THE ENVIRONMENTAL EXTERNALITY COSTS OF PETROLEUM

JUNE 1994

27/3

Prepared for
Western Regional Biomass Energy Program
1627 Cole Blvd.
Golden, CO 80401
(Contract number DE-AC65-90WAO5637)
and
Great Lakes Regional Biomass Energy Program
35 Wacker Dr., Suite 1850
Chicago, IL 60601
(Contract number CGLG-94-001)

Prepared by
ENERGETICS
7164 Columbia Gateway Drive
Columbia, MD 21046

Overview

While measurement and especially costing of environmental externalities is analytically difficult and rather controversial, there is a substantial and steadily growing literature on the external costs of energy. Table 1 is the result of a recent review and analysis of this literature with regard to petroleum and petroleum-derived fuels. This analysis concluded that, on the basis of the existing scientific literature and current environmental data, the externality cost of petroleum (as defined by air pollution alone) is approximately $45 per barrel. When this estimate is combined with a nominal world oil price of approximately $15 per barrel *the analysis implies that a "truer" cost of oil, i.e., a cost that includes the cost of environmental damages which oil use imposes on society at large, is $15 plus $45, or $60 per barrel.*

Table 1
Estimated Environmental Externality Costs of Petroleum (1992)

Externality	Cost Per Barrel
Primary Global Warming Emissions (N_2O, CO_2, CH_4)	$2.29
Regulated Air Pollutants (SO_2, NOx, CO, PM-10, VOC)	$42.78
Total Cost	**$45.07**

Environmental Externalities/Costs of Pollution

One of the primary reasons for the high level of oil use in the United States is that petroleum-derived fuels are less expensive than alternative fuels. However, while the nominal price of a barrel of oil is approximately $15, this price may not take into consideration other costs that use of gasoline and other petroleum products imposes on society. For example, production, transportation, storage and use (usually combustion) of petroleum-derived fuels have adverse effects on the environment. Air pollution is especially notable in this connection. Combustion of fuel oil and gasoline produces a variety of air pollutants that contribute to urban "smog," acid rain, and global climate change. The public pays a substantial price for these adverse impacts: e.g., the purchase of emission controls, destruction of recreation values, increased costs for treatment of disease, etc.

Because the preceding damages or costs are not included in the nominal price of petroleum they are referred to as "externalities." For a number of years discussion and controversy have swirled around the subject of environmental externalities. Economists, environmental scientists, environmental activists, industry and policymakers have argued about how to identify, quantify and assign cost to adverse environmental impacts associated with the use of petroleum and other fuels. Most of the literature that has emerged from this debate involves fuel use by utilities and is associated with attempts by state Public Utility Commissions (PUCs) to analyze ways of incorporating environmental costs in the price of electricity.

Several methodologies have been used to estimate the monetary cost of environmental damages associated with the use of petroleum and other fuels. One approach is contingent valuation, wherein the researcher determines how much the public would be willing to pay to protect or improve a natural area. For example, the value of improving an acidified lake would decided by determining how much the public believed it was worth to restore. An alternate method is determining the cost of preventing damage to the environment, for example, the cost of installing emission control devices. Another common method is determining costs of repairing already existing damages, such as the cost of cleaning up an oil spill. Finally, a number of analysts have used the "revealed preferences" or "shadow pricing" approach. In this methodology, environmental regulations are analyzed to estimate the costs that society is apparently willing to impose on itself to reduce emissions of various pollutants.[1] Very different estimates for external costs of the same pollutant may be determined based on the methodology. For example, the cost of controlling CO_2 emissions is probably much lower than the cost of repairing damages from global warming induced by high CO_2 emissions.

In 1991 the Alliance to save Energy summarized a number of attempts to estimate the cost of various air pollutants. This summary covered the following seven categories of emissions: SO_X (sulfur oxides), NO_X (nitrogen oxides), CO_2 (carbon dioxide), CH_4 (methane), CO (carbon monoxide), TSP and PM_{10} (particulates), and VOC's (volatile organic compounds). The analyses were conducted or sponsored by the Tellus Institute, the California Energy Commission, the New York Public Service Commission, the South Coast Air Quality Management District, PACE University Center for Environmental Legal Studies,

[1] Chernick, Paul and Emily Caverhill. *The Valuation of Externalities from Energy Production, Delivery, and Use: Fall 1989 Update.* A Report to the Boston Gas Company, December 22, 1989. Gayatri Schilberg, Jeff Nihigan and William B. Marcus, "Review of CEC Staff's Revised 'Valuing Emissions Reductions for Electricity Report 90': Staff Issue Report #3R." Prepared for the Independent Energy producers Association, December 5, 1989.

Bonneville Power Administration, and the Swedish Environmental Protection Agency. The cost estimates produced by these various organizations (updated to 1990 by the Alliance) are shown in Table 2 below.[2]

Table 2
Estimated Values for Air Externalities (1990 $/lb)

	Tellus	CEC	NYS	SCAQMD	PACE	BPA	Sweden
SO_x	0.78	9.07	0.43	39.2	2.12	0.20-1.80	1.19
NO_x	3.40	4.65	0.96	137	0.86	0.03-0.40	3.18
CO_2	0.012	0.004	0.0006	---	0.007	0.003	0.02
CH_4	0.12	0.04	---	---	---	---	---
CO	0.45	---	---	0.43	---	---	---
TSP	2.09	6.11	0.17	23.0	1.24	0.08-0.8	---
VOC	2.77	2.61	---	15.2	---	---	---

For the purpose of this analysis, the values developed by Tellus Institute for the Northeastern U.S. are used for the cost of air emission externalities.[3] The Tellus were calculated using the "revealed preferences" methodology mentioned above. Tellus estimates have been frequently cited in the literature on environmental externality costs and provide the most complete data set of the seven studies specified above. In addition, the Tellus values have been adopted for use in utility resource planning. The Massachusetts Department of Public Utilities has integrated the Tellus values into air emission requirements for resource planning and acquisition. They have also been used by the Public Service Commission of Nevada for a new rule governing utility planning. Finally, the Tellus values seem fairly conservative when compared to the other studies listed above; they generally seem to fall in the middle of the range of the other estimates.

Regulated Air Pollutants

The regulated air pollutants included in this analysis are SO_X, NO_X, CO, PM_{10} (particulate matter), and VOC's. With the exception of VOC's, these pollutants are considered to be "criteria" pollutants under the Clean Air Act and amendments. Criteria air pollutants are regulated under the Clean Air Act but are

[2] Alliance to Save Energy, American Council for An Energy Efficient Economy, Natural Resources Defense Council, and the Union of Concerned Scientists. American Energy Choices: Investing in a Strong Economy and a Clean Environment, 1991, Cambridge, MA. Technical Appendices, p. F-9.

[3] Bernow, Stephen S., Donald B. Marron, Valuation of Environmental Externalities for Energy Planning and Operations, May 1990 Update. May 14, 1990. Tellus Institute, Boston, MA.

also required to meet ambient air quality standards established by the Federal government. VOC's, although regulated in terms of emissions, do not have an established National Ambient Air Quality Standard (NAAQS) associated with their emissions.

Of primary concern with respect to urban air pollution is ozone. Major contributors to ozone are CO and NO_X. Increased levels of CO have the potential to affect persons that suffer from cardiovascular disease by reducing the oxygen-carrying capacity of the blood. VOC's react in the atmosphere with NO_X in the presence of sunlight to produce ozone. In addition, NO_X contributes to acid rain and global warming. Combustion of fuel oil produces SO_2, a respiratory irritant and contributor to acid rain. PM_{10} particulates affect the respiratory system by penetrating deeply into the lung. Finally, energy-related ozone emissions have been estimated to reduce U.S. crop yields by somewhere between 12 and 30 percent.[4]

Table 3 provides an estimate of the petroleum-related costs of the preceding air pollutants. To arrive at these estimates, recent air emissions data associated with oil were multiplied by updated cost data

Table 3
External Costs of Regulated Air Pollutants
(1992)

Externality	Tons/year	Cost/Ton	Gross Value (Billion Dollars)	Cost/Barrel
SO_x	3,258,000	$1,686	$5.49	$0.88
NO_x	11,943,000	$7,308	$87.28	$14.00
CO	71,024,000	$978	$69.47	$11.25
PM_{10}	915,000	$4,497	$4.11	$0.66
VOC	16,726,000	$5,959	$99.67	$15.99
TOTAL	**103,866,000**	---	**$266.02**	**$42.78**

from the Tellus Institute report.[5] These gross values were then divided by the total amount of oil consumed in 1992, 6.234 billion barrels, to estimate the cost of each pollutant.[6]

[4] Hubbard, Harold M., "The Real Cost of Energy," Scientific American (April 1991), p. 38.

[5] The air emissions data is derived from U.S. Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards. October 1993. National Air Pollution Emission Trends, 1900-1992, EPA/54/R-93-032, Research Triangle Park, N.C. The Tellus cost data were updated from 1989 to 1992 by assuming an increase in costs of 12 percent, the average overall rate of inflation for the U.S. economy as a whole during that time period, as suggested by the U.S. Department of Commerce, Bureau of Economic Analysis.

[6] The oil consumption total for 1992 is derived from the Monthly Energy Review, January 1994, DOE/EIA-0035 (94/01), Washington, D.C., p. 11.

Global Warming Emissions

There is a growing, but still controversial, body of evidence that anthropomorphic (i.e., man-made) sources of certain gases, primarily CO_2, CH_4, and N_2O (nitrous oxide), produce a "global warming" effect. Increased atmospheric temperatures have the potential to affect weather, alter ocean elevations and currents, impair crop yields, and endanger coastal cities. Currently, there are no regulatory provisions for pollutants associated with global climate change. CO_2 is primarily the result of the combustion of fossil fuels (i.e., petroleum and coal). Methane, CH_4, is produced by the decomposition of solid waste and animal gaseous emission and is also a byproduct of fossil fuel production. N_2O, more commonly refereed to as "laughing gas," also results from combustion of petroleum products and other fossil fuels, but the primary source is nitrogen fertilizers.

Table 4 estimates the petroleum-related external costs of the three preceding types of global warming emissions. The emission values were derived from EIA estimates for 1991, adjusted to 1992 based on trends in the EIA data during the 1985-1991 timeframe.[7] The costs per ton, once again, are the Tellus data updated to 1992.

Table 4
External Costs of Global Warming Emissions
(1992)

Externality	Tons/year	Cost/Ton	Gross Value (Million Dollars)	Cost/Barrel
CO_2	546,500,000	$24.70	$13,498,550,000	$2.17
CH_4	158,140	$4,435.20	$701,382,528	$0.11
N_2O	364,000	$246.40	$89,689,600	$0.01
TOTAL	**547,022,140**	**$4,706.30**	**$14,289,622,128**	**$2.29**

[7] Energy Information Administration. September 1993. Emissions from Greenhouse Gasses in the United States 1985-1990. Office of Energy Markets and End Use. United States Department of Energy. pp. 12, 29, 32 and 47.

This Copy Provided by

GOVERNORS' ETHANOL COALITION

Box 95085
Lincoln, NE 68509
Phone (402) 471-2867
FAX (402) 471-3064