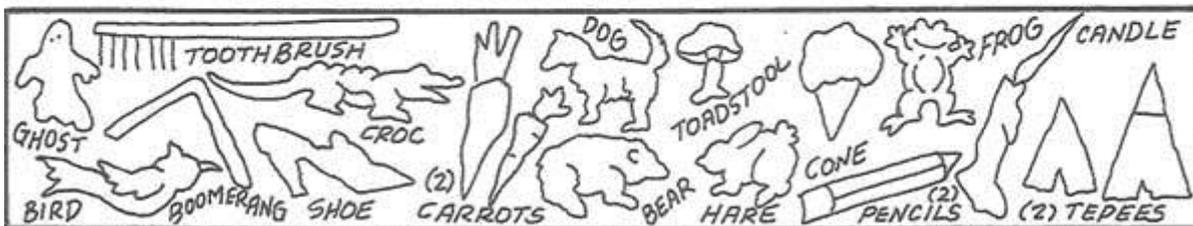


The Hidden Costs Of Energy*

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*With acknowledgement to the Committee on Health, Environmental, and Other External Costs and Benefits of Energy Production and Consumption, National Research Council, The Hidden Costs of Energy (2011), <http://www.nap.edu/>

A World Without Market Failures

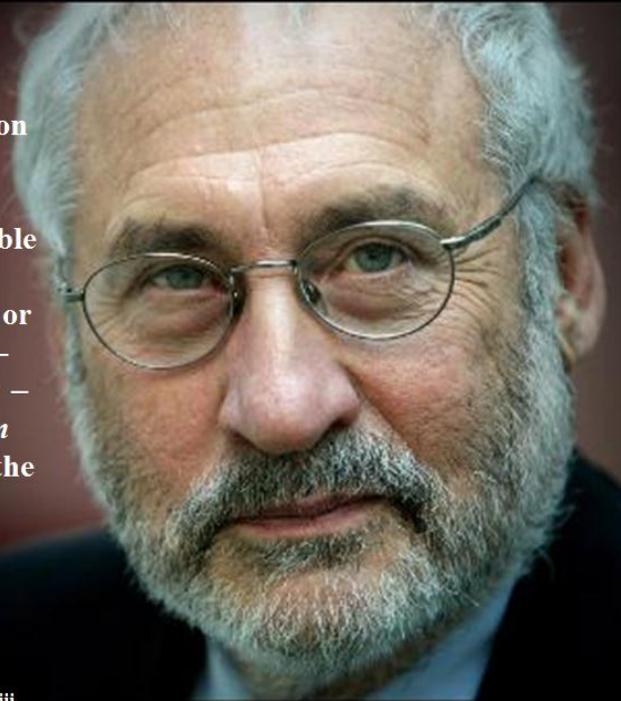
Nor does [the Liberal argument] deny that, where it is impossible to create the conditions necessary to make competition effective, we must resort to other methods of guiding economic activity.

Friedrich Hayek,
The Road to Serfdom (1944)



Today there is no respectable intellectual support for the proposition that markets, by themselves, lead to efficient, let alone equitable outcomes. Whenever information is imperfect or markets are incomplete – that is, essentially always – interventions exist that *in principle* could improve the efficiency of resource allocation.”

Joseph E. Stiglitz,
Forward to The Great Transformation
by Karl Polanyi
(1947, Boston: Beacon Press, 1992, p. viii)



Types of market failure and social responses

Type of market failure

Common social responses

Externalities

Prohibitions
Taxes and Subsidies
Contracting, creation of new markets

Public Goods

Public provision

Monopoly

Antitrust laws, competition policy
Industry regulation

Asymmetric Information

Consumer protection laws
Licensing and certification programs

Externalities



Externalities

The total electricity generation in the United States during 2008 was 4.11 million gigawatt hours (GWh), down very slightly from 2007. In terms of usage, the residential sector consumed the most electricity (36.6% of the total), followed by the commercial sector (36.3%). The industrial sector (26.9%), and transportation (0.2%) accounted for the rest (64).

TABLE 2-1 Net Electricity Generation by Energy

Energy Source	Net Electricity Generation (GWh)	Percent of Total Net Generation
Coal	2,000,000	48.5
Petroleum liquids ^a	31,200	0.8
Petroleum coke	14,200	0.4
Natural gas	877,000	21.3
Other gases ^b	11,600	0.3
Nuclear	806,000	19.6
Hydroelectric	248,000	6.0
Other renewables ^c	124,000	3.0

NOTE: Net electricity-generation numbers reported by the Energy Information Administration are rounded to three significant figures.

^aDistillate fuel oil, residual fuel oil, jet fuel, kerosene, and waste oil.

^bBlast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels.

^cWind, solar thermal, solar photovoltaic (PV), geothermal, wood, black liquor, other wood waste, biogenic municipal solid waste, landfill gas, sludge waste, agricultural by-products, and other biomass.

SOURCE: Data from EIA 2008, 2009a.

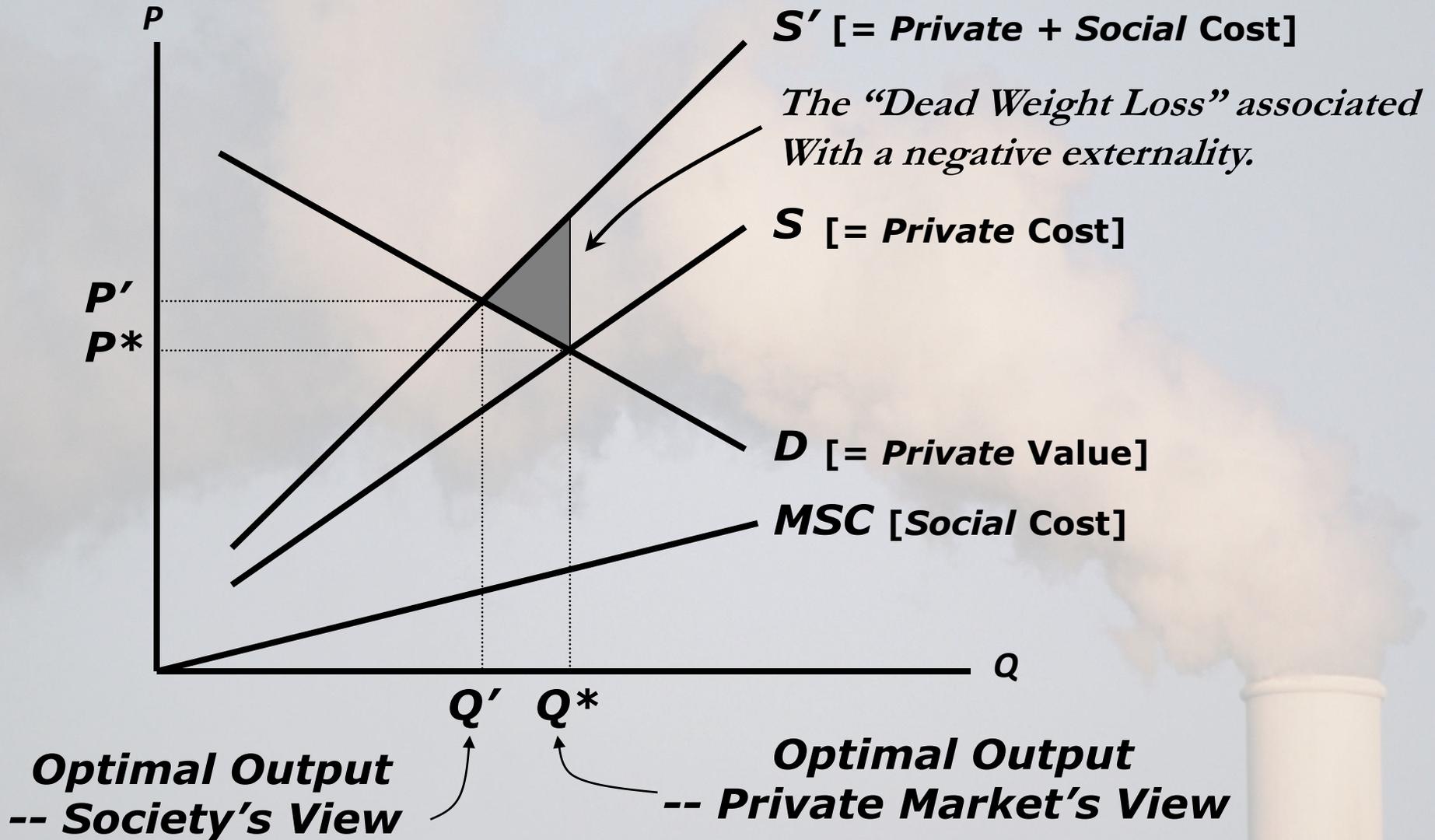
Committee on Health, Environmental, and Other External Costs and Benefits of Energy Production and Consumption, National Research Council, The Hidden Costs of Energy (2011),

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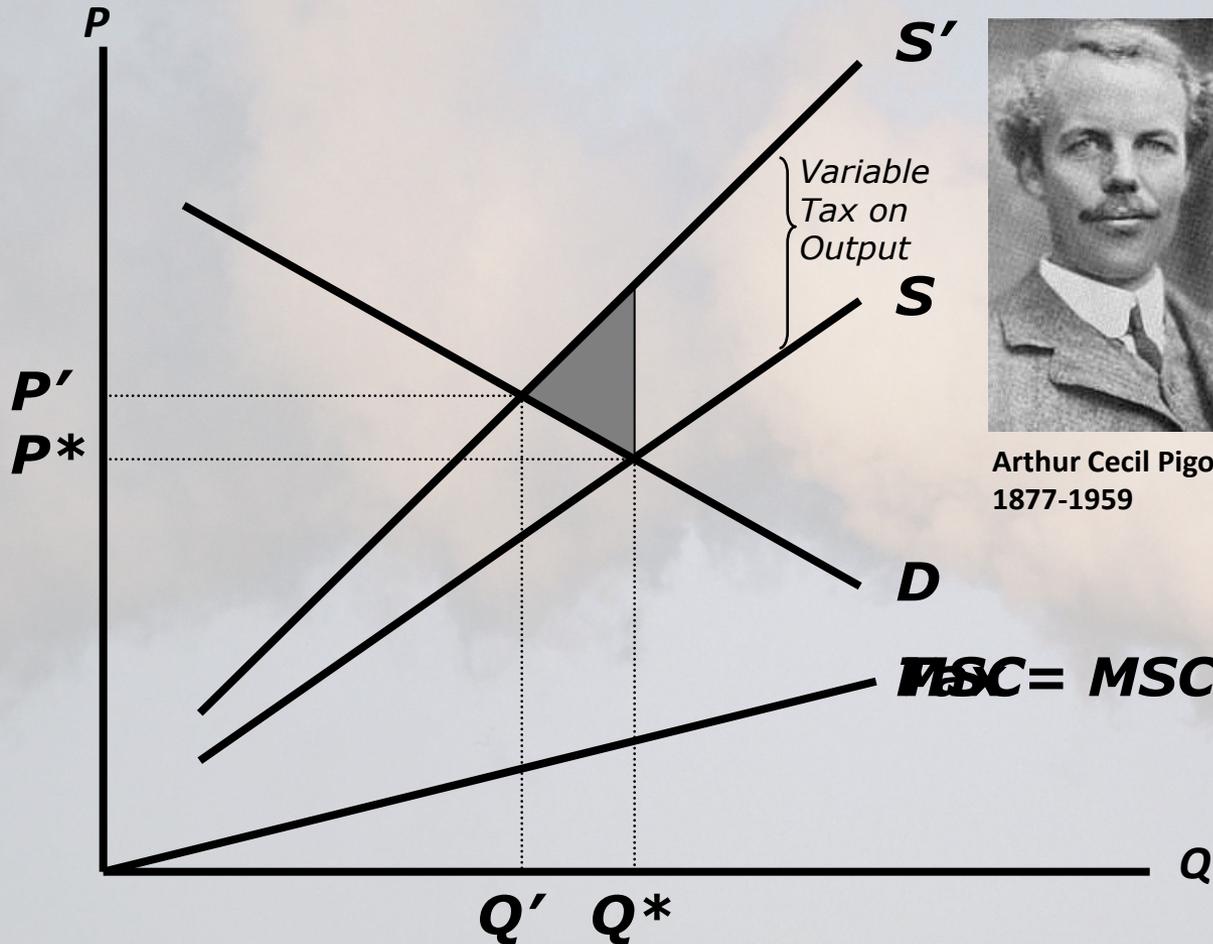


Negative Externalities -- "Hidden Costs"

Market prices reflect private valuations and private costs of production. Thus, they understate the full (private and social) costs of production.



Negative Externalities -- Pigovian Analysis



Arthur Cecil Pigou
1877-1959

The Economics Of Welfare (1920)

In theory, a tax set equal to the external social costs can correct the market failure by inducing suppliers to "internalize the externalities".

**Optimal Output
-- Society's View**

**Optimal Output
-- Private Market's View**

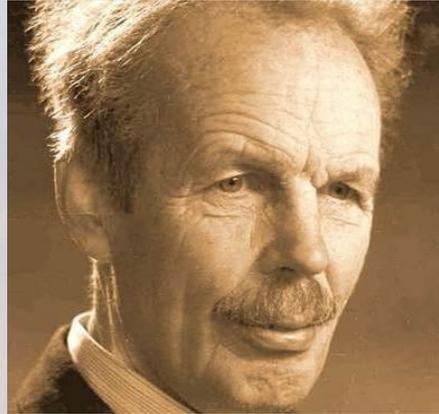
Negative Externalities -- Pigovian Analysis



Arthur Cecil Pigou
1877-1959

The Economics Of Welfare (1920)

In theory, a tax set equal to the external social costs can correct the market failure by inducing suppliers to "internalize the externalities".



Some Aspects of the Welfare State (1954)

"It must be confessed, however, that we seldom know enough to decide in what fields and to what extent the State, on account of [the gaps between private and public costs] could interfere with individual choice."

Negative Externalities -- Coasian Analysis

“The traditional approach [to the externality problem, the ‘Pigovian’ approach] has tended to obscure the nature of the choice that has to be made. The question is commonly thought of as one in which A inflicts harm on B. But this is wrong. We are dealing with a problem of a reciprocal nature. To avoid the harm to B would be to inflict harm on A ... The problem is to avoid the more serious harm.”



Ronald Coase
1910 -

The Problem of Social Cost (1960)

“It is strange that a doctrine as faulty as that developed by Pigou should have been so influential ...”

Negative Externalities -- Coasian Analysis



Calvin Cluck is a chicken farmer whose family has operated a 160-acre farm for four generations. Though small by today's egg production standards, Calvin is proud of his operation, and thinks of himself as a true steward of the land. He even recycles the chief by-product of his chickens' egg production, spreading it on his fields as fertilizer. Two years ago, two neighboring farms were sold, and subdivisions were built adjacent to Calvin's fields. They are nice single-family homes, but now the residents of those homes are threatening to take Calvin to court to force him to close his chicken operation. They claim that odors from his chickens infringe on their ability to enjoy their back yards.

Is this an externality problem?

If so, who is causing the externality?

How might it be resolved?

Negative Externalities -- Coasian Analysis

The Coase Theorem: In the absence of transaction costs, all government allocations of property rights are equally efficient, because interested parties will bargain privately to correct any externality.

Implication: Any market plagued by externalities can be made efficient if property rights are clearly defined and assigned (the “missing market” interpretation), and if transaction (bargaining) costs are negligible.

Economist.com

Economic man, cleaner planet

Sep 27th 2001



In a typical **tradable permit scheme**, a government decides upon acceptable levels of pollution and allocates credits for meeting those limits among companies. Those that can cut pollution at the lowest cost will have spare credits to sell; those with high abatement costs can then buy from them

Negative Externalities -- Coasian Analysis

Suppose that two utilities each release 10 tons of sulfur dioxide into the atmosphere, and that the government wants to reduce the total amount of sulfur dioxide emissions to 16 tons. Further, assume that it costs utilities different amounts to reduce their emissions:

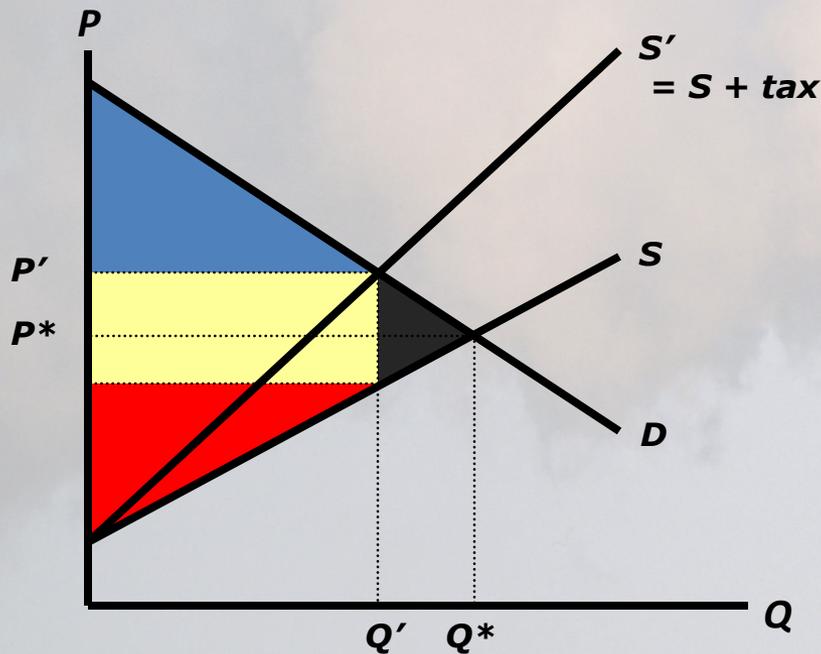
Utility	<u>Total Cost to reduce emissions to ...</u>		
	<u>9 Tons</u>	<u>8 Tons</u>	<u>7 Tons</u>
A	\$50,000	\$125,000	\$225,000
B	\$100,000	\$250,000	\$450,000

- How much will the reduction to 16 tons cost if the government simply limits each utility to 8 tons of sulfur dioxide emissions?
- If the government issues each utility the “right” to release 8 tons of sulfur dioxide, and further allows the utilities to sell these rights, what will happen and how much will reduction to 16 tons cost?

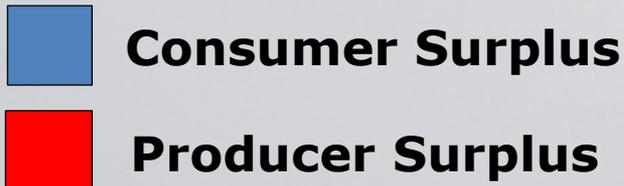
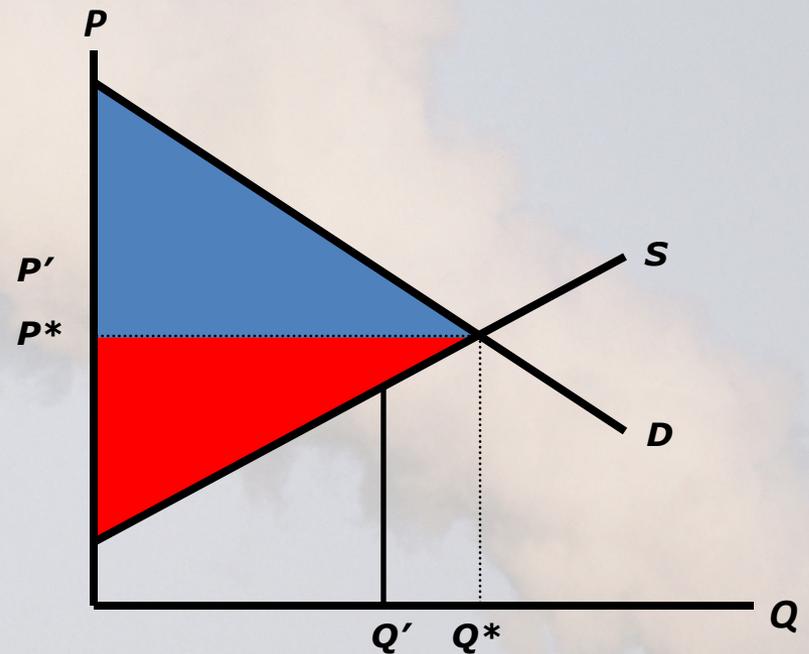
Negative Externalities -- Two Solutions

Carbon Tax vs. Cap & Trade: Welfare Analysis

Carbon Tax



Cap & Trade



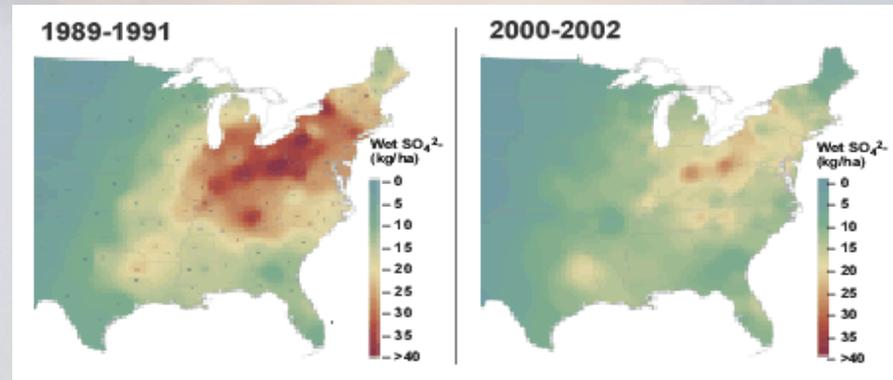
Negative Externalities -- Two Solutions

Carbon Tax vs. Cap & Trade



Cap-and-trade systems are also relatively inefficient (compared to Pigovian carbon taxes), for two reasons. First, they encourage utilities to pollute more before the cap-and-trade system is put into effect in order to "earn" pollution rights. Second, they waste the opportunity to use the Pigovian tax revenue to reduce distortionary taxes on labor and capital. Of course, cap-and-trade systems are better than heavy-handed regulatory systems. But they are not as desirable, in my view, as Pigovian taxes coupled with reductions in other taxes. One exception: **If the pollution rights are auctioned off rather than handed out, then cap-and-trade systems are almost identical to Pigovian taxes, including all the desirable efficiency properties.**

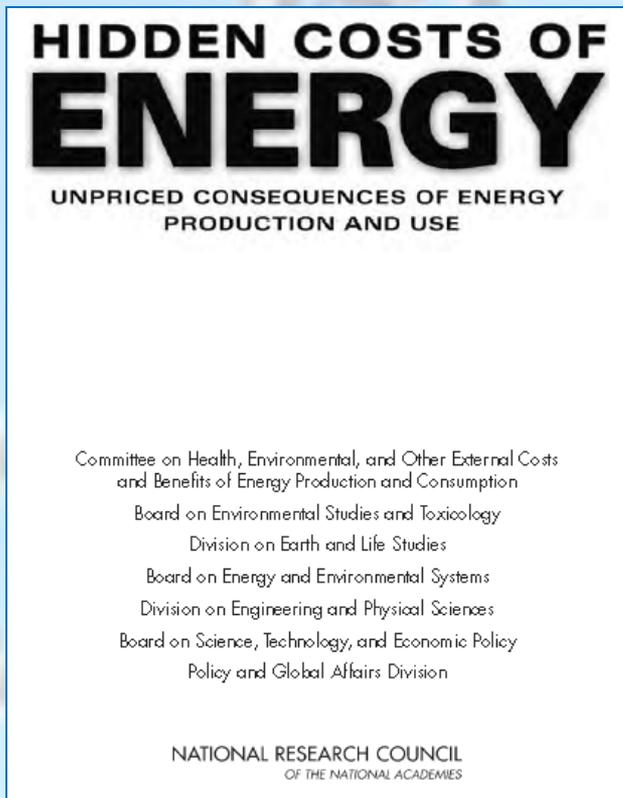
A cap-and-trade system was imposed on sulfur dioxide emissions in the US in the mid-1990s. As of the end of 2002, the last reporting period available as of this writing, reduction of SO₂ was ahead of schedule—down 41% from 1980—with the market price for emission allowances significantly lower than the dire predictions made by industry critics prior to the program's implementation. As one can see from the EPA chart below, wet deposition of sulfur dioxide is much less today than it was in 1990. Overall airborne sulfate concentrations have decreased similarly.



Hidden

Measuring the ~~External~~ Costs of Energy

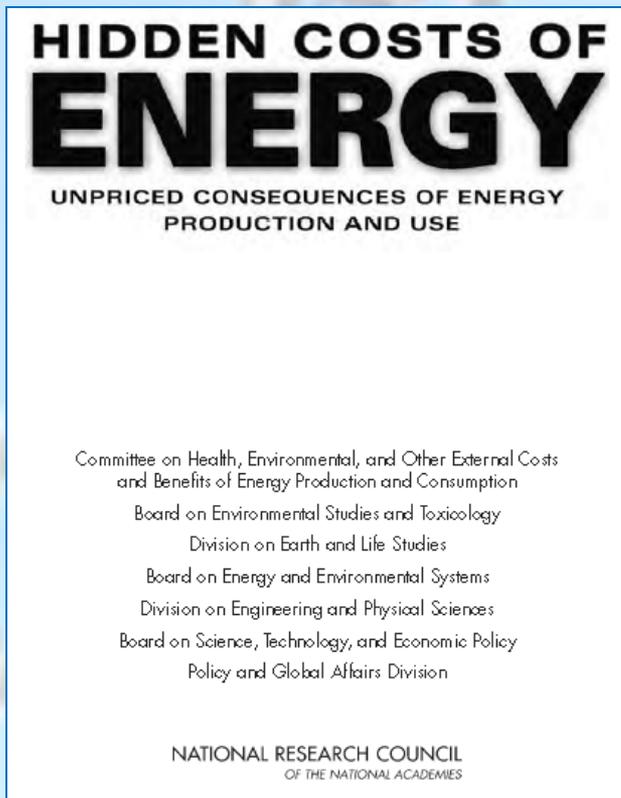
- ***What is an external cost of energy?*** Effects related to emissions of particulate matter (PM), sulfur dioxide (SO₂), and oxides of nitrogen (NO_x).
- Monetized effects of these pollutants on human health, grain crop and timber yields, building materials, recreation, and visibility of outdoor vistas.



Hidden

Measuring the ~~External~~ Costs of Energy

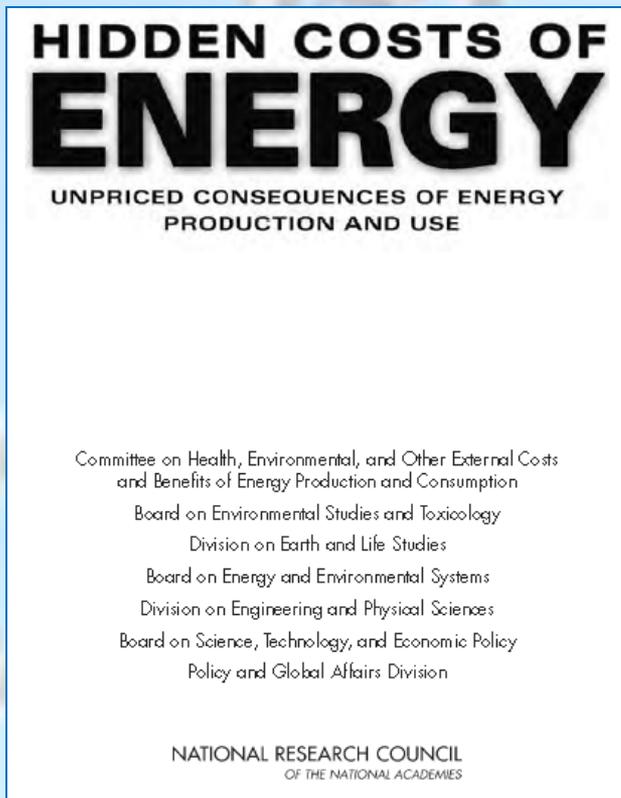
- Health damages, which include premature mortality and morbidity (such as chronic bronchitis and asthma), constituted the vast majority of monetized damages, with premature mortality being the single largest health-damage category.



Hidden

Measuring the ~~External~~ Costs of Energy

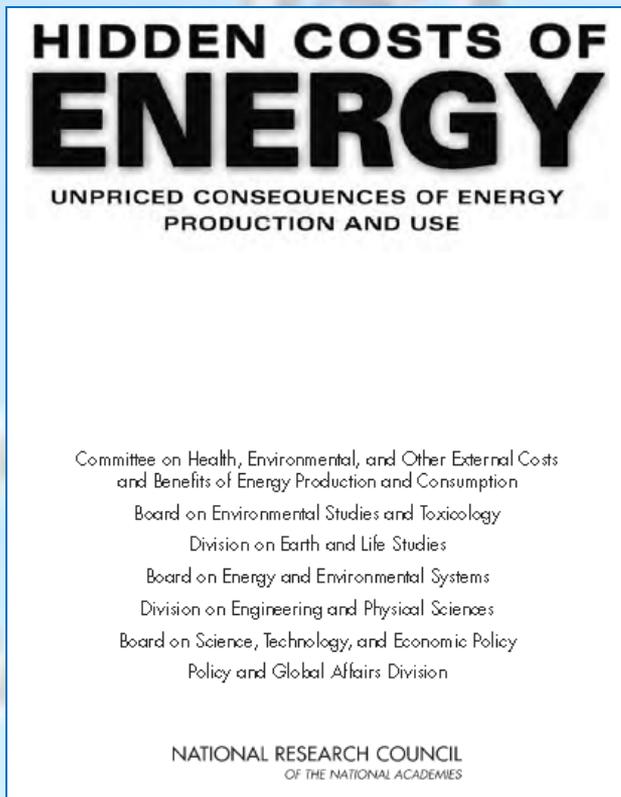
- Increased food prices caused by the conversion of agricultural land from food to biofuel production, are *not* considered to represent an external cost, as they result from (presumably properly functioning) markets.



Hidden

Measuring the ~~External~~ Costs of Energy

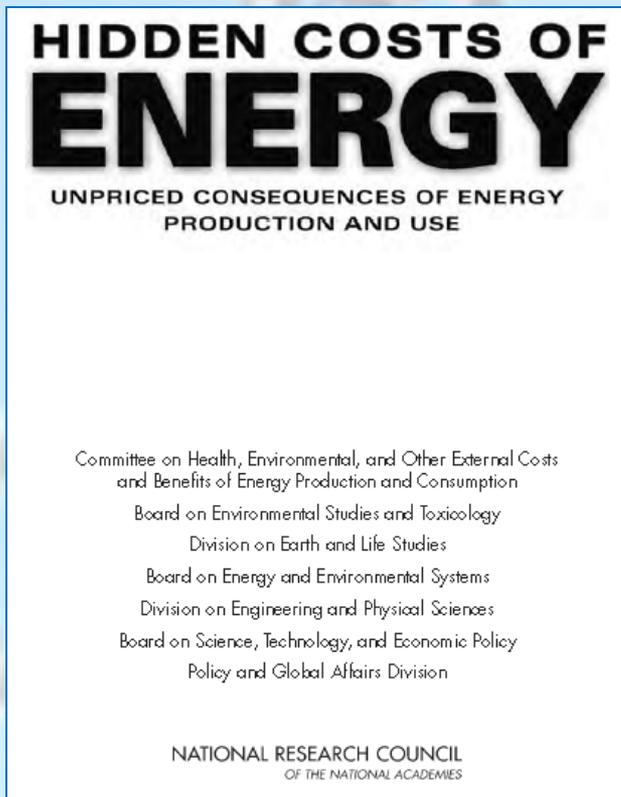
- External effects in the future through emissions of atmospheric greenhouse gases (GHGs) that may cause climate change were not included in the report's basic impact findings.



Hidden

Measuring the ~~External~~ Costs of Energy

- External (hidden) costs ranged from 19% to 70% of price:



External costs as a % of market price:

Electricity generation from coal 70%

Electricity generation from natural gas 19%

Transportation (primarily automotive gasoline) 42%

Heating (primarily from natural gas) 25%

Internalizing the External Costs



- External (hidden) costs ranged from 19% to 70% of price:

External costs as a % of market price:

Electricity generation from coal 70%

Electricity generation from natural gas 19%

Transportation (primarily automotive gasoline) 42%

Heating (primarily from natural gas) 25%

Filling up a Prius:

Without considering external costs:

8 gallons
X \$3.30

\$26.40

Adding in 42% for external costs:

8 gallons
X \$4.69

\$37.52

Internalizing the External Costs



- External (hidden) costs ranged from 19% to 70% of price:

External costs as a % of market price:

Electricity generation from coal 70%

Electricity generation from natural gas 19%

Transportation (primarily automotive gasoline) 42%

Heating (primarily from natural gas) 25%

Keeping the Lights On:

Without considering external costs:

2,500 kWh
 X 10.5¢

 \$262.50

Adding in 70% for external costs from coal-generated power:

2,500 kWh
 X 17.85¢

 \$446.25

Internalizing the External Costs

TABLE 1-2 Illustrative Impacts of Producing Electricity from Coal

	Human Health	Ecosystems	Security and Infrastructure
Coal Mining	Coal miners' mortality and morbidity	Land disturbance river alteration, acid mine drainage	
Transportation of coal to power plants	Death and injury from accidents	Vegetation damage from air pollution	Load on transportation systems
Burning of coal	Mortality and morbidity from air pollution	Ecosystem effects from cooling Water discharges Ecological changes from climate change	Degradation of building materials Agricultural shifts and coastal community impacts due to climate change
Disposal of waste	Health effects of heavy metals in ash and other waste	Ecosystems effects of ash and other wastes	
Transmission of electricity		Disturbance of ecosystems by utility towers and rights of way	Vulnerability of transmission system to attack or disaster

Internalizing the External Costs

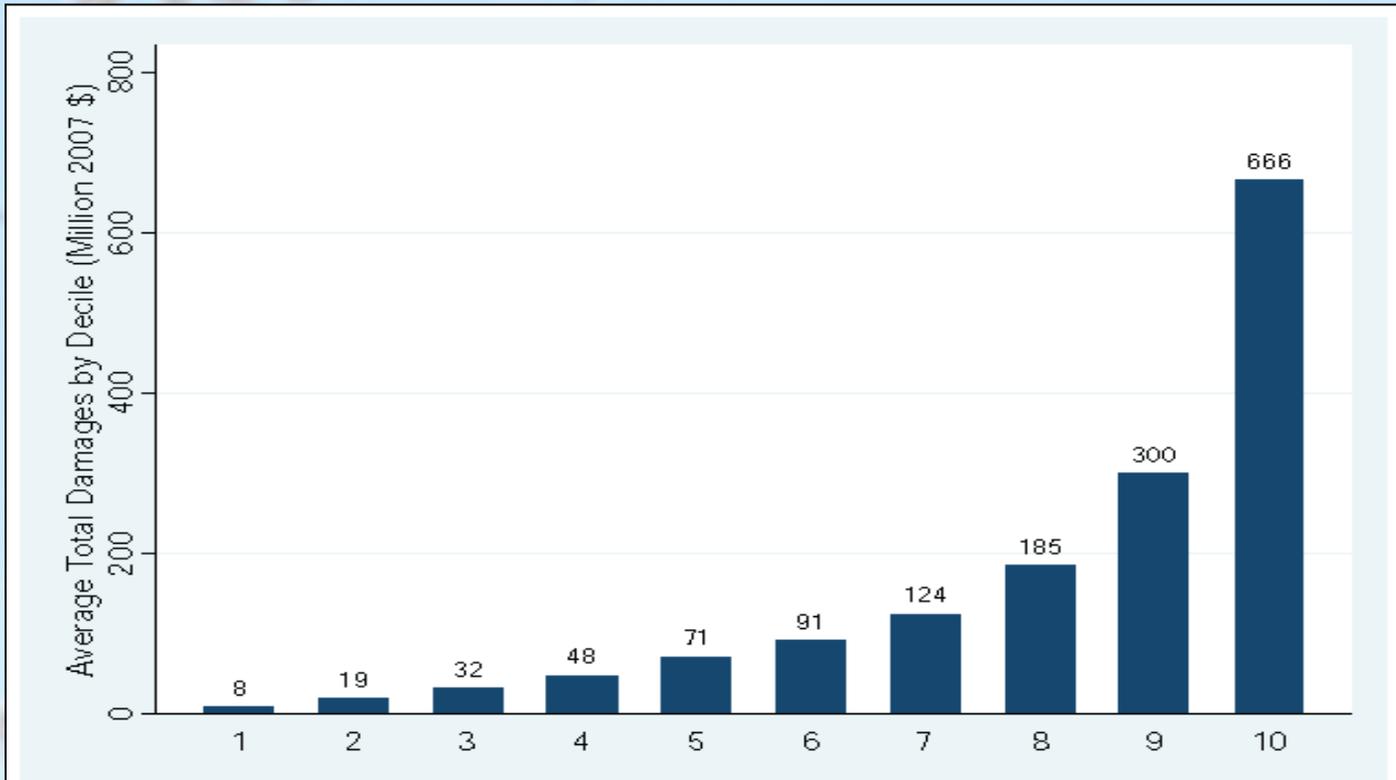


FIGURE S-1 Distribution of aggregate damages among the 406 coal-fired power plants analyzed in this study. In computing this chart, plants were sorted from smallest to largest based on damages associated with each plant. The lowest decile (10% increment) represents the 40 plants with the smallest damages per plant (far left). The decile of plants that produced the most damages is on the far right. The figure on the top of each bar is the average damage across all plants of damages associated with sulfur dioxide, oxides of nitrogen, and particulate matter. Damages related to climate-change effects are not included.

How Big is the Dead Weight Loss?

<u>Energy Use</u>	<u>Volume</u>	<u>Market Price (kWh)</u>	<u>External Cost (kWh)</u>	<u>Total External (Hidden) Cost</u>	<u>As a % of GDP</u>
Electricity generation from coal (gigawatts)	2,000,000	\$ 0.105	\$ 0.074	\$ 147,000,000,000	1.05%
Electricity generation from natural gas (gigawatts)	877,000	\$ 0.105	\$ 0.020	\$ 17,496,150,000	0.12%
Transportation -- gasoline (millions of gallons)	175,000	\$ 3.30	\$ 1.39	\$ 242,550,000,000	1.73%

Are the Hidden Costs of Energy a Potential Answer to Other Problems?

The need for taxes on energy externalities such as carbon emissions is central to our ability to reduce the harmful side effects of economic growth. It is striking how the political dialogue in the US has ignored a policy that has so many desirable features. Perhaps, in the near future, faced with the deadline of a dire economic situation, negotiators will formulate such a policy. It would generate substantial revenues while bringing so many long-run economic and environmental benefits. Simply put, externality taxes are the best fiscal instrument to employ at this time, in this country, and given the fiscal constraints faced by the US.

William D. Nordhaus, "Energy: Friend or Enemy?" [The New York Review of Books](#), October 27, 2011