHG Emissions, by Activity and Calorie Source

		High and low estimates of GHG emissions as CO_2-equivalent (g)									
	calories/	**Steak**		**Ground Beef**		**2% Milk**		**Non-fat Milk**		**US Diet**	
	1.5 miles	low	high	low	high	low	high	low	high	vegan	typical
driving, 20 mph[40]	11	1,100	1,200	1,100	1,100	1,000	1,100	1,000	1,100	1,000	1,000
bicycling, 10 mph	67	710	1,300	430	800	120	360	180	530	26	130
walking, 3 mph	123	1,300	2,400	790	1,500	230	660	330	970	48	230

Note: Total GHG emissions include those due to gasoline consumption.

Table 2 includes high and low GHG emissions estimates for several beef and dairy products, with typical and vegan U.S. diets for comparison. We have also included estimated emissions for a bicyclist riding the same 1.5 miles at a moderate 10 mph pace (note that neither the bicyclist's nor the driver's emissions include life-cycle emissions for the vehicle itself). All caloric expenditures are for a 189-pound, 35-year-old male.[41] As noted by Goodall, what really stands out in this comparison is the astoundingly high GHG values for walking when the calories come from beef or dairy. The idea that moving a 2,853 pound Nissan Sentra[42] *plus* a 189-pound driver could possibly generate fewer GHGs than if that driver simply walked the same distance underscores the staggering carbon intensity of beef and dairy production. To be fair to Goodall, this was in fact his underlying message: meat-intensive diets are energy intensive and greenhouse gas intensive.

However, it is misleading to suggest "it makes more sense to drive than walk, if walking means you need to eat more to replace the energy lost."[43] From the limited perspective of the GHG emissions,[44] several key variables affect the decision to drive or walk, including the vehicle's fuel economy and the source of the food you consume to replace the energy used. Goodall and Tierney based their analysis on relatively extreme assumptions. Assumptions reflecting an average U.S. diet and more representative fuel economy standards yield a very different result. In sum, if you reward your exercise with a steak or a hot fudge sundae, you're not doing the planet any favors. But as shown by the estimated GHG emissions of the typical U.S. diet, walking—even for a group of four people—makes more sense than driving a given distance.

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[1] Tierney, J. (2008) How Virtuous is Ed Begley Jr.? *New York Times Blogs: TierneyLabs.* February 25, 2008. http://tierneylab.blogs.nytimes.com/2008/02/25/how-virtuous-is-ed-begley-jr.
Levitt, S. (2008) "Be Green: Drive." *New York Times Blogs: Freakonomics.* March 19, 2008. http://freakonomics.blogs.nytimes.com/2008/03/19/be-green-drive/.

[2] "Life-cycle" here refers to the entire life cycle of a food or fuel, from fertilizer inputs to the energy used to extract or harvest and process and transport the food or fuel, to its storage and disposal.

3 Our assumptions and calculations can be found at www.pacinst.org/topics/integrity_of_science/case_studies/walking_vs_driving_calculations.xls. We expect that others may find different numbers or values to be more appropriate for the comparison. This is exactly the point: these numbers are not exact. The assumptions used to select the numbers directly affect the results. Readers are encouraged to substitute other numbers in the posted spreadsheet, to observe how differences in estimated GHG, level of activity, fuel economy, assumed energy source, and basal metabolic rate all affect the results.

[4] In September 2006, the Web site "Ask Pablo" compared the emissions of a beef-powered cyclist with those of a 20 mpg car. http://www.triplepundit.com/pages/askpablo-the-myth-of-the-beefp-002257.php. Michael Bluejay's

"Bicycling Wastes Gas?" quotes J. Robbins' *Diet for a New America* (1987): "This is because the energy needed to produce the food you would burn in walking a given distance is greater than the energy needed to fuel your car to travel the same distance, assuming that the car gets 24 miles per gallon or better." http://bicycleuniverse.info/transpo/beef.html.

[5] Goodall uses the example of a 3-mile roundtrip on his Web site (www.lowcarbonlife.net) and a 1.5-mile trip in *How to Live a Low-carbon Life*, while Tierney uses a 1.5-mile trip. We evaluate a 1.5-mile trip.

[6] Goodall, C. (2007). *How to Live a Low-carbon Life*. Earthscan Publications. United Kingdom. www.lowcarbonlife.net.

[7] Goodall, C. "Better to drive than to walk." July 19, 2007. http://www.lowcarbonlife.net/downloads/beef.pdf.

[8] Goodall, C. (2008). Comment, *New York Times Blogs: Tierney Labs*. February 25, 2008. http://tierneylab.blogs.nytimes.com/2008/02/25/how-virtuous-is-ed-begley-jr/#comment-99762.

[9] Kennedy, D. "Walking to the shops 'damages planet more than going by car,'" *The Times* [UK]. July 4, 2007. http://www.timesonline.co.uk/tol/news/uk/science/article2195538.ece.

[10] See Tierney, note 1.

[11] "Calories" are used here in the conventional sense of food calories, as reported on nutritional labels. All calorie expenditures are from Ainsworth, B. E., W. Haskell, M. Whitt, M. Irwin, A. Swartz, S. Strath, W. O'Brien, D. Bassett, Jr., K. Schmitz, P. Emplaincourt, D. Jacobs, Jr., and A. Leon. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise.* 32 (9): S498–S516. http://personal.uncc.edu/jtlightf/classmats/assessment/ainsworth_MSSE_32_2000.pdf.
Calorie expenditures assume a 189 lb, 5' 9 ½″, 35-year-old male, reflecting the median age from the U.S. 2000 census and the mean height and weight for that age. U.S. Census Bureau. (2000). All Across The U.S.A.: Population Distribution and Composition. Chapter 2. Census 2000. http://www.census.gov/population/pop-profile/2000/chap02.pdf.
Height and weight from National Center for Health Statistics (2004). Mean Body Weight, Height, and Body Mass Index (BMI) 1960-2002: United States. Center for Disease Control and Prevention. http://www.cdc.gov/nchs/pressroom/04news/americans.htm.
Height, weight, and age affect basal metabolic rate (BMR), which we used to calculate energy requirements for the various activities displayed in Table 2. See Frankenfield, D.C., W. Rowe, J. Smith, and R. Cooney. (2003).Validation of several established equations for resting metabolic rate in obese and non-obese people. *Journal of the American Dietetic Association.* 103: 1152-1159. A woman with the same age, height, and weight would have a BMR about 10% lower than that of the man used in this analysis, decreasing GHG emissions proportionately.

[12] Food calories are from USDA National Nutrient Database for Standard Reference. http://www.nal.usda.gov/fnic/foodcomp/search/.

[13] Ogino, A., H. Orito, K. Shimada, and H. Hirooka. (2007). Evaluating environmental impacts of the Japanese beef cow-calf system by the life cycle assessment method. *Animal Science Journal* 78: 424–432.

[14] Leaner cuts of beef have significantly lower caloric content than fattier cuts. For example, a 67 g portion of pan-fried ground beef contains about 66% more calories than the same amount of lean, broiled top sirloin, according to the USDA National Nutrient Database for Standard Reference. http://www.nal.usda.gov/fnic/foodcomp/search/. Consuming the same amount of calories in a leaner cut of beef would require consuming more beef, generating more GHG.

[15] Johnson, K.A., and D.E. Johnson. (1995). Methane emissions from cattle. *Journal of Animal Science*. 73: 2483-2492.

[16] Williams, A.G., E. Audsley, and D.L. Sandars. (2006). Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Main Report. Defra Research Project IS0205. Bedford: Cranfield University and Defra.
The numbers reported in Carlsson-Kanyama et al. (2003) suggest the emissions would be about 9% lower than the Japanese study. Pimentel (1996) report 35 kcal of energy is needed to produce a kcal of beef protein, though this does not include processing, transportation, or marketing. Depending on energy source assumptions, this converts to about 18 kg CO_2-equivalent/kg beef, consistent with the British study. A recent article (Weiss 2008) reports emissions of 7.2 kg CO_2-equivalent/6 ounce portion of steak, equivalent to 42.1 kg CO_2-equivalent/kg of beef, even higher than the numbers reported by the Japanese study.
Carlsson-Kanyama A., M. Pipping Ekström, and H. Shanahan, (2003). Food and life cycle energy inputs: consequences of diet and ways to increase efficiency, *Ecological Economics* 44: 293-307
Pimentel D., and M. Pimentel, eds. (1996). *Food, Energy, and Society* (revised edition). University Press of Colorado.
Weiss, K.R. (2008). Treading lighter with low-carbon diets. *Los Angeles Times*. April 22, 2008. http://www.latimes.com/news/printedition/front/la-me-lowcarbon22apr22,1,1642275,full.story)

[17] Beef, top sirloin, separable lean only, trimmed to zero inches of fat, all grades, cooked, broiled. Common Name: Sirloin steak, Sirloin strip NDB No: 13454. Source: USDA National Nutrient Database (NDB) for Standard Reference, http://www.nal.usda.gov/fnic/foodcomp/search/.
[18] USDA Commodity, beef, ground bulk/coarse ground, frozen, cooked. NDB No: 23502.
[19] Milk, reduced fat, fluid, 2% milkfat, with added vitamin A. NDB No: 01079.
[20] Milk, nonfat, fluid, with added vitamin A (fat free or skim). NDB No: 01085.
[21] Apples, raw, with skin. NDB No: 09003.
[22] United States Department of Agriculture. National Nutrient Database for Standard Reference. http://www.nal.usda.gov/fnic/foodcomp/search/.
[23] High beef values from Ogino et al. (2007); low values from Williams et al. (2006). See notes 13 and 16.
[24] High milk values calculated from Goodall (2007); low values from Garnett, T. (2007). Meat and Dairy Production & Consumption, Food Climate Research Network. http://www.fcrn.org.uk/frcnResearch/.
[25] Milà i Canals, L., S.J. Cowell, S. Sim, and L. Basson. (2007). Comparing Local versus Imported Apples: A Focus on Energy Use. Environmental Science and Pollution Research 14(5) 338-344. http://dx.doi.org/10.1065/espr2007.04.412. This article reports primary energy use for apple production, in MJ/kg. We have converted these to CO_2-equivalents using low and high carbon energy sources.
[26] For purposes of comparison, we assumed daily caloric intake of U.S. males to be the same for the typical and vegan diets. Daily caloric intake from Center for Disease Control and Prevention. (2007). Monitoring the Nation's Health December Newsletter. http://www.cdc.gov/nchs/pressroom/data/MNH_1207.htm. Emissions from Eshel, G., and P. Martin. (2006). Diet, Energy and Global Warming. *Earth Interactions* 10: 1-17. http://geosci.uchicago.edu/~gidon/papers/nutri/nutriEI.pdf.
[27] http://www.lowcarbonlife.net/default.asp?page=40.
[28] The EPA estimates a gallon of gas produces a value of 8,788 g or 8.8 kg (19.4 lbs) of CO_2, and estimates greenhouse gases other than CO_2 emitted, for example N_2O, CH_4, and HFCs, at an additional 5% of CO_2 equivalent. We therefore assume a total of 9.26 kg of CO_2 equivalent per gallon of gasoline. Environmental Protection Agency. (2005). Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle, EPA420-F-05-004, February 2005. http://www.epa.gov/OMS/climate/420f05004.htm.
[29] According to EPA's 2007 report, average combined city/highway mileage for the 2007 model year vehicles is 20.2 mpg. The best-selling vehicle in the U.S. is the Ford F-150 pickup truck, with an EPA-reported city fuel economy of 13-15 mpg (depending on vehicle model). For the 1.5-mile cold-start trip evaluated here, the F-150 would be assumed to get 7-8 mpg, making the comparison even less favorable for driving. Environmental Protection Agency. (2007). Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2007. http://www.epa.gov/otaq/fetrends.htm.
[30] Federal Trade Commission. (2005). "FTC Consumer Alert: Good, Better, Best: How to Improve Gas Mileage." http://www.ftc.gov/bcp/edu/pubs/consumer/alerts/alt064.shtm.
[31] The EPA reports 17.1 mpg as the average city fuel economy of light duty cars and trucks in both the 2006 and 2007 model years. This value is the highest average city mileage since 1998, when the value was 17.2 mpg. (See note 28). In this analysis, we assume a fuel economy of 17.1 mpg, both because it is representative of typical U.S. vehicles on the road, and because it reflects the expected decrease in fuel economy for the presumed 24 mpg car if started cold for this short trip.
[32] Brinkman N., M. Wang, T. Weber, and T. Darlington, (2005). Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems–A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions. http://www.transportation.anl.gov/pdfs/TA/339.pdf.
[33] We presume such life-cycle manufacturing and maintenance GHG emissions to be negligible (1.5 miles/100,000+ mile lifetime of the car), though Goodall suggests that such emissions would increase the total for this 1.5-mile trip by about 15%. Goodall, C. 2008. "Responses to criticisms of 'walking versus driving.'" http://www.lowcarbonlife.net/default.asp?page=96.
[34] Ainsworth et al. (2000). See note 11.
[35] That is, we should include the driver's activities over the total 30 minutes that otherwise would have been spent walking. If, for example, the driver returned home and then decided to exercise during the 25 minutes saved by not walking, the total emissions would almost certainly exceed those if the driver had just walked the 1.5 miles. If the driver returned home and took a nap, the total emissions over these 30 minutes (5 minutes driving plus 25 minutes sleeping) would be approximately 40% less than the emissions generated if the driver had walked, using the Japanese study's numbers, or 10% greater than walking, using the British study's numbers, if all the calories burned by the activity were replaced solely by top sirloin.
[36] Garnett, T. (2007). Meat and Dairy Production & Consumption, Food Climate Research Network. http://www.fcrn.org.uk/frcnResearch/.

[37] This high GHG estimate comes from Table 10.7 of *How to Live a Low-carbon Life* (p. 194), which states 154 ml (5.2 ounces) of milk, generating 0.425 kg of CO_2-equivalent, would be required to replace the energy needed to walk 1.5 miles. This rate apparently assumes a "very brisk" 4 mph pace, drinking milk with 3.25% fat. Goodall uses a generic energy multiplier of nine calories of fossil-fuel energy to create one calorie of food energy, and converts these units of energy to grams of CO_2 by assuming that the energy comes from natural gas. Goodall also "assumes that food energy is converted by the body at 80 per cent efficiency," but does not provide a source for this assumption.

[38] Block, G. (2004). Foods contributing to energy intake in the US: data from NHANES III and NHANES 1999-2000. *Journal of Food Composition and Analysis*. 17 (3-4): 439-447. http://www.berkeley.edu/news/media/releases/2004/06/01_usdiet.shtml.

[39] Eshel and Martin. (2006). See note 26. Their estimates should not be considered definitive, but do offer a basis for comparison. An analysis of Swedish food consumption patterns, Carlsson-Kanyama et al. (2003) (see note 16) found that total daily life cycle dietary energy requirements can range from 13-51 MJ per person. Depending on the sources of this energy, this could generate 1.2 - 9.9 kg CO_2-equivalent per day, per person, similar to Eshel & Martin's values at the low end, but almost double at the high end.

[40] Assuming 17.1 mpg.

[41] Assumes an age of 35 years. See note 11.

[42] The Nissan Sentra has an EPA (2008) city rating of 24 mpg; as noted above, we assume a cold-start rate of 17.1 mpg. According to the EPA, the Toyota Prius gets twice as many mpg as the Nissan Sentra; however, we found a variety of conflicting accounts on the expected fuel efficiency of a cold-start Prius. If the Prius's mileage were affected by cold temperatures at the same rate as a conventional engine, the GHG values listed in Table 2 for driving would be just over half those listed for a 17.1 mpg car.

[43] http://www.lowcarbonlife.net/default.asp?page=93.

[44] Of course, a host of other factors affect such decisions, including personal health and fitness, quality of life, and time, among others. Such broader questions, including the impacts of health and longevity on climate change, are well beyond the scope of this analysis.