Andy H. Barnett *is Professor of Economics and Chair of the Department of Economics, International Studies, and Public Administration at the American University of Sharjah in the United Arab Emirates and Emeritus Professor of Economics at Auburn University, Auburn, Alabama. He is the co-author of four books and more than 60 professional articles dealing with economics-related issues involving the electricity industry, telecommunications industry, economic regulation, medical economics, and environmental policy and law.*

Justin P. Isaacs *is Assistant Professor of Economics at Hampden-Sydney College in Hampden-Sydney, Virginia, where his research focuses on public policy and regulated markets. He received his Ph.D. from Auburn University, where he wrote his dissertation on vertical integration in the electric utility industry. He is also a principal consultant for Algernon Economics, LLC, where he specializes in market analysis and telecommunications auctions.*

Henry Thompson *who is based in the Auburn University Department of Agricultural Economics, specializes in international and energy economics, with 70 academic articles and a textbook to his credit. He is Treasurer of the International Economics and Finance Society and serves on the Editorial Board of the Review of International Economics.*

Stranded Clean Air Costs: How Big?

Concerns over global climate change have prompted proposals for more stringent control of carbon dioxide emissions from the electric industry. Phase II of the Clean Air Act Amendments of 1990 will raise costs of competitive coal-fired electric generators and could strand more costs than restructuring did. Whether ratepayers, taxpayers, or stockholders should pay stranded costs is a political issue.

Andy H. Barnett, Justin P. Isaacs, Henry Thompson

I. Background

Phase II regulations of the 1990 Amendments to the Clean Air Act (CAA) aimed at sulfur dioxides (SO_2) and nitrogen oxides (NO_x) along with international initiatives to reduce carbon dioxide (CO_2) emissions will raise the relative cost of generating electricity with coal-fired base load generators. Stranded costs, associated with restructuring and retail competition in the electric industry, refer to induced changes in the value of generators. Stranded cost would be the difference between the book value and altered market value of electricity assets, and Joskow has pointed out that it depends on the expected future performance of generators.[1] Higher costs from tighter emission controls would lower market values of coal generators.

Title IV of the 1990 CAA administered by the Environmental Protection Agency (EPA) has two phases aimed at reducing acid rain. Phase I from 1995 to 1999 applied

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to 261 generators producing the largest quantities of SO_2 and NO_x as well as an additional 174 participating generators based on EPA substitution rules. Phase I generators on average are about 37 years old. Phase II began in January 2001 and affects virtually all fossil fuel generators including utilities and nonutilities with capacity over 25 MW.[2] The cost of CAA regulations is relatively high for older coal-fired generators. While SO_2 emissions from Phase I units have steadily decreased, they have increased from unaffected units. In 1985, Phase I generators accounted for 67 percent of total SO_2 emissions but this fell to 45 percent by 1995. All generators have plans to meet Phase II regulations by switching to gas or low sulfur coal, adding scrubbers, or purchasing vouchers. The least costly form of compliance is to switch fuels, estimated at $133 per ton of removed SO_2 compared with $322 for scrubbers. The industry may face a critical issue of whether older coal-fired generators remain competitive.

Attention is likely to continue to focus on pollution from the electric industry. The Natural Resources Defense Council pointed out in 1997 that about two-thirds of the SO_2 and about one-third of the NO_x and CO_2 emissions in the U.S. come from the electric industry.[3] Global climate change remains a topic of contemporary political concern and the source of potential legislation on CO_2 emissions. Gas-fired generators are less polluting and CAA regulations will have smaller effects on their costs. Only a few coal-fired generators meet Phase II CAA standards for NO_x, with some generators operating at four times their allowance. It has been pointed out that gas produces no SO_2 or particulate matter, and only 2 percent of the NO_x and half the CO_2 of coal.[4] Fuel efficiency for coal generators is 33 percent but almost double that for newer combined cycle gas generators. Projections about profits from different generators, however, depend crucially on fuel costs. Gas prices are seasonal and known to move unexpectedly. Moreover, gas supplies will not last as long as coal and gas transport is limited to pipelines. Costs will rise and regulations for CO_2 and SO_x are difficult to predict. Underlying the politics may be the willingness of consumers to pay for clean air.

If CAA regulations cause incumbent utilities to shut down coal-fired generators, assets will be stranded.

If CAA regulations cause incumbent utilities to shut down coal-fired generators, assets will be stranded. Potential entrants only have to consider which generator to install. CAA regulations and who will pay stranded costs are political issues that will be decided by public service commissions, state lawmakers, the EPA, the Executive Branch, Congress, the courts, and international treaties. These political decisions will affect profits of incumbent utilities as well as entrants in the restructuring electric industry. This article focuses on the potential impact of CAA regulations on stranded costs.

II. Increased Pollution with Restructuring

Table 1 summarizes some background data on generation and projected changes in the electric industry. Fossil fuels accounted for 68 percent of total U.S. generation in 1999. Coal is the primary fossil fuel, accounting for 56 percent of total generation. Base load coal and nuclear plants, 79 percent of total generation, are designed to run continuously.[5] Gas accounted for 9 percent of 1999 generation and has been used in intermediate or peak load generators that can be brought up quickly and cheaply.

Numerous studies have attempted to predict how the electric industry would evolve with retail competition. Electricity prices are projected to fall for some customers in some states due to increasing supply. Estimates of national average price decreases range up to 20 percent but 10 percent might be a

Table 1: Background Data

1999 U.S. Generation, EIA	
Total	3,183 million MWh
Shares	
Coal	56%
Nuclear	23%
Renewable	10%
Gas	9%
Oil	3%
Potential Price Change Due to Restructuring	
−10%	Average national price after restructuring = \$0.06 per kWh
Price Elasticity of Demand	
−0.75	
Potential Output Increase Due to Restructuring	
Range of increase estimated in literature	2.5%–20%
Present working assumption	7.5%
Output after restructuring	3,428 million MWh
Increased Emissions Due to Restructuring (1,000 tons per year)	
SO_2	12
NO_x	8
CO_2	2,356

better working assumption, subject of course to fuel costs. The change in quantity demanded will depend on the price elasticity of demand. Estimates in the literature vary from about −0.5 to −1.0 depending on the type of customer and time horizon. The present study assumes an elasticity of −0.75. A 10 percent price decline would then lead to a 7.5 percent increase in quantity demanded. Given the 3,189 million MWh demanded in 1999, this price decrease would create increased generation of 239 million MWh.

With present generators and technology, pollution would increase with output. The amount of pollution depends on the type of generators used to produce the added electricity. Short of CAA regulations, it would be reasonable to assume the existing mix of coal and gas will expand to meet increased demand over at least a 10-year period. Nuclear generation is running at about full capacity and hydro generation cannot be arbitrarily increased. Under these assumptions, the additional 239 million MWh would create 12 tons of SO_2, 8 tons of NO_x, and 2.4 million tons of CO_2. Generation already in violation of CAA requirements would be under pressure to increase production and emissions.

III. Isolating Stranded CAA Costs

Consider the decision facing a utility with a coal-fired generator. The total cost of generation with a separated cost of meeting CAA regulations can be expressed

$$c_0(w_0, x) + r_0 + r(x) \quad (1)$$

where c_0 is the cost of generation; w_0 the vector of input prices; x the electricity output; r_0 the fixed emission control cost; and $r(x)$ is the variable emission control cost.

Variable cost c_0 is a function of input prices and output. The cost of tighter emission controls is the lowest available cost of switching to upgraded equipment or a different fuel. Some equipment and permit costs are fixed while others might depend on output.

The ''implicit capital cost'' s_0 of a generator is the difference between book value k_0 and market value m_0:

$$s_0 = k_0 - m_0. \quad (2)$$

Book value k_0 is based on historical cost and depreciation. If loans were taken or bonds sold to finance the generator, book value would not include the principle or face value repaid. With equity funding, book value would be the historical cost of what it took to put the generator in place. Market value m_0 of the generator is its present value. With bond financing, the market value of the generator might be an estimate of its price if sold. With stock financing, market value might be the current value of that

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stock. Neither measure is perfect because market value is difficult to estimate before a sale and stock prices are subject to erratic expectations.[6] If $k_0 > m_0$, the generator has stranded costs.

The costs of a new generator would be

$$c_1(w_1, x), \tag{3}$$

where c_1 is the cost of operation; w_1 the vector of input costs.

For a new generator, emission control cost is embodied in the associated production function or a different fuel mix.

The stranded cost $s_0 = k_0 - m_0$ of an old generator must be paid and the total cost of a new generator for an incumbent utility that has an old generator is

$$c_1(w_1, x) + s_0. \tag{4}$$

An incumbent facing the choice between (1) and (4) would be at a cost disadvantage due to stranded cost if

$$c_1(w_1, x) < c_0(w_0, x) + r_0 + r(x) < c_1(w_1, x) + s_0. \tag{5}$$

The incumbent would maintain its old generator rather than upgrade to a new one but an entrant could operate at lower cost with a new generator.

If an incumbent builds a new generator to replace one that is not amortized, stranded costs become the value of the old plant that is not recovered plus perhaps the fixed costs of the new one.[7] Higher output could reverse the inequalities in (6). Old generators might be cost effective at low output levels but ineffective with retail competition and higher output. In this sense, incumbent utilities could be "stranded" by their implicit capital cost s_0.

IV. Stranded Clean Air Costs

Stranded costs are sunk costs that represent past economic decisions and do not enter into

efficiency consideration. In the underlying competitive model with free entry and exit, firms that make inefficient decisions go out of business. In the political regime of regulated semi-public or public utilities with large sunk costs, economic efficiency will be weighed against political feasibility.

There are various influences that come into play to complicate the comparison in (5). Fuel choice is based on tenuous projections of fuel costs. Biewald calculates that virtually all of the stock of existing generators would remain competitive, carefully distinguishing between base load, intermediate, and peaking generation.[8] Hyman makes the point that emission control costs of an old coal-fired generator are higher than the costs of a new gas-fired one.[9] Ray stresses the high cost of scrubbing SO_2 from coal and points out that gas emits less CO_2.[10] In 1999, average desulfurization costs were 1.13 millions per kWh and average installed costs for flue gas desulfurization were \$125 per kWh.[11] CAA regulations raise the relative cost of coal-fired generators and decrease the market value m_0 of old generators. In (4), a lower market value m_0 implies higher stranded cost.

If fuels were nonpolluting, it might be that

$$c_0(w_0, x) + r_0 + r(x) < c_1(w_1, x), \tag{6}$$

reversing the inequality in (6). The new generator would not be competitive. CAA regulations can switch the inequality in (6) and create stranded costs. In practice, investment in new generation might be driven by CAA costs rather than retail competition.

V. Conclusions and Policy Implications

More stringent CAA regulations will increase the costs of coal-fired generators, perhaps "stranding more costs" than restructuring. Writing in 1997, Biewald found that only a few nuclear generators in the stock of existing generators would not remain competitive. The present article suggests that CAA regulations are poised to create more stranded costs than retail competition.

If the decision is made to shut down an old generator, its stranded costs involve the debt or capital losses. Some states have provisions to pass stranded costs to taxpayers. The political argument is that investments were made with one set of rules and those investors are in an unfair long position due to the rule changes that would allow retail competition and the breakup of regulated monopolies. Whether the same remedy should apply to stranded CAA costs is a separate political issue.■

Endnotes:

1. Paul Joskow, *Does Stranded Costs Recovery Distort Competition*? ELEC J., Apr. 1996, at 31–44.

2. Energy Information Agency, *The Effects of Title IV of the Clean Air Act Amendments of 1990 on Electric Utilities: An Update* (1997).

3. Natural Resources Defence Council, *Benchmarking Air Emissions of Electric Utility Generators in the Eastern United States* (1997).

4. Leonard Hyman, *America's Electric Utilities: Past, Present, and Future*, Public Utilities Reports Inc., Vienna, VA (1994).

5. Bruce Biewald, *Competition and Clean Air: The Operating Economics of Electricity Generation*, ELEC J., Jan./Feb. 1997, at 41–45.

6. Jonathan Lesser and Malcolm Ainspan, *Using Markets to Value Stranded Costs*, ELEC J., Oct. 1996, at 66–74.

7. Biewald, *supra* note 5.

8. *Id.*

9. Hyman, *supra* note 4.

10. BILL RAY, ENVIRONMENTAL ENGINEERING (Boston: PWS Publishing Company, 1995).

11. Energy Information Agency, Form EIA-767, *Steam-Electric Plant Operation and Design Report* (1999).

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