



Indirect Energy and Your Wallet

By Kenneth P. Green and Aparna Mathur

The average household spends nearly as much on the consumption of indirect energy as it does on direct energy consumption. Understanding how money is spent and who spends it will be important when Congress addresses climate change and our energy infrastructure.

As part of AEI's ongoing research into how Americans use and produce energy, we recently published an *Energy and Environment Outlook* examining the question of indirect energy use.¹ Indirect energy is the energy embedded in the goods and services we purchase. An example of indirect energy consumption (one that ranks high as a percentage of Americans' indirect energy use) is prescription medication. Energy is required to create a drug, sterilize it, package and transport it safely to pharmacies, repackage it into individual bottles, and so on. This is distinct from direct energy consumption, like using gasoline to run our cars, oil to heat our houses, or electricity to keep our televisions on.²

In this *Outlook*, we will further explore Americans' use of indirect energy—this time by examining how much money an average household spends on indirect energy and what options Americans have to reduce that spending. This will be particularly relevant as Congress considers putting a tax on carbon emissions, either directly or through a carbon-emission trading system, in coming years.

The methodology we used for calculating the energy component of different consumption items was explained in the previous *Outlook*. The “energy component” refers to the use of coal, petroleum and natural gas, electricity, water, and

other utilities in the production of consumer goods. Briefly, using the “Make” and “Use” tables from the U.S. Department of Commerce's Bureau of Economic Analysis, we were able to calculate the total value of energy that was used in the production of industrial and consumer goods. For instance, our calculations show that 7 percent of the cost of the food produced on farms is from the energy—coal, oil, natural gas, and petroleum—that is used to produce it. The other 93 percent of the cost comes from things such as the labor needed to grow it and the fertilizer, pesticides, water, and machinery needed to harvest, process, and transport it to markets. Similarly, even the production of fuels such as oil and gas involves the use of nonenergy items like chemical products, metals, and mineral products. This is why the energy component of fuels does not total 100 percent in table 1, which shows the indirect energy content of consumer goods in 2006.

Table 1 shows that the energy component of fuels—by which we mean the energy used (in dollar terms) in the production of fuels such as gasoline and oil, fuel oil, and coal—is more than 40 percent, while that of nonfuel everyday consumption items, such as airline travel, pharmaceuticals, and food, varies from 2 percent to 18 percent.

We next wanted to see how these energy components could be used to study indirect energy expenditures at the household level. For instance, if a typical household spends \$1,000 on airline

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TABLE 1
INDIRECT ENERGY CONTENT OF CONSUMER GOODS, 2006

	Energy component of individual consumption items (percent)		Energy component of individual consumption items (percent)
Fuel oil and coal	47.52	Tobacco products	1.90
Gasoline and oil	41.44	Religious and welfare activities	1.88
Electricity	20.40	Spectator sports	1.83
Gas	20.40	Net purchases of used autos	1.82
Airline travel	18.48	Domestic services	1.76
Water and other sanitary services	9.99	Auto repair, greasing, washing, parking, storage, rental, and leasing	1.73
Drug preparations and sundries	7.32	Furniture, including mattresses and bedsprings	1.65
Food produced and consumed on farms ("Foodhome")	6.65	Women's and children's clothing	1.62
Toilet articles and preparations	5.86	Kitchen and other household appliances	1.60
Railway	4.99	Ophthalmic products and orthopedic appliances	1.55
Cleaning and polishing preparations, miscellaneous household supplies, and paper products	4.83	Wheel goods, sports and photographic equipment, boats, and pleasure aircraft	1.54
Purchased meals and beverages ("Foodout")	4.19	Men's and boys' clothing	1.54
Flowers, seeds, and potted plants	3.70	Books and maps	1.51
Mass transit systems	3.41	Shoes	1.50
Taxicabs	3.40	Radio and television repair	1.50
Buses	3.40	Other	1.47
Medical care and hospitalization	3.01	Jewelry and watches	1.46
Workers' compensation	3.01	New autos	1.28
Insurance	3.01	Magazines, newspapers, and sheet music	1.25
Income loss	3.01	Nursery, elementary, and secondary schools	1.21
Funeral and burial expenses	2.99	Computers, peripherals, and software	1.17
China, glassware, tableware, and utensils	2.66	Video and audio goods, including musical instruments	1.12
Expense of handling life insurance and pension plans	2.58	Standard clothing issued to military personnel	1.09
Stationery and writing supplies	2.45	Higher education	0.89
Food furnished to employees (including military)	2.37	Motion picture theaters	0.48
Food purchased for off-premise consumption ("Foodhome")	2.33	Services furnished without payment by financial intermediaries (except life insurance carriers)	0.45
Dentists	2.25	Bridge, tunnel, ferry, and road tolls	0.42
Physicians	2.25	Nonprofit hospitals	0.40
Other professional services	2.24	Proprietary hospitals	0.40
Theaters, opera houses, and nonprofit entertainment (except athletics)	2.20	Government hospitals	0.40
Other durable house furnishings	2.17	Nursing homes	0.40
Semidurable house furnishings	2.17	Owner-occupied nonfarm dwellings	0.32
Parimutuel net receipts	2.15	Tenant-occupied nonfarm dwellings	0.32
Tires, tubes, accessories, and other parts	2.13	Rental value of farm dwellings	0.32
Nondurable toys and sport supplies	2.08	Telephone and telegraph	0.27
Cleaning, storage, and repair of clothing and shoes	2.00	Legal services	0.19
Barbershops, beauty parlors, and health clubs	1.98	Brokerage charges and investment counseling	0.10
Clubs and fraternal organizations	1.97	Bank service charges, trust services, and safe deposit box rental	0.06
Commercial participant amusements	1.95		

SOURCE: Authors' calculations.

NOTE: The consumption item categories defined here are those used by the National Income and Product Accounts of the Bureau of Economic Analysis.

TABLE 2
AGGREGATE INDIRECT ENERGY EXPENDITURES, 2003

Indirect energy expenditures (in billion \$)	
Food	40.26
Transportation	18.12
Entertainment	10.24
Health care	9.68
Housing	9.22
Religion	3.89
Financials	2.56
Education	2.06
Beauty	1.99

SOURCE: Authors' calculations.
NOTE: Not all categories shown.

travel in a year, the household's indirect energy expenditure on airline travel is \$184.80 (see table 1). This is the value of the energy purchased by the household when it "consumes" airline travel.

To get household expenditure data, we accessed information from the Consumer Expenditure Survey (CES).³ These data—including income, expenditures, and family or household characteristics—provide information on the buying habits of American consumers. The microlevel data are also available from the National Bureau of Economic Research (NBER), and we used data from 2003, the most recent year available. The consumption items on which survey data are collected are defined differently than the National Income and Product Accounts (NIPA) consumption categories used in table 1. Therefore, we needed to match the NIPA categories to CES consumption categories to extend the analysis to household level expenditure data. For example, the food category is broken down into "Foodhome," "Foodout," and "Foodwork" in the CES data, while the NIPA categories for food are "Food Purchased for Off-Premise Consumption," "Purchased Meals and Beverages," "Food Furnished to Employees," and "Food Produced and Consumed on Farms." NBER provides mapping that allowed us to aggregate the different NIPA consumption categories into CES categories.⁴ The mapping shows that "Food Purchased for Off-Premise Consumption" and "Food Produced and Consumed on Farms" can be aggregated to match the CES category "Foodhome." Using this mapping and the

information on the energy content of NIPA consumption items shown in table 1, we were able to calculate the energy content of different CES consumption items. We did so by averaging the energy content of the different NIPA subcomponents for each CES category.

Next, we calculated the energy expenditures for all households by weighting their consumption expenditures by the energy component of the different consumption goods. Aggregate indirect energy expenditures totaled \$113.2 billion, and aggregate direct energy expenditures totaled \$127.75 billion. This means that the amount of money that American consumers spend on indirect energy is almost 90 percent of what they spend on gas, electricity, and other direct energy. As table 2 shows, the aggregate indirect expenditures for all households in 2003 can be broken down into different categories (using the same groupings we used in the previous *Outlook*).

Elasticity

In this section, we explore the elasticity of demand for indirect energy with respect to income. The elasticity measures the ease with which consumers can alter their demand for or use of indirect energy as their incomes change. We also provide descriptive statistics showing the average indirect energy consumption in different income deciles. The entire set of households in the CES data is divided into different percentiles of income—such as the bottom 10 percent, the next 10 percent, and so on—to study how consumption patterns vary across income groups. Table 3 shows the ratio of indirect expenditures to income across these different income classes.

As table 3 indicates, the bottom 10 percent of the population have the highest expenditures-to-income ratio, while the top has the lowest. To see why, we looked at the average indirect energy expenditures for different income groups as well as the average income for each group (see table 4). While expenditures are sharply higher in the richest income class relative to the poorest (by close to 400 percent), the income differences are even steeper. Therefore, while expenditures go up by a lot, incomes go up by even more, which is why the ratio of expenditures to income goes down as we move from the bottom to the top. This finding has implications with regard to the regressivity of any potential carbon-pricing scheme. Poorer households will be hit not only by higher direct energy costs, but disproportionately by indirect energy costs as well, particularly in the cost of food.

TABLE 3
DISTRIBUTION ACROSS INCOME CLASSES, 2003

Decile	Ratio of indirect energy expenditures to income (percent)
Bottom (poorest)	5.05
Second	3.72
Third	2.86
Fourth	2.46
Fifth	2.12
Sixth	1.99
Seventh	1.79
Eighth	1.65
Ninth	1.49
Top (richest)	1.33

SOURCE: Authors' calculations.

This leads us to the question of elasticity. If incomes increase by a lot but expenditures do not change a lot, this suggests that demand for indirect energy is fairly inelastic. (In fact, the actual number is fairly close to zero, suggesting that demand is almost perfectly inelastic.) This makes intuitive sense since we are including an entire host of consumption goods that people buy on a daily basis, and there are likely to be few alternatives to this consumption basket taken as a whole. However, the elasticity for different types of goods inside the basket may be higher. In table 5, we report our elasticity estimates for different subcategories of indirect energy consumption.

TABLE 4
DISTRIBUTION OF INDIRECT ENERGY EXPENDITURES AND INCOME, 2003

Decile	Average indirect energy expenditures	Average income
Bottom (poorest)	\$426.91	\$8,493.33
Second	\$504.48	\$13,757.95
Third	\$585.19	\$20,570.09
Fourth	\$683.46	\$27,738.84
Fifth	\$766.42	\$36,111.09
Sixth	\$903.72	\$45,384.14
Seventh	\$1,040.78	\$57,971.80
Eighth	\$1,208.94	\$73,196.41
Ninth	\$1,387.58	\$93,446.51
Top (richest)	\$2,115.47	\$163,473.78

SOURCE: Authors' calculations.

TABLE 5
INCOME ELASTICITY OF DEMAND, 2003

	Elasticity with regard to income
Transportation	0.47
Home furnishings	0.47
Entertainment	0.41
Foodout	0.39
Automobiles	0.33
Food	0.32
Foodhome	0.27
Telephone	0.27
Doctors	0.27
Education	0.25
Health	0.25
Airline travel	0.13
Health insurance	0.13
Hospital	0.10
Higher education	0.07
Drugs	0.06

SOURCE: Authors' calculations.

In general, these numbers show that as incomes go up, people tend to buy more of these items since the elasticities are all positive. In economic terms, these are “normal” goods. The demand for some items, however, is more elastic than for others. For instance, an “elasticity with regard to income” number of 0.45 for transportation means that a 1 percent increase in income would lead to a 0.45 percent increase in transportation expenditures. By contrast, a 0.06 for drugs means that a 1 percent increase in income would lead to a minuscule increase in drug expenditures. It makes sense that higher-income households will spend more on eating out and investing in home furnishings than lower-income households. Similarly, expenditures on cars and visits to doctors are likely to go up as incomes rise. For some items, such as drugs and schooling, however, the expenditures do not change much as incomes go up. The elasticity is close to zero.

TABLE 6
VALUE OF INDIRECT ENERGY CONSUMPTION FOR A TYPICAL MIDDLE-INCOME HOUSEHOLD, 2003

	Expenditures	Energy share	Value of energy used	Elasticity with regard to income
Foodhome	\$4,589.99	0.0449	\$206.09	0.28
Business services (brokerage charges and investment counseling, bank service charges, etc.)	\$3,756.08	0.0020	\$7.51	0.27
Automobiles	\$2,933.47	0.0150	\$43.99	0.34
Rent (home)	\$2,545.63	0.0032	\$8.14	0.23
Clothes	\$2,181.54	0.0144	\$31.41	0.36
Health insurance (medical care and hospitalization, income loss, and workers' compensation)	\$1,324.10	0.0301	\$39.85	0.14
Charity	\$1,186.83	0.0188	\$22.31	0.31
Car services (repair, greasing, washing, parking, storage, rental, and leasing)	\$1,170.91	0.0173	\$20.25	0.34
Recreational sports	\$916.31	0.0181	\$16.58	0.34
Beauty (hair stylists and health clubs)	\$722.74	0.0198	\$14.31	0.30
Home furnishings	\$596.92	0.0202	\$12.05	0.47
Doctors	\$538.70	0.0225	\$12.12	0.27
Life insurance (expense of handling life insurance and pension plans, legal services, and funeral and burial expenses)	\$530.26	0.0188	\$9.96	0.19
Higher education	\$442.68	0.0089	\$3.93	0.07
Auto insurance	\$426.71	0.0301	\$12.84	0.19
Tailors (cleaning, storage, and repair of clothes and shoes)	\$300.92	0.0200	\$6.01	0.20
Drugs (drug preparations and sundries)	\$262.75	0.0732	\$19.23	0.06
Airfare	\$125.87	0.1848	\$23.26	0.13
Hospitals	\$77.79	0.0040	\$0.31	0.10
Mass transit	\$71.55	0.0341	\$2.43	0.06
Orthopedic (ophthalmic products and orthopedic appliances)	\$59.00	0.0155	\$0.91	0.15

SOURCE: Authors' calculations.

NOTE: These averages are per household for 2003 in the median income decile—that is, those above the bottom 40 percent and below the top 40 percent. The reason the numbers look small is that they include households that had zero expenditures in each category. If households that had only positive expenditures were included, the numbers would be much higher.

Energy Saving

To see how much energy people could save by cutting down on some consumption items, we looked at the consumption of different goods by households in the fifth income decile (or the median household). Table 6 shows these expenditures and associated cost savings.

Table 6 shows the value of energy used by an average household when it consumes everyday items like airline travel, meals, beauty products, and automobiles. By our

calculations, Foodhome has a higher indirect energy content than Foodout (see table 1). This is surprising at first glance since one would expect that food cooked at home would involve less energy than food produced at restaurants. We get this result because the definition of Foodhome includes food produced and consumed on farms, and farm production is highly energy intensive. If we exclude this component, Foodhome has an energy content of 0.0233, which is nearly half that of food eaten out. This implies that there could be tremendous

energy saving if people consumed more food at home (see table 7). The energy component of airline travel is the highest at 18 percent. Therefore, people could save on energy by using trains, buses, or even cars for longer-distance travel. At the same time, the elasticity of airline travel—or, more specifically, of expenditure on airfare—is much lower, at 0.13. Getting people to use alternative modes of travel may not be easy. Drugs have about 7 percent indirect energy, while hospitals and doctors have about 1–2 percent. The elasticity of consumption of hospitals and drugs is low but significantly higher for doctors.

Conclusion

For a variety of reasons, many Americans want to reduce their energy consumption or engage in less energy-intensive activities. Some people place a high value on reducing the export of U.S. dollars to foreign energy providers. Some are concerned about greenhouse gas emissions and conventional pollution caused by the burning of fossil fuels. Others are simply concerned about their household budget, and, when that budget is strained by higher energy costs, they seek ways to trim energy use. In addition, it is a near certainty that the Obama administration is going to impose greenhouse gas controls and tighten energy efficiency standards, sharply increasing the cost of coal-based electricity, oil-based fertilizer, and natural-gas-based products including a vast array of chemicals used in household products. This will likely stimulate American households to examine their energy use to find ways they can cut back with the least inconvenience or loss of lifestyle quality.

Other than a few campaigns by activist groups emphasizing the carbon intensity of meat consumption, the overwhelming focus of energy policy and conservation campaigns has been on direct forms of energy consumption that are fairly hard to change: housing size and location, commuting distance and mode, and so on. The focus on direct energy use obscures the fact that Americans have many choices when it comes to reducing their energy expenditures besides cutting back on the direct use of oil, natural gas, and electricity. Table 7 shows the top ten areas in which Americans display the greatest levels of flexibility in their purchasing behavior, as well as how much the median household spends on the indirect

TABLE 7
TOP TEN EXPENDITURES WITH THE HIGHEST ELASTICITIES
OF CONSUMPTION AND THEIR ENERGY COMPONENT

	Average energy component (percent)	Expenditure
Food consumed at restaurants	4.19	\$2,160.53
Household furniture, kitchen appliances, and tableware	2.02	\$596.92
Barbershops, beauty parlors, and health clubs	1.97	\$722.74
Charitable activities	1.88	\$1,186.83
Recreational sports (boats, pleasure craft, and photographic equipment)	1.80	\$916.31
Jewelry and watches	1.72	\$183.34
Car services (repair, parking, washing, renting, and leasing)	1.70	\$1,170.91
Video and audio goods, including musical instruments and computers, and spectator sports	1.68	\$2,398.36
Purchase of new and used cars	1.50	\$2,933.47
Clothing and shoes	1.44	\$2,181.53

SOURCE: Authors' calculations.

energy embodied in those goods. Turning to a somewhat simpler, less gadget-filled lifestyle with more dining at home can significantly reduce the amount of money American households spend buying energy indirectly as part of their use of consumer goods and services. People willing to be flexible in areas usually considered resistant to change, such as the consumption of air travel, medical services, and automobile use, could realize still more significant reductions in indirect energy expenditures.

Notes

1. Kenneth P. Green and Aparna Mathur, "Measuring and Reducing Americans' Indirect Energy Use," *Energy and Environment Outlook*, no. 2 (December 2008), available at www.aei.org/publication29020.

2. The definition of direct and indirect energy used here is taken from Gilbert Metcalf, Kevin A. Hassett, and Aparna Mathur, "The Incidence of a U.S. Carbon Tax: A Lifetime and Regional Analysis," forthcoming in *The Energy Journal*, draft available at www.aei.org/publication27440.

3. U.S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditure Survey, available at www.bls.gov/cex/#data (accessed February 5, 2009).

4. This mapping is available at www.nber.org/ces_cbo/readme.txt.old (accessed February 5, 2009).