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Greenhouse Gases and the American Lifestyle: Understanding Interstate Differences in Emissions

Elizabeth A. Stanton, Frank Ackerman, and Kristen Sheeran

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ecotrust
721 NW Ninth Ave
Suite 200
Portland, OR 97209
www.ecotrust.org

Economics for
Equity and the Environment
721 NW Ninth Ave
Suite 200
Portland, OR 97209
www.e3network s.org

SEI STOCKHOLM ENVIRONMENT INSTITUTE
Tufts University
11 Curtis Avenue
Somerville, MA 02144
www.sei-us.org

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Stanton and Ackerman: Stockholm Environment Institute-U.S. Center, Tufts University, Somerville MA
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Introduction

Does a high standard of living require high greenhouse gas emissions? Does reducing emissions mean impoverishing ourselves? The fear expressed in these questions has inspired some of the resistance to new, ambitious climate policies. This fear, however, is unfounded; there is no rigid link between emissions and well-being. The same standard of living can be produced with many different levels of emissions. Some of the best evidence for this can be found within the United States: individual states vary only modestly in average incomes, but have widely differing per capita emissions.

This report analyzes interstate variation in per capita emissions, seeking to explain why some states have much lower emissions than others. Some of the differences are based on objective factors beyond anyone's control: for instance, the coldest states have high heating needs, while the hottest states use a lot of air conditioning. Other differences may be based on policies and measures that have lowered emissions in some states, and could be replicated in others. Identifying the causes of interstate differences in emissions may also help clarify the potential regional impacts of policies, such as a cap and trade system, which put a price on carbon emissions.

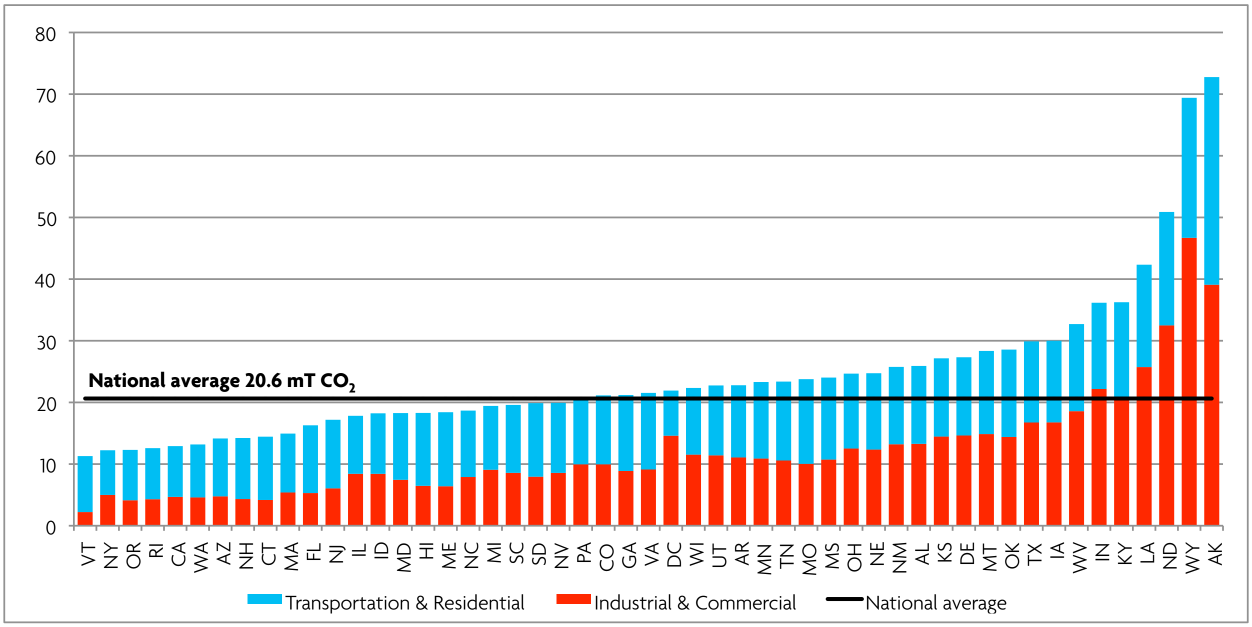
Our analysis begins with reported data on emissions for the 50 states and the District of Columbia, from standard government sources (see Appendix C for details). Throughout this report, emissions are measured in metric tons of carbon dioxide (mT CO_2 for short). We focus on energy-related carbon dioxide emissions, which account for the great majority of greenhouse gas emissions and are the category most likely to be regulated under a cap and trade system. Emissions from electricity generation are attributed to the sectors where electricity is used – residential, commercial, industrial, and transportation. Emissions of other greenhouse gases, such as methane and nitrous oxide from agriculture and waste management, are omitted from our analysis, as is any estimate of sequestration in soils and forests. For consistency we use data for 2004 throughout, because some of the data series were not available for more recent years.

In this report, we adjust the reported emissions data for interstate electricity sales, and then identify the fraction of each state's emissions that come from household emissions, i.e. residential heating, electricity, and personal transportation. Statistical analysis of household emissions then identifies portions of interstate variation that can be attributed to objective factors such as climate and population density. A final section discusses potential implications for climate policy.

State by State Greenhouse Gas Emissions

U.S. per capita greenhouse gas emissions vary enormously from state to state (see Figure 1). The highest-emission states have more than six times the per capita emissions of the lowest.

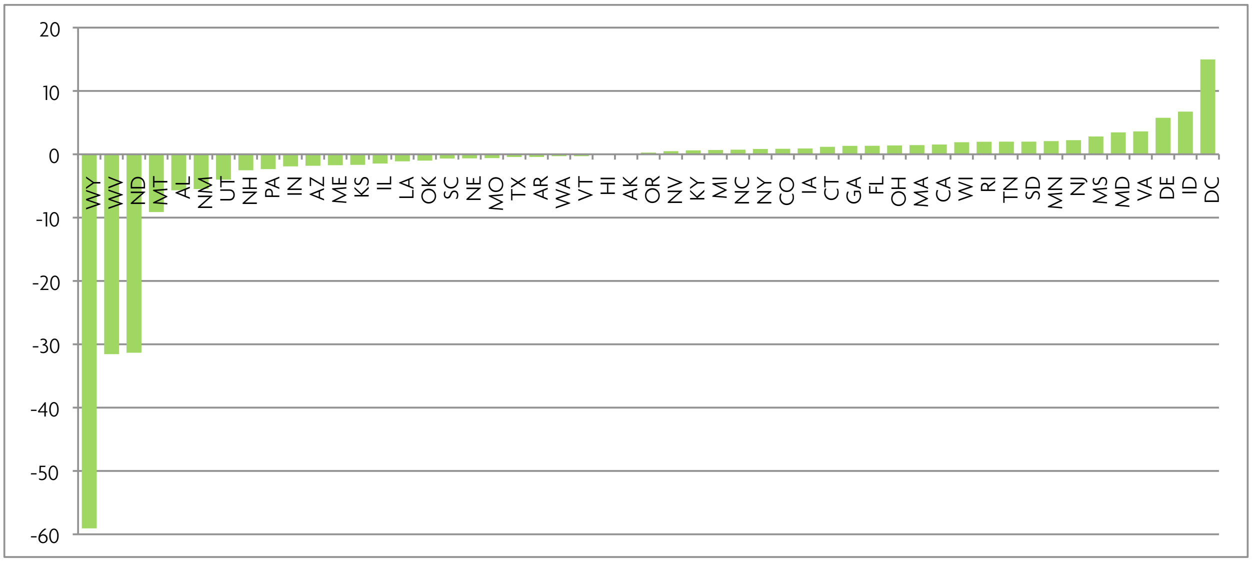
Figure 1: U.S. emissions per capita by state (mT CO_2)



Source: Authors' calculations using 2004 data.

In this report, we measure state emissions as the total of energy-related carbon dioxide emissions, consisting of industrial, commercial, transportation, residential direct fuel use, and residential electricity emissions. The data shown in Figure 1 have been adjusted for interstate electricity sales, attributing electricity generation emissions to the states where the electricity is used, not where it is generated (see Appendix D). This adjustment is necessary because some states generate much more electricity than they use, while others import from them. In particular, three states with relatively small populations, Wyoming, West Virginia and North Dakota, export large amounts of electricity to other states; the resulting emissions look enormous on a per capita basis (see Figure 2). Overall, 10 percent of all U.S. electricity is exported out of state; electricity exported from Wyoming, West Virginia, and North Dakota accounts for 26 percent of all electricity crossing state lines.

Figure 2: Emissions from electricity imports and exports (mT CO_2 per capita)



Source: Authors' calculations using 2004 data.
Note: In this graph, imports are shown as positive numbers (above the zero line), and exports are negative (below the line). Data in Figure 1 and throughout this report have been corrected for exports and imports, attributing electricity emissions to the consuming states.

After correcting for electricity imports and exports, a few states stand out as having emissions per capita around half the national average of 21 metric tons (mT) of CO_2 each year (see Figure 1). Vermont (11 mT CO_2), New York and Oregon (12 mT CO_2), and Rhode Island, California, and Washington (13 mT CO_2) all provide a U.S. lifestyle with European levels of greenhouse gas emissions.[1] Emissions in these six states are roughly comparable to those of Belgium, Demark, Germany, Ireland, Japan, and the United Kingdom (10 mT CO_2), or Finland (12 mT CO_2).[2]

On the other end of the spectrum, Alaska (73 mT CO_2), Wyoming (70 mT CO_2), North Dakota (51 mT CO_2), and Louisiana (42 mT CO_2) all emit more than twice the national per capita average (and that's *after* subtracting the emissions attributable to exported electricity). Kentucky and Indiana (36 mT CO_2), and West Virginia (33 mT CO_2) are not far behind – each emitting more than one and half times the national average.

As Figure 1 demonstrates, large shares of every state's emissions are the result of industrial and commercial activities; for these purposes, the commercial category includes government activities. Emissions from industrial production help to create goods that are often sold out of state, or outside of the United States altogether. If industries have to pay a price for carbon emissions and pass the cost on to their customers, that cost will be borne by customers throughout the country or even overseas, not by the residents of the state where production is located. Likewise, the District of Columbia has very high per capita emissions in the commercial sector, because that sector includes electricity used in government; but the federal government and its emissions are the responsibility of the entire country, not just those who live in the capital.

Therefore, the remainder of this report focuses exclusively on transportation and residential emissions. These are the emissions for which each state's residents bear the most direct responsibility. Transportation and residential emissions can be addressed by public policy and private households' actions alike, and any state by state differences in the consequences of a carbon tax or permit system will be easier to identify by excluding industrial, commercial, and government emissions that impact the nation as a whole.

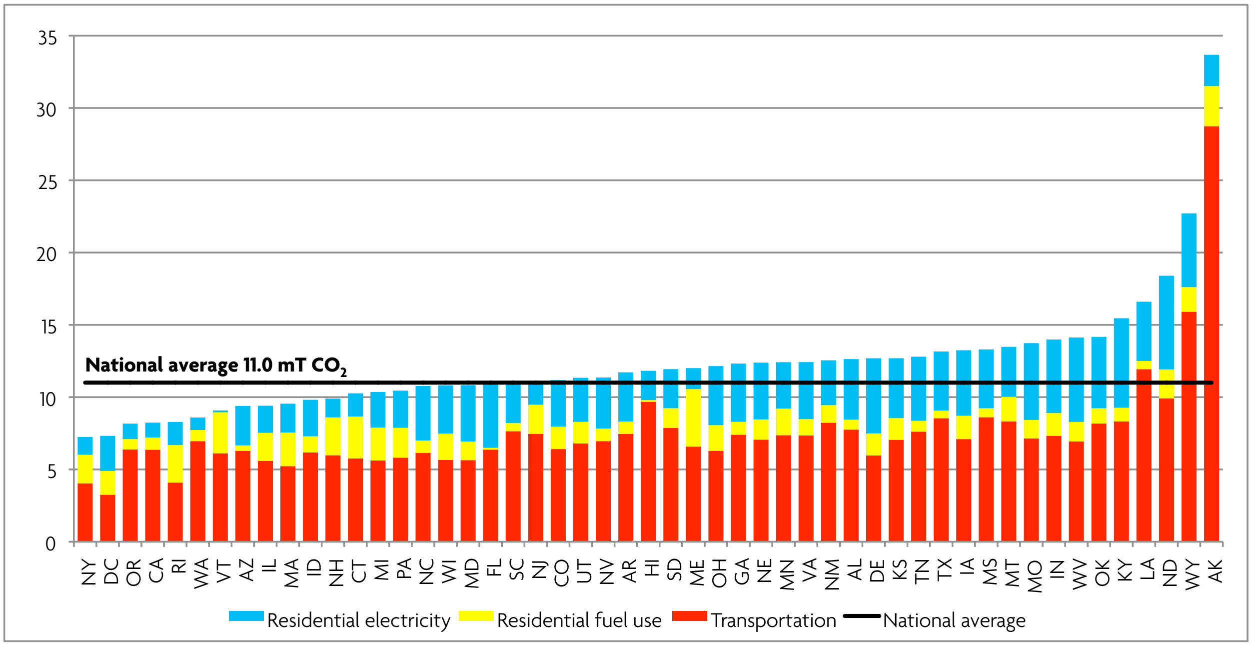
In transportation and residential emissions, the same six states – New York (7 mT CO_2), Oregon, California, and Rhode Island (8 mT CO_2), Washington and Vermont (9 mT CO_2) – together with the District of Columbia (7 mT CO_2), have remarkably low emissions per capita, far lower than the national average of 11 mT CO_2 (see

[1] See Appendix A for detailed data by state for emissions sub-categories and other notable variables used in this report.
[2] World Bank, *World Development Indicators Online Database*, 2004 CO_2 emissions per capita.

Figure 3). On average, across the United States, 39 percent of all greenhouse emissions are industrial or commercial, 27 percent are from transportation, 5 percent from residential fuel use, and 12 percent from residential electricity.

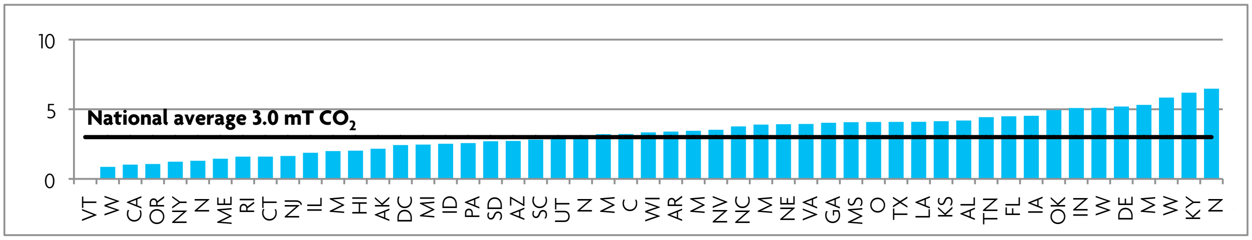
The District of Columbia, New York and Rhode Island have the lowest transportation emissions (see Figure 4), while Vermont, Washington, California, Oregon, and New York have the lowest residential electricity emissions (see Figure 6). Curiously, none of these states has especially low emissions from heating and other direct use of fuel in homes (see Figure 5). The following sections look more closely at each of these categories in turn, and explore what makes it possible for some states to have lower greenhouse gas emissions in each category, compared to the rest of the United States.

Figure 3: U.S. transportation and residential emissions per capita by state (mT CO_2)



Source: Authors' calculations using 2004 data.

Figure 4: U.S. residential electricity emissions per capita by state (mT CO_2)

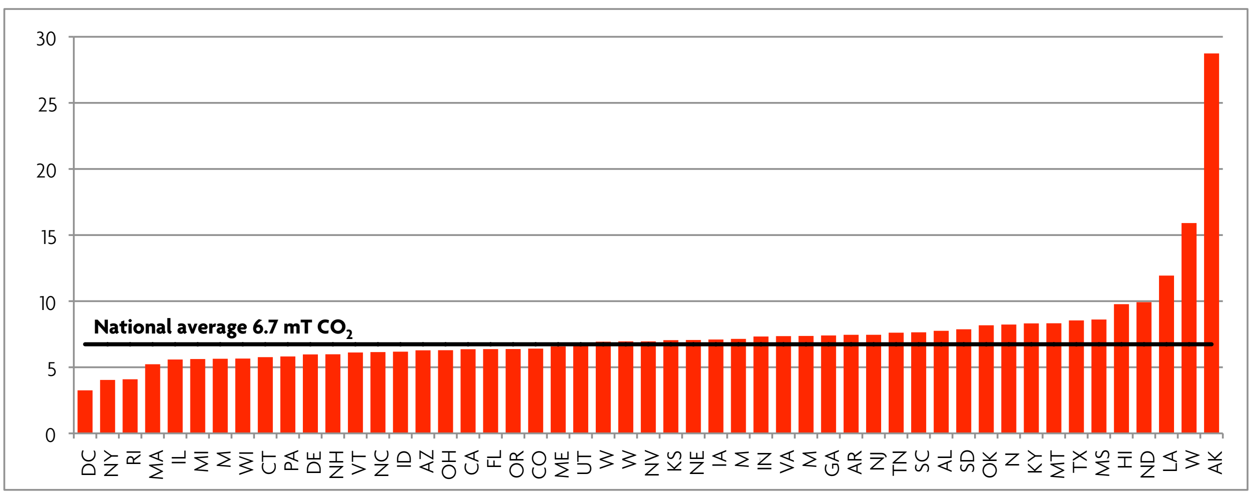


Source: Authors' calculations using 2004 data.

Figure 5: U.S. residential fuel use emissions per capita by state (mT CO_2)

Source: Authors' calculations using 2004 data.

Figure 6: U.S. transportation emissions per capita by state (mT CO_2)

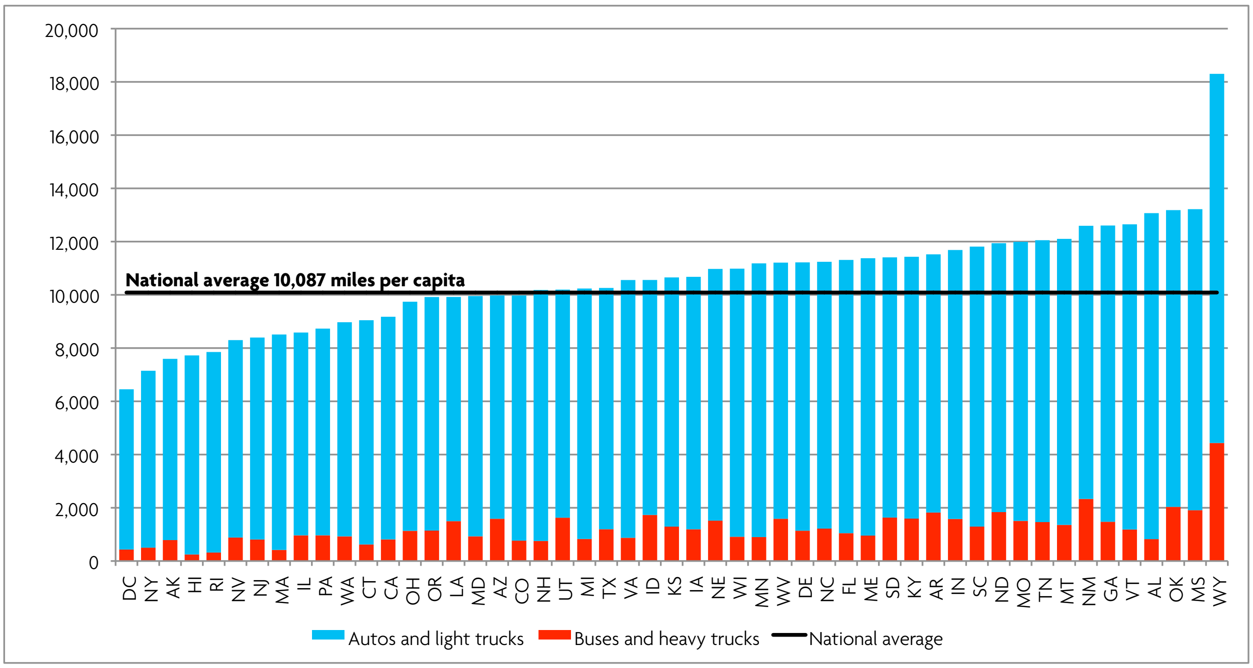


Source: Authors' calculations using 2004 data.

Transportation Emissions

Transportation is responsible for more than one quarter of all U.S. greenhouse gas emissions. Transportation emissions by state are very strongly correlated with the number of vehicle miles traveled. Buses and heavy trucks have a much bigger impact, per mile, on emissions than cars (which include vans, pickup trucks, and SUVs) but represent just 10 percent of all vehicle miles traveled in the United States (see Figure 7).

Figure 7: U.S. vehicle miles traveled per capita by state



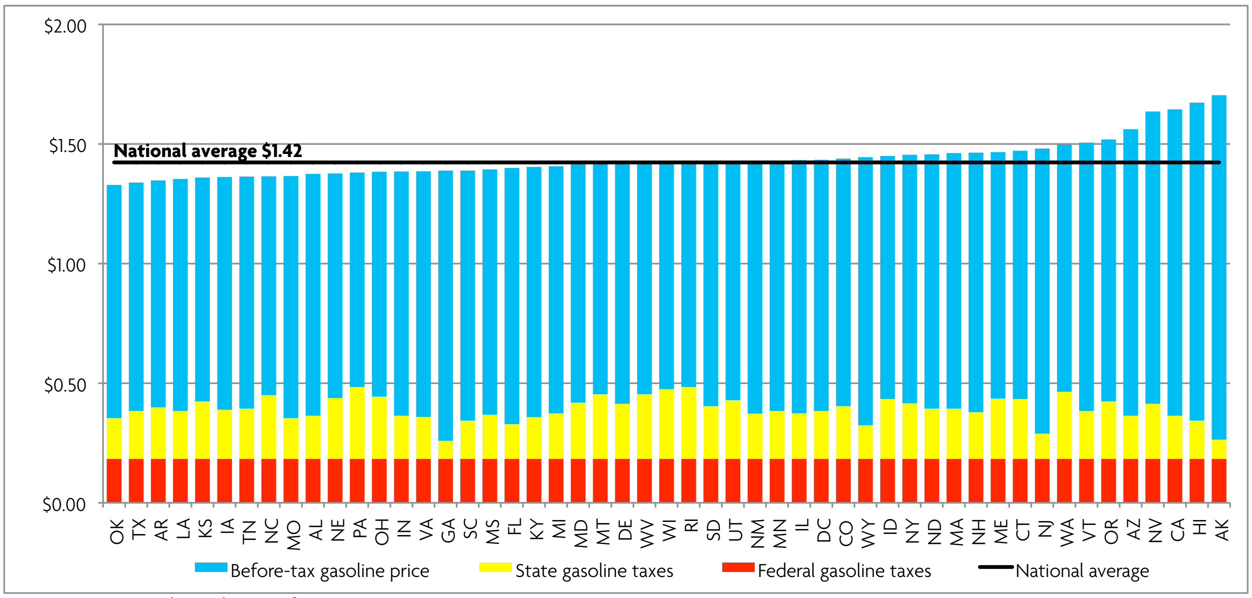
Source: Authors' calculations using 2004 data.

The share of the population living in urban areas, overall population density, the share of workers using public transportation, and the average gasoline price are all important determinants of the number of car miles traveled per state. Among the six low emissions states, plus the District of Columbia, only Vermont is predominantly rural. The District of Columbia is more densely populated than any state; Rhode Island and New York, the states with the lowest transportation emissions per capita after the District of Columbia, are also particular dense. Public policy can reduce car miles traveled with careful zoning and the creation of incentives for housing – including low-income housing – sited within a short commuting distance to industrial and business districts, and for shopping districts sited at close proximity to residential areas.

On average, across the United States, 5 percent of all workers rely on public transportation for their commute. The corresponding figures are 34 percent and 25 percent, respectively, for the District of Columbia and New York State, the areas with by far the highest use of public transportation. In general, every one percent increase in the share of workers using public transportation corresponds to 87 fewer car vehicle miles traveled per capita, or a little less than 1 percent decline from the national average (see Appendix B for statistical analyses). Public policy to create or expand public transportation infrastructure and subsidize its price to consumers can have an important impact on car miles traveled. Similarly, safe bike paths and pedestrian walkways provide another low emissions alternative to driving to work, school or shopping.

Gasoline prices are another important determinant of car miles traveled: higher gasoline prices encourage car owners to car pool, use public transportation, bike and walk. Every 10 cent increase to the price of gasoline corresponds to 530 fewer car vehicle miles traveled per capita (or about a 5 percent decline from the national average).[3] In 2004 – the year of all emissions data in this report – the national average price for a gallon of regular was $1.42. Of that $0.18 was a federal tax and, on average, $0.20 was a state tax; that is, a little more than a quarter of gasoline prices were the result of taxes, with some important difference from state to state (see Figure 8). Gasoline prices have changed dramatically over the last few years – with the national average reaching a high of $3.56 in June 2008 only to descend to $1.22 in December 2008 – but federal and state gasoline taxes have remained virtually unchanged.[4]

Figure 8: U.S. average gasoline price by state



Source: See Appendix C; data are for 2004.

High gasoline prices in certain states – Alaska, Hawaii, the West Coast, and the Southwest – are not caused by high gasoline taxes; the location of refineries and costs to transport gasoline to consumers are more likely explanations. Gasoline taxes and, more generally, carbon taxes and permits systems, however, can be used as a tool to decrease vehicle miles traveled and transportation emissions. In comparison, gasoline taxes and prices are far higher in Europe. In the European Union, taxes represented at least 50 percent of the gasoline price in every country, and 69 percent on average, as of January 2009.[5]

In the United States, if 5 percent of their workers used public transportation for their commute and higher state gas taxes brought their gasoline prices to parity with the national average, car vehicle miles traveled would decline by 8 percent in Oklahoma, Arkansas, Texas and Kansas (see Figure 9). If all states had the national average public transportation use and gasoline price, 36 states would see a reduction in their car miles traveled and in their transportation emissions. (Of course, this same change would mean an increase in car miles in states that already have higher than average public transportation use and gasoline prices.)

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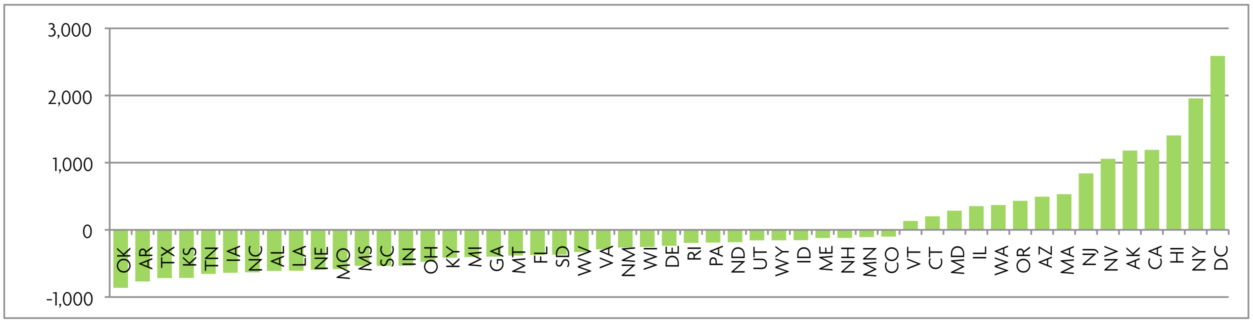
[3] These figures could overestimate the sensitivity of vehicle miles to gasoline prices, if there are other causal factors that are omitted from our analysis; see Appendix B for regression results.
[4] EIA (2009), *Petroleum Marketing Monthly April 2009*, http://www.eia.doe.gov/oil_gas/petroleum/data_publications/petroleum_marketing_monthly/pmm.html.
[5] European Commission, Market Observatory for Energy, *Evolution of oil and petroleum product prices and taxation levels during the year 2008 in the European Union*, http://ec.europa.eu/energy/observatory/oil/doc/prices/oil_price_in_2008.pdf

Figure 9: Change in per capita car miles due to gasoline prices and public transportation



Source: Authors' calculations using 2004 data.

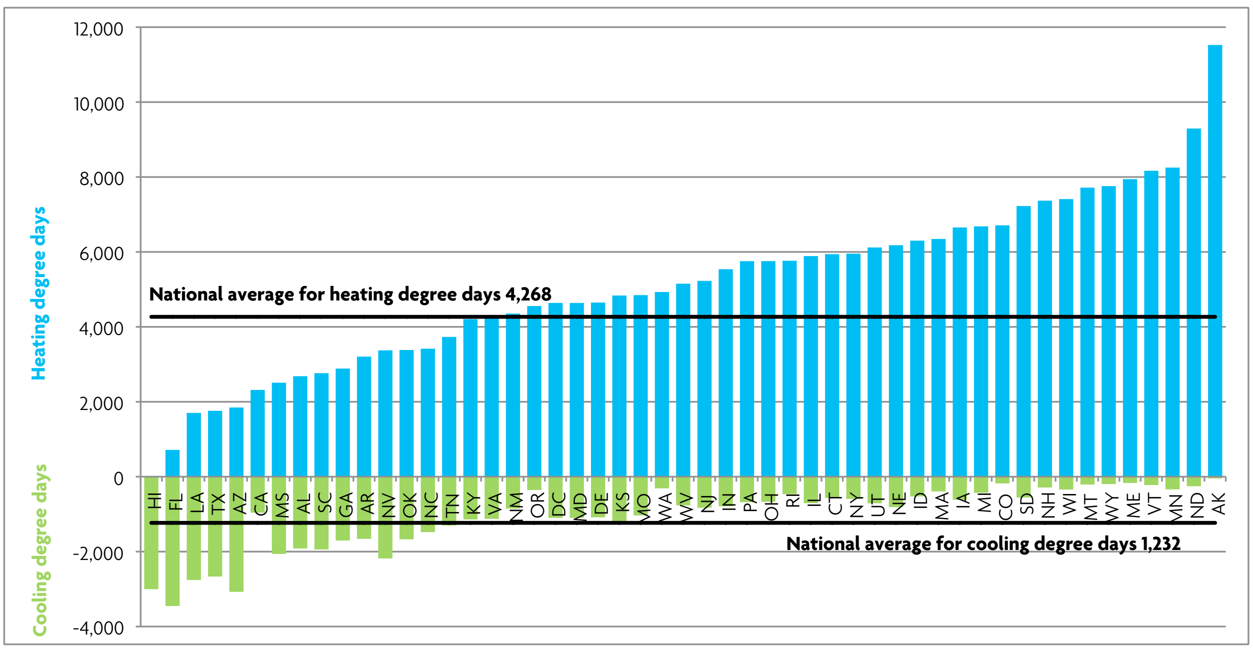
Note: This graph shows the increase (positive) or decrease (negative) in per capita car miles that would result if each state had the national average gasoline price and public transportation use. States with below-average gasoline prices and public transportation use have negative results in this graph: at national average rates their per capita car miles would decrease below actual levels. States with above-average gasoline prices and public transportation use have positive results: at national average rates their per capita car miles would increase above actual levels.

Residential Fuel-Use Emissions

Five percent of U.S. greenhouse gas emissions are the result of direct fuel use in homes, primarily for heating. Heating needs are commonly measured in terms of degree days – on a given day, this is the number of degrees by which the temperature falls below a set minimum such as 65ºF; on an annual basis, heating degree days are the sum of the degrees below the minimum temperature for every day of the year. Every 1,000 additional heating degree days corresponds to a 25 percent increase in residential fuel-use emissions (see Appendix B for statistical analyses).

Heating degree days range from very nearly zero in Hawaii to 11,500 in Alaska (see Figure 10). Public policy can provide incentives and technical assistance for better insulation in homes and businesses – and the potential impact of these types of measures should not be under-estimated – but the essential fact is that colder states require more heating fuel: Some states will always have higher residential fuel-use emissions than others. This being said, it should be noted that New York, the District of Columbia, Oregon, Rhode Island, Washington, and Vermont, all with heating degree days above the national average, are among the states with the lowest total transportation and residential emissions per capita. Vermont has the fourth highest heating degree days in the nation, but the seventh lowest transportation and residential emissions per capita. Cold climates are an obstacle to lowering greenhouse gas emissions, but they need not be an insurmountable one.

Figure 10: U.S. heating degree days and cooling degree days by state

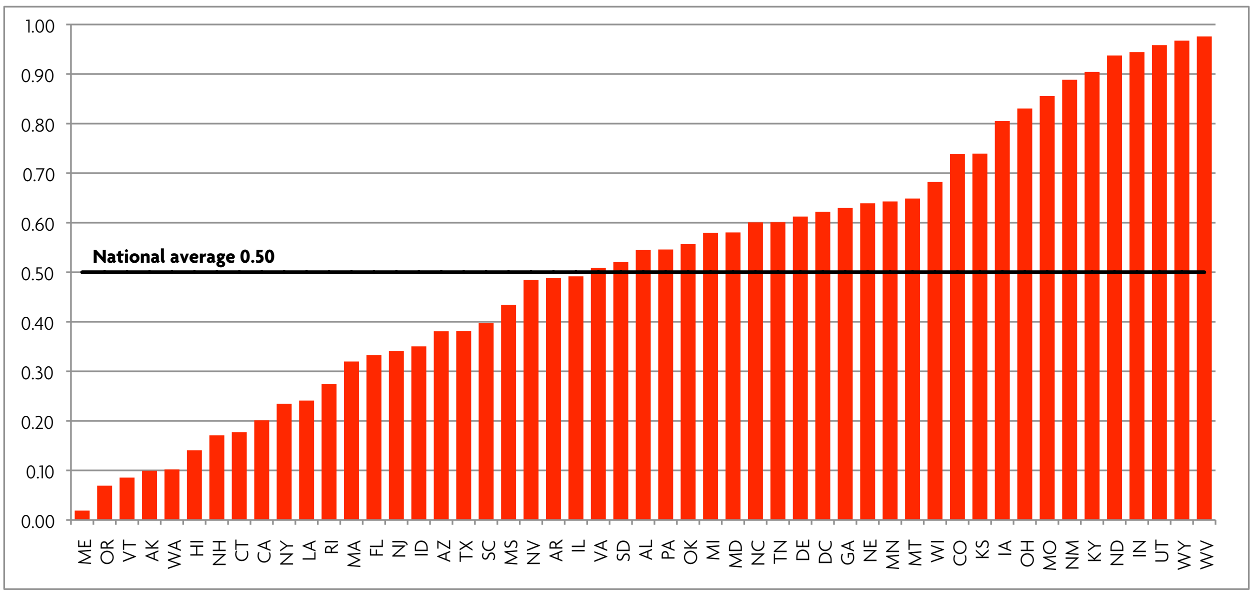


Source: See Appendix C; data are for 2004.

Residential Electricity Emissions

Residential electricity use is the source of 12 percent of all U.S. greenhouse gas emissions. Both the amount of electricity consumed and the sources of fuel used to generate electricity are key determinants of residential electricity emissions. Half of all electricity generated in the United States comes from coal-powered plants. The differences in coal use from state to state (measured by electricity consumed, not by electricity generated) are enormous: the share of electricity generated by coal is less than 10 percent in Maine, Oregon, Vermont and Alaska, but more than 90 percent in West Virginia, Wyoming, Utah, Indiana, North Dakota and Kentucky. Every additional 10 percent of electricity generated from coal corresponds to a 12 percent jump in residential electricity emissions per capita (see Appendix B for statistical analyses). This is an important area for public policy to address greenhouse gas emissions; with the exception of the District of Columbia (which imports its electricity from other states), all of the states with the lowest transportation and residential emissions use electricity generated with less than 30 percent coal (see Figure 11).

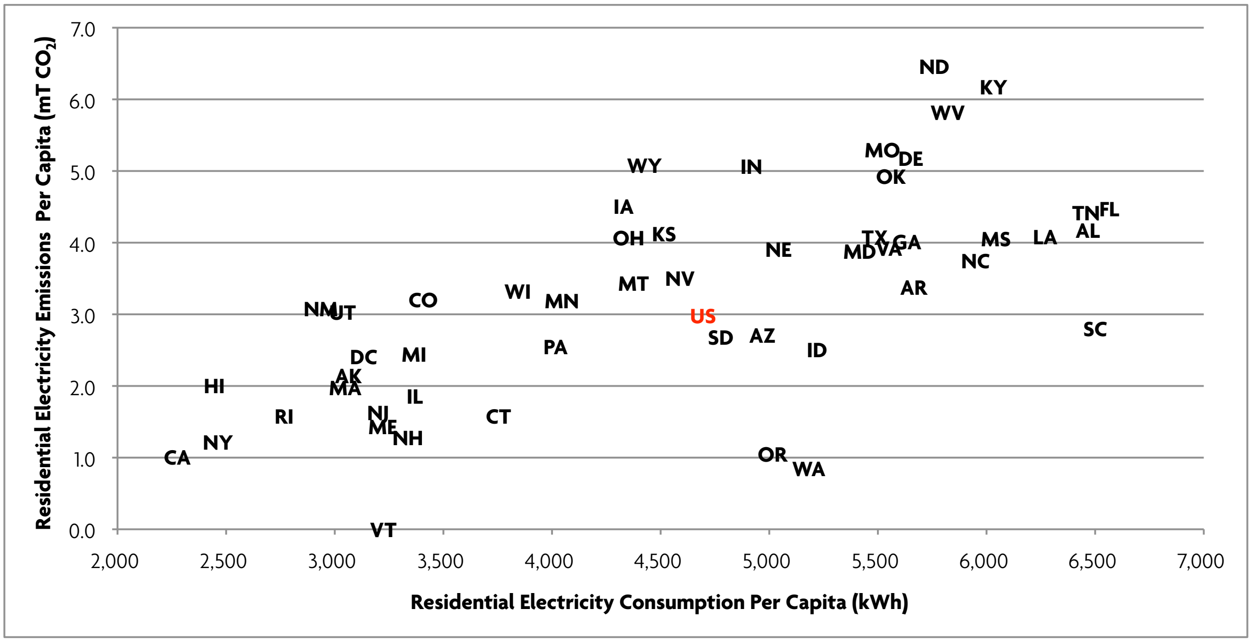
Figure 11: Share of electricity generated from coal



Source: See Appendix C; data are for 2004.

The amount of electricity used by each household is also important to the scale of greenhouse gas emissions. In Figure 12, states with higher residential electricity consumption per capita have correspondingly higher emissions. The exceptions are states like Vermont, Oregon and Washington that use electricity generated from hydropower and nuclear power with little or no greenhouse gas emissions.

Figure 12: Residential Electricity: Emissions versus Consumption



Source: See Appendix C; data are for 2004.

Residential electricity consumption in each state is strongly influenced by the average electricity price, energy efficiency of appliances and lighting, and the number of cooling degree days. The average U.S. electricity price was 8 cents per kWh in 2004, but prices ranged as low as 5 cents in Kentucky, Idaho, Wyoming and West Virginia, and as high as 16 cents in Hawaii and 13 cents in New York. A 1 cent per kWh increase in the price of electricity corresponds to 361 kWh less per year used in homes (an 8 percent decrease from the national average of 4,700 kWh per year).[6] Public policy, via specific electricity taxes or more general carbon taxes, can reduce electricity consumption and greenhouse gas emissions.

The American Council for an Energy-Efficient Economy publishes energy efficiency scores by state each year. States are scored according to the existence of energy efficiency policy in eight categories, each of which is weighted by its energy savings potential.[7] Possible scores range from zero to 44. Although the correlation between these scores and residential electricity consumption is far from perfect, all six of the states with the lowest transportation and residential emissions per capita – Vermont, California, Oregon, Washington, New York and Rhode Island – were among the most energy efficient; the District of Columbia ranked twenty-second.

Cooling degree days – the annual sum of the number of degrees above a fixed temperature each day – are associated with higher residential electricity consumption (see Figure 10 above). Every additional 100 cooling degree days corresponds to 67 more kWh of residential electricity use per year (a 1.5 percent increase to the national average). Of the seven low emission states or districts, all are below the national average in cooling degree days. As with emissions from heating, public policy cannot address the hotter climates experienced in some states, but it can create incentives for better insulation and more efficient air conditioning systems.

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[6] This could overestimate the effect of electricity prices, if there are factors omitted from our analysis that affect electricity consumption; see Appendix B for regression results.
[7] ACEEE (2007) The State Energy Efficiency Scorecard for 2006 http://www.aceee.org/pubs/e075.htm.

Conclusion: Carbon Costs and State Burdens

If a new climate policy, such as a cap and trade system or a carbon tax, imposes a price on greenhouse gas emissions, how much will the burdens vary from state to state? The differences, which look enormous at first glance, become smaller but do not entirely vanish as the data are examined more closely. Costs imposed on electricity producers will be borne by the consumers of electricity, not by the states where it is produced. Correction for this factor results in the distribution of per capita emissions shown in Figure 1, where the range from the highest to the lowest emission state is about 6 to 1.

An additional correction is needed to identify the impacts on households in different parts of the country. Industrial emissions vary widely from state to state; costs imposed on these emissions will be borne by each industry's customers throughout the country and overseas, not by the states where production occurs. Emissions attributable to federal government activities are the responsibility of the country as a whole; their costs are borne by taxpayers nationwide, regardless of where the emissions occur. (Emissions from commercial activity and from state and local government, not discussed in this report, are relatively small and are likely to be uniformly distributed across the country). The remaining categories, the transportation and residential sectors, are the areas where household activities result in emissions. As seen in Figure 3, if we exclude the extreme outlier of Alaska, the range from highest to lowest states is about 3 to 1 in transportation and residential emissions.

That range of 3 to 1 in emissions from household activities is the result of many factors, some more controllable than others. Some parts of the country are colder than others, and face greater heating requirements; some are hotter, and need more energy for cooling. People who live in rural, low-density states drive more than those who live in urban, high-density areas, resulting in more transportation emissions. These factors are difficult or impossible to change.

Other factors affecting household emissions are more readily addressed by climate and energy policies. The extent of public transportation in urban areas varies widely from state to state; the level of gasoline taxes differs as well. Both of these policies have a direct, measurable effect on automobile usage and thus on transportation emissions. The reliance on coal power for electricity generation has a large impact on residential (and non-residential) electricity emissions. Efficiency measures, although measured imperfectly in our data, are important as well.

Should states with above-average emissions receive compensation for the costs of carbon emissions under a cap and trade system or a carbon tax? This is an understandable response to state inequalities in emissions, but it is problematic on at least three levels.

First, the economic problems facing American households are much deeper than the potential impact of climate legislation on energy costs. There is widespread insecurity and inequality, made worse by years of tax cuts for the rich and cuts in services for the rest of us, and amplified by the severe economic downturn that began last year. These problems affect American households in all states. They were not caused by environmental policies, and cannot be solved by rolling back environmental protection. Rather, our economic problems require systematic solutions, requiring honesty and transparency in finance, redistributing burdens to those who can afford to pay them, and creating jobs and restoring services for those who now find themselves in need of help. This is a worthy and urgent goal, which cannot be achieved by changing our climate and energy policies.

Second, the inequality in transportation and residential emissions by state, seen in Figure 3, is not extreme compared to other economic costs and benefits. There are 38 states with per capita transportation and residential emissions between 75 percent and 125 percent of the national average; there are 46 states plus the District of Columbia between 50 percent and 150 percent of the average. Many existing taxes, benefits such as farm payments and unemployment compensation, military spending, and other government programs display comparable or greater inequalities between states.[8] It would be impossible to compensate every state for every

[8] The distribution of farm payments per capita, as seen in the Environmental Working Group subsidies database, and the distribution of military contracts per capita, as seen at http://www.statemaster.com/graph/mil_def_con_exp_percap-defense-contracts-expenditures-per-capita, are far more unequal, with less than half the states between 50 percent and 150 percent of the national average on both measures.

such inequality; it would mark a significant change in course for public policy to insist on compensation for interstate inequalities in the case of climate policies.

Finally, providing exact compensation to states to offset the effects of a carbon price would lessen or even erase this policy's positive impact on reducing emissions. The purpose of a carbon price, whether achieved through a cap and trade system or a tax, is to create market incentives for people and businesses to reduce emissions. Rebating money in exact proportion to the tax simply undoes the incentive effect, defeating the purpose of market-based policies. If climate policy involves direct compensation to households, it should take the form of a fixed lump-sum payment that is not tied to the level of household emissions. Similarly, if climate policy differentiates between states, state allotments of carbon revenues should not be tied directly to the states' emissions performance. A more effective way to deal with interstate emissions inequalities may be through programs aimed at giving people better opportunities to respond to the incentive, lower their emissions, and thereby lower their costs: information, and perhaps subsidies, for better insulation and heating and cooling systems; chances to buy more fuel-efficient cars and trucks; opportunities to generate and to buy low-carbon electricity; urban planning, better transit, and provision of commercial and government services in ways that can reduce driving needs.

Above all, information about policies that have succeeded in reducing emissions in some states should be circulated to the rest of the country. How have some states managed to reduce their emissions well below the national average? The data analyses provided in this report offer only a partial explanation. There is much more to be learned from a detailed examination of the policies of the lowest-emission states. These states are not the poorest states in the nation; they have shown that it is possible to produce a comfortable American lifestyle with carbon emissions well below average. Following their example more widely is an important first step on the road to reducing our greenhouse gas emissions to a sustainable level.

Appendix A: State Data

	Emissions per capita (metric tons CO2)								
	Transportation total per capita emissions	Non-electricity residential emissions	Electricity Residential emissions	Commercial total per capita emissions	Industrial total per capita emissions	Total per capita emissions by state (use basis)	From Import (+) or Export (-) of Electricity	Heating degree days	Cooling degree days
National Average	6.74	1.27	3.00	3.60	6.03	20.63	0.08	4,268	1,232
Alaska	28.74	2.77	2.17	6.04	33.05	72.77	0.00	11,525	4
Alabama	7.76	0.69	4.19	3.41	9.87	25.91	-5.68	2,683	1,915
Arkansas	7.46	0.86	3.40	3.06	8.01	22.79	-0.42	3,205	1,658
Arizona	6.28	0.38	2.73	2.82	1.95	14.15	-1.81	1,847	3,074
California	6.37	0.84	1.03	1.84	2.83	12.91	1.54	2,316	959
Colorado	6.41	1.55	3.22	4.90	5.06	21.14	0.87	6,711	179
Connecticut	5.77	2.90	1.60	2.72	1.45	14.44	1.18	5,941	565
District of Columbia	3.25	1.64	2.43	14.10	0.50	21.92	14.98	4,638	1,100
Delaware	5.97	1.52	5.20	5.76	8.88	27.33	5.76	4,649	1,084
Florida	6.37	0.12	4.49	3.76	1.53	16.29	1.34	716	3,452
Georgia	7.41	0.89	4.03	3.75	5.13	21.20	1.33	2,886	1,703
Hawaii	9.77	0.02	2.03	2.54	3.93	18.29	0.00	20	3,002
Iowa	7.10	1.61	4.53	5.09	11.67	30.00	0.92	6,653	616
Idaho	6.18	1.11	2.52	2.57	5.85	18.23	6.74	6,301	526
Illinois	5.59	1.94	1.88	3.00	5.42	17.83	-1.46	5,890	706
Indiana	7.33	1.57	5.09	4.79	17.38	36.16	-1.91	5,539	790
Kansas	7.05	1.50	4.14	5.49	8.97	27.15	-1.67	4,837	1,215
Kentucky	8.32	0.95	6.19	5.27	15.53	36.25	0.62	4,206	1,141
Louisiana	11.94	0.57	4.10	3.68	22.05	42.33	-1.11	1,703	2,758
Massachusetts	5.23	2.32	2.00	3.65	1.75	14.94	1.45	6,346	393
Maryland	5.64	1.28	3.90	3.31	4.14	18.27	3.46	4,638	1,100
Maine	6.58	3.98	1.45	3.05	3.36	18.41	-1.73	7,943	166
Michigan	5.62	2.27	2.46	3.93	5.15	19.43	0.68	6,683	428
Minnesota	7.37	1.84	3.21	4.37	6.52	23.31	2.08	8,251	337
Missouri	7.15	1.28	5.31	5.58	4.46	23.77	-0.60	4,847	1,033
Mississipi	8.61	0.62	4.07	3.43	7.29	24.03	2.81	2,509	2,061
Montana	8.33	1.70	3.45	4.86	10.01	28.35	-9.12	7,716	208
North Carolina	6.15	0.86	3.77	3.71	4.19	18.67	0.73	3,417	1,479
North Dakota	9.92	2.00	6.48	8.48	24.01	50.89	-31.33	9,294	254
Nebraska	7.06	1.40	3.93	4.86	7.49	24.74	-0.64	6,179	812
New Hampshire	5.98	2.62	1.30	2.72	1.61	14.23	-2.52	7,368	288
New Jersey	7.46	2.02	1.65	3.49	2.57	17.18	2.23	5,227	829
New Mexico	8.23	1.22	3.10	5.41	7.80	25.76	-5.48	4,354	850
Nevada	6.96	0.87	3.53	3.40	5.16	19.93	0.49	3,373	2,182
New York	4.04	1.97	1.24	3.73	1.27	12.24	0.83	5,953	594
Ohio	6.29	1.77	4.09	4.68	7.84	24.67	1.40	5,755	669
Oklahoma	8.18	1.05	4.94	4.93	9.47	28.57	-1.00	3,382	1,671
Oregon	6.38	0.72	1.07	1.43	2.70	12.30	0.27	4,556	355
Pennsylvania	5.82	2.06	2.57	3.28	6.68	20.41	-2.34	5,754	680
Rhode Island	4.09	2.59	1.60	3.00	1.30	12.58	1.98	5,765	467
South Carolina	7.64	0.56	2.82	2.39	6.18	19.59	-0.66	2,764	1,941
South Dakota	7.87	1.36	2.70	3.54	4.41	19.89	2.00	7,225	556
Tennessee	7.62	0.75	4.43	3.88	6.69	23.38	1.99	3,732	1,301
Texas	8.54	0.52	4.09	3.91	12.83	29.90	-0.42	1,759	2,665
Utah	6.79	1.50	3.05	4.89	6.53	22.75	-4.00	6,119	708
Virginia	7.36	1.12	3.94	4.72	4.40	21.54	3.61	4,278	1,126
Vermont	6.12	2.95	0.02	1.21	1.01	11.30	0.00	8,167	221
Washington	6.96	0.77	0.86	1.24	3.35	13.18	-0.30	4,931	311
Wisconsin	5.66	1.82	3.34	4.08	7.45	22.35	1.91	7,411	342
West Virginia	6.93	1.35	5.84	4.95	13.63	32.71	-31.56	5,152	764
Wyoming	15.91	1.70	5.10	9.36	37.33	69.40	-59.06	7,757	196

Appendix A: State Data (continued)

	Vehicle Miles per capita							
	Truck and bus vehicle miles	Automobile vehicle miles	Average gasoline price	State gasoline taxes	Share of population using public transit	Residential electricity per capita (kWh)	Average electricity price per kWh ($2004)	Share of electricity generated from coal
National Average	1,065	9,022	$1.42	$0.20	0.046	4,702	$0.08	0.50
Alaska	787	6,808	$1.70	$0.08	0.011	3,055	$0.11	0.10
Alabama	822	12,247	$1.38	$0.18	0.005	6,457	$0.06	0.54
Arkansas	1,821	9,699	$1.35	$0.22	0.004	5,656	$0.06	0.49
Arizona	1,588	8,391	$1.56	$0.18	0.018	4,961	$0.07	0.38
California	812	8,365	$1.65	$0.18	0.048	2,267	$0.11	0.20
Colorado	765	9,213	$1.44	$0.22	0.025	3,396	$0.07	0.74
Connecticut	622	8,424	$1.47	$0.25	0.039	3,747	$0.10	0.18
District of Columbia	432	6,019	$1.43	$0.20	0.336	3,122	$0.07	0.62
Delaware	1,139	10,081	$1.42	$0.23	0.021	5,641	$0.08	0.61
Florida	1,045	10,266	$1.40	$0.15	0.017	6,556	$0.08	0.33
Georgia	1,475	11,130	$1.39	$0.08	0.021	5,623	$0.07	0.63
Hawaii	246	7,478	$1.67	$0.16	0.055	2,435	$0.16	0.14
Iowa	1,193	9,484	$1.36	$0.21	0.010	4,320	$0.06	0.80
Idaho	1,732	8,827	$1.45	$0.25	0.012	5,208	$0.05	0.35
Illinois	965	7,619	$1.43	$0.19	0.080	3,359	$0.07	0.49
Indiana	1,580	10,105	$1.39	$0.18	0.008	4,906	$0.06	0.94
Kansas	1,292	9,362	$1.36	$0.24	0.002	4,511	$0.06	0.74
Kentucky	1,593	9,837	$1.40	$0.17	0.010	6,024	$0.05	0.90
Louisiana	1,496	8,425	$1.35	$0.20	0.018	6,261	$0.07	0.24
Massachusetts	417	8,093	$1.46	$0.21	0.083	3,038	$0.11	0.32
Maryland	928	9,028	$1.42	$0.24	0.083	5,405	$0.07	0.58
Maine	956	10,420	$1.47	$0.25	0.006	3,211	$0.10	0.02
Michigan	828	9,409	$1.41	$0.19	0.009	3,354	$0.07	0.58
Minnesota	900	10,282	$1.43	$0.20	0.029	4,037	$0.06	0.64
Missouri	1,507	10,485	$1.37	$0.17	0.014	5,510	$0.06	0.86
Mississipi	1,909	11,310	$1.39	$0.18	0.002	6,037	$0.07	0.43
Montana	1,358	10,745	$1.42	$0.27	0.005	4,372	$0.06	0.65
North Carolina	1,219	10,023	$1.37	$0.27	0.009	5,940	$0.07	0.60
North Dakota	1,838	10,103	$1.46	$0.21	0.004	5,748	$0.06	0.94
Nebraska	1,517	9,457	$1.38	$0.25	0.006	5,031	$0.06	0.64
New Hampshire	752	9,429	$1.46	$0.20	0.007	3,325	$0.11	0.17
New Jersey	809	7,587	$1.48	$0.11	0.107	3,193	$0.10	0.34
New Mexico	2,332	10,262	$1.43	$0.19	0.012	2,928	$0.07	0.89
Nevada	882	7,417	$1.64	$0.23	0.038	4,583	$0.09	0.48
New York	502	6,646	$1.46	$0.23	0.251	2,451	$0.13	0.23
Ohio	1,134	8,608	$1.38	$0.26	0.015	4,341	$0.07	0.83
Oklahoma	2,035	11,147	$1.33	$0.17	0.004	5,553	$0.07	0.56
Oregon	1,144	8,775	$1.52	$0.24	0.037	5,008	$0.06	0.07
Pennsylvania	966	7,766	$1.38	$0.30	0.050	4,008	$0.08	0.55
Rhode Island	319	7,534	$1.43	$0.30	0.022	2,756	$0.11	0.27
South Carolina	1,293	10,519	$1.39	$0.16	0.005	6,489	$0.06	0.40
South Dakota	1,632	9,775	$1.43	$0.22	0.002	4,765	$0.06	0.52
Tennessee	1,462	10,591	$1.36	$0.21	0.007	6,449	$0.06	0.60
Texas	1,194	9,065	$1.34	$0.20	0.015	5,475	$0.08	0.38
Utah	1,627	8,569	$1.43	$0.25	0.026	3,032	$0.06	0.96
Virginia	873	9,683	$1.39	$0.18	0.035	5,541	$0.06	0.51
Vermont	1,184	11,465	$1.51	$0.20	0.011	3,220	$0.11	0.09
Washington	927	8,044	$1.50	$0.28	0.043	5,171	$0.06	0.10
Wisconsin	912	10,072	$1.42	$0.29	0.019	3,831	$0.07	0.68
West Virginia	1,587	9,623	$1.42	$0.27	0.011	5,814	$0.05	0.98
Wyoming	4,435	13,868	$1.45	$0.14	0.015	4,417	$0.05	0.97

Appendix B: Regressions

Note: All regressions include data for 49 states and the District of Columbia; Alaska proved to be an extreme outlier, especially on transportation data, and was omitted throughout the regressions. For variables defined as percentages, 1 percent refers to 0.01.

Table 1: Transportation emissions per capita
Dependent variable: Transportation emissions per capita (mT CO_2)
Independent variables: Heavy truck vehicle miles traveled (VMT) per capita; and automobile/light-truck VMT per capita

	Coefficient	Significance[a]		
Heavy truck VMT per capita	0.0020	**	Observations	50
Auto/light-truck VMT per capita	0.0002		R-squared	0.559
constant	2.8284			

a) * indicates significance at the 95% level; ** indicates significance at the 99% level

Table 2: Automobile and light-truck vehicle miles traveled per capita
Dependent variable: Automobile and light-truck vehicle miles traveled per capita
Independent variables: Percentage of urban population; inverse population density (square miles per person); average gasoline price per gallon (in $2004); and percentage of workers using public transportation

	Coefficient	Significance[a]		
Percentage urban population	-2,649.64	*	Observations	50
Inverse density	9.61	*	R-squared	0.609
Percentage workers using public transportation	-8,724.45	**		
Average gasoline price ($2004/gallon)	-5,305.16	**		
constant	18,904.91			

a) * indicates significance at the 95% level; ** indicates significance at the 99% level

Table 3: Fuel-based residential emissions per capita
Dependent variable: Fuel-based residential emissions per capita (mT CO_2)
Independent variables: Heating degree days

	Coefficient	Significance[a]		
Heating degree days	0.0003	**	Observations	50
constant	-0.0391		R-squared	0.633

a) * indicates significance at the 95% level; ** indicates significance at the 99% level

Table 4: Residential electricity emissions per capita
Dependent variable: Residential electricity emissions per capita (mT CO_2)
Independent variables: Residential electricity consumption per capita (kWh); and percentage of electricity generated from coal

	Coefficient	Significance[a]		
Residential electricity consumption per capita (kWh)	0.0006	**	Observations	50
Percentage of electricity generated from coal	3.6542	**	R-squared	0.847
constant	-1.4189			

a) * indicates significance at the 95% level; ** indicates significance at the 99% level

Table 5: Residential electricity consumption per capita
Dependent variable: Residential electricity consumption per capita (kWh)
Independent variables: Average electricity price per kWh (in $2004); energy efficiency; and cooling degree days

	Coefficient	Significance[a]		
Average electricity price ($2004/kWh)	-36,739.22	**	Observations	50
Energy efficiency	-7.37		R-squared	0.681
Cooling degree days	0.75	**		
constant	6,620.16			
a) * indicates significance at the 95% level; ** indicates significance at the 99% level				

Appendix C: Data sources

All data are 2004 except where otherwise indicated.

Population: U.S. Census (2008), *National and State Population Estimates*, “Table 1: Annual Estimates of the Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2007”, http://www.census.gov/popest/states/NST-ann-est.html

Emissions by sector: EIA (2008), *Environment: energy-related emissions data & environmental analyses*, “Table 2. 2005 State Emissions by Sector (Million Metric Tons of Carbon Dioxide)”, http://www.eia.doe.gov/environment.html

Vehicles miles traveled per capita: U.S. Department of Transportation, Federal Highway Administration (2005), *Highway Statistics 2004*, “Federal-Aid Highway Travel – 2004: Annual Vehicle-Miles”, http://www.fhwa.dot.gov/policy/ohim/hs04/htm/vm3.htm

Share of vehicles miles traveled from heavy trucks and buses: U.S. Department of Transportation, Federal Highway Administration (2004), *Highway Statistics 2004*, “Selected Measures for Identifying Peer States”, http://www.fhwa.dot.gov/policy/ohim/hs04/htm/ps1.htm

Electricity consumption by sector: EIA (2009), *Electric Power Annual 2007 – State Data Tables*, “Retail Sales of Electricity by State by Sector by Provider, 1990-2007”, http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html

Electricity generation: EIA (2009), *Electric Power Annual 2007 – State Data Tables*, “1990–2007 Net Generation by State by Type of Producer by Energy Source (EIA-906)”, http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html

Average gasoline price per gallon: EIA (2008), *Petroleum Navigator*, “Gasoline Prices by Formulation, Grade, Sales Type”, http://tonto.eia.doe.gov/dnav/pet/pet_pri_allmg_a_EPM0_PTA_cpgal_a.htm

Federal and state gasoline taxes per gallon: EIA (2005), *Petroleum Marketing Monthly April 2005*, “Table EN1. Federal and State Motor Fuels Taxes”, http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/petroleum_marketing_monthly/historical/2005/2005_04/pdf/enote.pdf

Share of workers commuting by public transportation: U.S. Census (2005), *2004 American Community Survey*, Table B08006. Sex of Workers by Means of Transportation”, http://factfinder.census.gov/home/saff/main.html?_lang=en&_ts=

Average electricity price per kWh: EIA (2006), *State Electricity Profiles 2004*, “Table A1. Selected Electric Industry Summary Statistics by State, 2004”, http://tonto.eia.doe.gov/ftproot/electricity/stateprofiles/04st_profiles/062904.pdf

July 2003/June 2004 annual heating degree days: NOAA (2005), *Historical Climatology Series 5-1, Period July 2003 through June 2005*, “State Heating Degree Days (Divisions Weighted by 2000 Population)”, http://www.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200307-200506.pdf. Data for Alaska and Hawaii are “normal” data for 1971-2000: NOAA (2000), *Historical Climatography Series No.5-1, State, Regional, and National Monthly Heating Degree Days, Weighted by Population (2000 Census), 1971-2000 (and previous normal periods)*, “Alaska-Hawaii-Territories-Census Regions”

January to December 2004 annual cooling degree days: NOAA (2005), *Historical Climatology Series 5-2, Period January 2004 through December 2005*, “State Cooling Degree Days (Divisions Weighted by 2000 Population)”, http://www.ncdc.noaa.gov/oa/documentlibrary/hcs/cdd.200401-200512.pdf. Data for Alaska and Hawaii are “normal” data for 1971-2000: NOAA (2000), *Historical Climatography Series No.5-2, State, Regional, and National Monthly Cooling Degree Days, Weighted by Population (2000 Census), 1971–2000 (and previous normal periods)*, “Alaska-Hawaii-Territories-Census Regions”.

Share of electricity generated from coal: EIA (2009), *Electric Power Annual 2007 - State Data Tables*, "1990–2007 Net Generation by State by Type of Producer by Energy Source (EIA-906)", http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html

Energy efficiency: Eldridge, Maggie, Bill Prindle, Dan York, and Steve Nadel (2007), American Council for an Energy-Efficient Economy, *The State Energy Efficiency Scorecard for 2006*, Report # E075, http://www.aceee.org/pubs/e075.htm. Note: States were scored according to the existence of energy efficiency policies in eight categories. Each category was weighted by its energy savings potential. The maximum total score was 44.

Appendix D: Interstate Electricity Sales Adjustment

We adjusted the reported data for electricity generation, emissions, and purchases by state as follows:

1. For Hawaii and Alaska, all in-state generation emissions were assigned to that state's electricity consumers, in proportion to their use of electricity. These states do not participate in electricity exports or imports.

2. For the remaining 48 states plus the District of Columbia, we calculated the ratio of nationwide generation plus net foreign imports to electricity purchases. That ratio is greater than 1 because there are losses in transmission and distribution of electricity; it takes more than 1 kWh of generation to deliver 1 kWh of electricity to an end user. We multiplied each state's electricity purchases by that ratio, obtaining the amount of generation needed to supply each state's electricity users.

3. For each state, we compared actual generation to the generation needed to supply that state's electricity users; the difference is net exports to or imports from other states.

4. For exporting states, we assumed that exports and in-state use of electricity have the same emissions intensity; the state's emissions from electricity generation are allocated to in-state users and to exports, in proportion to the use of electricity.

5. All electricity exports, and the associated emissions, are combined into a single nationwide export pool.

6. Importing states are assumed to receive electricity from the export pool, with the proportionate share of emissions. That is, all interstate imports are assumed to have the average emissions intensity of the nationwide export pool.

This method is suggested by Scott Jiusto (2006) "The differences that methods make: Cross-border power flows and accounting for carbon emissions from electricity use." Energy Policy 34(17): 2915–2928.