CONTROLLING ACID DEPOSITION
BY SEASONAL GAS SUBSTITUTION
IN COAL- AND OIL-FIRED POWER PLANTS

Gary Galeucia

MIT Energy Laboratory Report No. MIT-EL 86-004
June 1986

Controlling Acid Deposition By Seasonal Gas Substitution In Coal- And Oil-Fired Power Plants

by

Gary B. Galeucia

Submitted to the Alfred P. Sloan School of Management on May 16, 1986, in partial fulfillment of the requirements for the Degree of Master of Science in Management.

Abstract

Acid deposition, primarily the result of sulfur emissions due to fossil fuel combustion, is a serious environmental problem. Resolving the problem will impose costs measuring in the billions of dollars. Based on evidence that the rate of wet sulfate deposition in eastern North America is higher in the summer half of the year than in the winter half of the year, seasonal control of emissions is proposed as a means of minimizing acid deposition control costs. This paper evaluates the proposal that natural gas be substituted for coal and oil in electric power plants during April through September.

A model is presented that simulates the substitution of natural gas for coal and oil in power plants in the eastern 31 state region so as to minimize total costs with respect to deposition reductions at an Adirondack receptor. The results of the model show: 1) changes in fuel consumption as a result of substitution, 2) the increased effectiveness of seasonal versus year-round controls, and 3) the costs of achieving various levels of deposition reduction at an Adirondack receptor.

The costs of seasonal gas substitution, in terms of emission and deposition reductions, are compared to cost estimates for other proposed control methods and strategies. An example is given that calculates the cost with respect to deposition of a source-oriented control strategy, so that the cost of seasonal gas substitution can be fairly compared with it. The conclusion of these cost comparisons is that seasonal gas substitution is cost-competitive with some other control methods, at least in some states.

Thesis Supervisor: Dr. Henry D. Jacoby, Professor of Management

Acknowledgement: This research was performed at the MIT Energy Laboratory with the support of the Electric Utility Program and under the supervision of Prof. James A. Fay and Dr. Dan S. Golomb. Their assistance and guidance is gratefully acknowledged.

Table of Contents

I. INTRODUCTION

Until recently, air pollution was considered a local problem. Now it is known that winds can carry air pollutants hundreds of miles from their points of origin. Transported air pollutants can damage aquatic ecosystems, crops, manmade materials, forests, and human health. The process by which air pollutants damage these resources is referred to as "acid rain". The term acid rain is used to describe the complex chemical changes that result from the presence of oxides of sulfur, oxides of nitrogen, and other compounds in the air that may lead to increased acidity in precipitation, in ground and surface waters, and in soil. A more comprehensive and accurate term is acid deposition, since the transfer of acid material from the atmosphere to the biosphere may occur not only in the aqueous phase (rain, snow, fog, etc.) but also as dry deposition, in which gaseous or particulate material is adsorbed by the ground, vegetation, or surface water.

Precipitation acidity* considerably below pH 5.6 has been observed in the eastern United States and Canada, as well as many other areas in the world. Increased acidity in precipitation and dry deposition of acidic material may increase the acidity of surface waters, with consequent adverse impacts on fish and other aquatic life. Increased acidity may also affect vegetation, such as forests or crops, directly or indirectly through changes in the soil.

It has also been claimed that increased acidity of surface water could adversely impact human health by mobilizing toxic ions such as lead and copper into drinking water. However, there appears to be little reason to believe that such health effects

*Acidity is usually measured on a logarithmic scale called pH. PH is defined as the negative logarithm of the hydrogen ion concentration, which is measured in molar equivalents per liter. A neutral solution has a pH = 7.0, and the scale ranges from pH = 0 (strong acid) to pH = 14 (strong alkali). Carbon dioxide dissolves in water to form a weak acid; the pH for pure water in equilibrium with CO_2 is 5.6.

will become a significant public policy issue; the main concerns about the effects of acid deposition seem to be the adverse consequences for aquatic and terrestrial ecological systems.

Sulfur dioxide ($SO2$) is the major chemical compound responsible for precipitation acidity; it is produced largely as the result of the combustion of fossil fuels, i.e. coal and petroleum products. $SO2$, along with other chemical compounds, is oxidized into acid compounds primarily in the atmosphere. Precipitation and gravity cause these acid compounds to be deposited on the Earth's surface, sometimes at great distances from the sources of the original pollutants. The sources of these pollutants include electric utilities, automobiles, and smelters.

These pollution sources exist as the result of economic activity. Consequently, reducing pollutant emissions is not without cost. Economic theory tells us that pollutant emissions should be reduced to the point where the marginal cost of reducing the emissions equals the marginal benefit derived from the lower emission level. This simple principle is greatly complicated by uncertainties regarding the magnitude of the costs and benefits of lower emission levels. It is complicated further because these pollutants cross political boundaries to damage areas far from the sources of the economic activity that generated the emissions. Consequently, political realities and questions of equity are part of the problem.

What is known of the acid rain problem is that there are identifiable and quantifiable sources of emissions, and that there are areas suffering varying degrees of damage due, at least in part, to these emissions.

Formulating a policy that balances costs and benefits, let alone political and equity concerns, is a very complex and continuing task. Acid rain policy has evolved rapidly in the 1980's. It has moved away from legislation calling for broad-based emissions reductions toward more efficient policies that recognize the spatial relationships between emissions sources and the areas sensitive to the deposition caused by the emissions.

This paper presents evidence that acid rain policy should step beyond the recognition of these spatial relationships toward a recognition of temporal relationships between emissions and deposition. What is meant by temporal relationships is that there are seasonal variations in deposition rates for a relatively constant rate of emissions. Just as it is more efficient to seek relatively greater control of emissions from sources that are relatively close to sensitive areas, it is also more efficient to exert relatively greater control of emissions when the deposition rate as a result of the emissions is highest.

As one means of controlling emissions when deposition rates are highest, this paper investigates the impacts of substituting natural gas for coal and oil in electric utility boilers during April through September. A seasonal gas substitution model has been developed to quantify the costs of this strategy for various levels of deposition reduction. The model is static in that it is run for a single year, 1983; this means that actual price and quantity data for coal, oil, and gas comes from that year. The model is concerned with emissions of sulfur dioxide (SO2), from electric utilities in the 31 eastern states and the District of Columbia (DC), as well as the resulting deposition of sulfate (SO4) at a single receptor in the Adirondack Mountains of New York.

The paper starts by describing how acid deposition is formed as a result of emissions from fossil fuel combustion. This is followed by a presentation of the finding that deposition rates are seasonally variable for a relatively constant rate of emissions. Next, the policy dilemma that acid rain creates is briefly described and is followed by a review of how acid rain policy has evolved from source-oriented to receptor-oriented control strategies. By combining the idea of receptor-oriented or targeted strategies with the evidence of seasonal variation in deposition rates, a new type of targeted control strategy is created. The original targeted strategy related emission sources and deposition receptors spatially. The new targeted strategy, in addition to being spatially targeted, is targeted temporally in order to take advantage of seasonal variations in deposition rates.

To utilize this new strategy, seasonal substitution of natural gas for coal and oil is proposed. A model is presented that simulates the substitution of natural gas for coal and oil so as to minimize the cost of achieving deposition reductions. The results of the model show: 1) the changes in fuel consumption as a result of substitution, 2) the increased effectiveness of seasonal versus annual gas substitution, and 3) the costs of seasonal gas substitution. The costs, in terms of emission and deposition reductions achieved, are compared to cost estimates for other proposed control methods and strategies. An example is given that calculates the cost with respect to deposition of a source-oriented strategy, so that the cost of seasonal gas substitution can be fairly compared with it. The conclusion of these cost comparisons is that seasonal gas substitution is cost-competitive with these control strategies, at least in some states.

The model does not consider two important factors: 1) the availability of gas supply, and 2) the capital cost for seasonal gas substitution. These factors are discussed briefly, with the conclusions being that: 1) there may be restrictive limits to gas supply and deliverability, and 2) capital costs for seasonal gas substitution are probably very low relative to capital-intensive control methods such as flue gas desulfurization. The paper ends by restating the conclusions made throughout.

II. ACID DEPOSITION

II. 1. How Acid Deposition is Formed

The dominant precursors of acid deposition are sulfur dioxide (S02) and nitrogen oxides (NOx). The sulfur oxide precursors, the focus of this paper, are primarily produced by burning sulfur-containing fuels (e.g. coal and oil). After release into the atmosphere, the sulfur oxides (SOx) will oxidize and can form acids when combined with water. The particular sequence of changes a pollutant undergoes depends on the physical and chemical characteristics of the air mass in which it travels. These characteristics (e.g. initial concentrations of pollutants, wind speed, air turbulence, sunlight intensity, temperature, rainfall frequency) are highly variable, which is why scientists cannot precisely characterize the detailed path of a pollutant from its "source" to its "sink".

To become acid, emitted S02 must be oxidized either: 1) in the gas phase, 2) after absorptions into water droplets, or 3) after dry deposition on the ground. The transformed pollutant can be deposited in wet form (as rain, snow, or fog), or in dry form (due to particles containing the pollutant settling out of the atmosphere). The amount of time a pollutant remains in the atmosphere, and therefore how far it is transported, depends significantly on its chemical form. For example, S02 gas is dry-deposited at a greater rate than sulfate particles (products of oxidation). If S02 is quickly converted to sulfate (S04), a smaller fraction of emitted sulfur compounds will be deposited locally, in the absence of precipitation. The rate of conversion from S02 to S04 depends on the chemical composition of the atmosphere. The frequency and intensity of precipitation controls the rate of wet sulfate deposition.

Dry deposition is believed to occur at a fairly constant rate over time (i.e. a certain percentage of the S02 in the air is dry-deposited each hour), with some variability induced by local conditions. Wet deposition is episodic, and the amount deposited varies considerably even within a rainfall event. For example, a short rain may deposit heavy doses if pollutants have been forming and accumulating in the local atmosphere over time. Without sufficient time for pollutant concentrations to accumulate, a second rainfall event in quick succession may result in little new acid deposition.

In general, areas close to emission sources receive significant proportions of their pollution from steady dry deposition of S02. Areas remote from emission sources receive a greater share of total deposition from wet deposition, since much of the S02 available for dry deposition has been depleted or converted to a wet form. Deposition in this paper refers to wet sulfate (SO_4) deposition. Air over any particular area will carry some residual pollution from distant areas, as well as infusions from nearer sources. The continuous replenishment and depletion of pollutants along the path of the air mass, makes precise source-receptor relationships difficult to determine.

II. 2. Seasonal Variation In Deposition Rates

Analysis of several years of precipitation chemistry data has established that wet sulfate deposition rates in the northeastern U.S. and southeastern Canada are higher in summer months (April-September) than in winter months (October-March) (Bowersox et al., 1985; Golomb et al., 1985). Figure 1 shows the seasonal patterns of sulfate deposition over three years at four receptors. Seasonal differences in sulfate deposition can be clearly seen.

The exact causes of the differences in seasonal deposition patterns are not perfectly understood; they are probably linked to seasonal storm tracks. Raynor and Hayes (1982) observed that sulfate (and hydrogen) ion concentrations are highest in precipitation associated with cold fronts and squall lines, which occur most frequently in summer months. These higher concentrations are apparently due to the faster conversion of the emitted sulfur dioxide into sulfate in summer. The quantity of sulfate being deposited in a storm is a function of the previous trajectory of the warm, moist air mass and the amount of precipitation in the storm. In winter, more of the unoxidized SO_2 is blown offshore and hence does not fall on the land as acid wet sulfate.

Although the chain of processes from emissons of pollutants to eventual deposition of acid and acid-producing substances is complex and not fully understood, all evidence points to a relationship between emissions and deposition. Current scientific understanding suggests that reducing sulfur dioxide emissions would reduce the deposition of sulfates. The greatest potential for reducing acid deposition in the eastern U.S. comes from the reduction of SO_2 emissions.

III. THE OLD AND NEW OF ACID RAIN POLICY

III. 1. The Policy Dilemma

Fossil fuels are vital to the U.S. economy's production of goods and services. However, burning these fuels also produces large quantities of pollutants--substances that, once released into the atmosphere, can damage natural resources, health, agricultural crops, manmade materials, and visibility. Consequently, our Nation's laws and policies must strike a balance between the economic benefits and the risks of fossil fuel combustion.

Recognition of the risks of damage has led some individuals and groups to call on the federal government to control pollutant emissions, most specifically sulfur dioxide, more stringently than current laws require. Others, pointing to uncertainties about the causes and consequences of transported pollutants, are concerned that more stringent emission controls may be mandated prematurely or at too great a cost.

Transported air pollutants also raise significant equity issues. The individuals served by the activities which generate emissions can be different from those who incur resource damage. Similarly, particular groups and regions might bear the costs of controlling emissions, while others receive the benefits.

Transported air pollutants have become an issue for potential federal action because they cross political boundaries. The current federal system of pollution control relies on state-level abatement programs to limit pollution levels in individual states. (National emission standards for new sources of pollution--New Source Performance Standards--are the exception to this.) However, no effective means of controlling extensive pollution transport across state lines currently exists. Transported pollutants also cross the international boundary into and from Canada. Article 1, Section 10 of the Constitution prohibits states from entering into agreements with foreign nations without the consent of Congress; thus, any pollution control agreements with Canada would require federal action.

Existing federal air pollution control mechanisms are governed primarily by the Clean Air Act. To date, control strategies developed under the Act have focused on controlling local ambient air concentrations. The effectiveness of this approach for controlling transported air pollutants is questionable. For example, the so called "tall stacks" approach has been used by utilities to meet local ambient standards as specified by the Clean Air Act. By releasing emissions far enough above the ground, the pollutants are carried away from the local area, and Clean Air Act compliance is attained. The pollutants are transported away from the local area, but are not reduced in total. For any acid rain policy to be effective it must specifically control emissions that can be transported through the atmosphere to receptors with resources sensitive to acidity.

III. 2. Source-Oriented Control Strategies

A dynamic linkage exists between acid rain policy formulation and the control strategies that will be called for when policy is formulated. To illustrate, in the first years of this decade the emphasis of policy was on controlling SO_2 emissions. The early theory was simply that emissions caused acid rain. Therefore, most legislative proposals of the early 1980's called for broad-based emission reductions and distributed the reductions proportionally throughout the eastern 31 states. These proposals are known as source-oriented control strategies because they are concerned only with emissions at the source and do not consider source proximity to adversely impacted areas.

The emphasis of recent policy has evolved as more has been learned about acid rain. What has been learned is that: "First, ...in the northeastern U.S. and southeastern Canada the rainfall is more acidic than rainfall elsewhere in the country; secondly, this same region is located close to those areas in the U.S. and Canada which have the greatest density of sulfur oxides emissions. Thirdly, there are acidified clear lakes -lakes not directly affected by man's activities- in areas that receive heavy acid deposition, and in contrast there are few affected lakes where deposition is light. Most scientists active in the field believe that acidic deposition has been a major contributor to the acidification of these lakes. But not all areas in the eastern U.S. are sensitive to acid rain. The areas at risk are those which receive the deposition and have limited buffering capacity" (Elkins, 1985).

Notice that Mr. Elkins', who is Director, Office of Program Development, Office of Air and Radiation, U.S. EPA, emphasis is on acid deposition rather than emissions, the effects of deposition, and the sensitivity to acid deposition. Control strategies that are concerned with the proximity of emission sources to adversely impacted areas are known as targeted or receptor-oriented strategies. Mr. Elkins is telling us something about the direction of acid rain policy, namely that when EPA is ready to make an acid rain control policy recommendation, targeted control strategies are likely to be part of that policy.

This emphasis on acid deposition and targeted control strategies is manifesting iself in EPA's research agenda. "We are now greatly expanding our research efforts to deal with the gaps in our knowledge, and to put our country in a better position to recommend targeted and efficient policies" (Elkins, 1985). EPA's research mission is explicitly directed at economically efficient, targeted control policy, with particular attention toward deposition and sensitivity to deposition. <u>The task at hand is to identify emission control methods that mesh with this policy orientation.</u>

III. 3. Targeted Control Strategies

Recent work in atmospheric modeling has brought new meaning to the idea of targeted strategy. The traditional definition says that source/receptor pollutant transport relationships exist that make it more efficient to identify areas sensitive to deposition and then use those transport relationships to identify the primary sources that contribute to deposition in the sensitive area. This definition could be characterized as being spatially targeted.

The new, added dimension to the idea of targeted strategy can be characterized as being temporally targeted. <u>Differences in seasonal rates of sulfate deposition create the opportunity for seasonal control of sulfur emissions as a more effective means of reducing annual amounts of sulfate deposition.</u> By encouraging or requiring $SO2$ emissions to be curtailed in the summer half of the year, there is a larger reduction of annual deposition per ton of $SO2$ removed than if the same quantity were removed year-round. Therefore, it may prove to be less expensive to reduce deposition by controlling emissions only in the summer half of the year, rather than year-round. In other words, there will be a larger reduction in annual deposition per dollar spent controlling emissions during the summer half of the year, than if the same number of dollars were spent controlling emissions year-round.

IV. SEASONAL GAS SUBSTITUTION

IV. 1. Why Natural Gas?

Seasonal control of emissions can be accomplished by substituting lower sulfur fuels for higher sulfur fuels during periods with higher deposition rates (i.e. April-September). This paper evaluates the annual wet sulfate deposition reduction that would result from substituting natural gas for coal and residual oil in utility boilers during April through September.

Natural gas was chosen as a substitute fuel because it produces virtually no sulfur dioxide when burned. Seasonal gas substitution allows a continued utilization of existing coal resources in the winter half (October -March) of the year and increased utilization of natural gas during the summer half (April-September) of the year. While the fuel price differential between gas and coal may be substantial, the capital required for retrofit gas burner installation is expected to be quite low. Thus, the comparative annual cost to a achieve a given target deposition reduction --by seasonal fuel switching to natural gas vs. year-round scrubber operation-- may very well turn out to be in favor of gas subsitution. This is precisely the goal of the paper: estimating the costs of seasonal gas substitution in sulfur emitting power plants in absolute units as well as relative to the costs that would result if these plants installed emission control devices (e.g. scrubbers) to achieve the same amount of sulfate deposition at an environmentally sensitive receptor.

Important factors to be considered in seasonal natural gas substitution strategies include:

1. In the summer months there is currently excess capacity in the natural gas distribution system. According to Wilkinson (1984) only 78% of the pipeline capacity is used in the summer months, and in some regions as little as 51%. Summer gas supply and deliverability will be discussed later in this paper.
2. Seasonal gas substitution could be implemented rapidly relative to the period needed to install scrubbers or develop "clean burning" technology for a large number of plants. The quick implementation schedule would allay fears that further delays in reducing acid deposition may cause irreparable damage to the environment.

Anticipated benefits, beyond lower sulfate deposition, from seasonal gas substitution include:

1. Improved local air quality with lower ambient air concentrations of SO_2 and

particulates.

2. Improved visibility.

3. Increased potential for achieving attainment in non-attainment areas.

4. Decreased dependence upon imported oil.

5. Reduced sensitivity to fuel supply disruptions e.g. coal strikes or oil embargos.

6. Increased reliance on domestic energy resources.

7. Decreased consumption of limestone and other sulfur-capture materials used in emission controls.

8. Decreased land requirements and cost for scrubber sludge and flyash disposal.

IV. 2. Natural Gas as a Boiler Fuel

Natural gas has never been a favorite utility boiler fuel in most parts of the eastern U.S. Combustion of natural gas produces more than 10% of total btu output by electric utilities in only seven of the eastern 31 states (EIA, 1984a). The primary reason for this pattern is that natural gas is an expensive boiler fuel relative to coal. This reason is certainly a viable one. There are two less viable reasons why natural gas may continue to be disfavored as a boiler fuel.

The first concerns the perception by some that gas reserves are imminently exhaustible. A reasonable range for the amount of the remaining conventional natural gas in the U.S. Lower 48 that is recoverable under present and easily forseeable technological and economic conditions is 430 to 900 trillion cubic feet (TCF) as of December 1982 (OTA, 1985). (This resource estimate does not include Alaskan, Canadian, Mexican, or unconventional resources.) At a consumption rate of 20 TCF per year, slightly higher than present consumption, <u>the resource estimated above will last 21 to 45 years</u>. The best explanation for this misperception of imminent exhaustibility is that in the 1970's gas demand exceeded gas supply as a result of price controls on natural gas. The market disequilibrium created the image that we were running out sooner rather than later.

This first misperception led policymakers to restrict gas use, which in turn has created a second misperception, namely that gas use is restricted. Restrictions on gas use in electric utility power plants were enacted when the federal Powerplant and Industrial Fuel Use Act (PIFUA) of 1978 was signed into law on November 9, 1978. However, PIFUA restrictions were sharply repealed by the Omnibus Budget Reconciliation Act signed into law on August 13, 1981. Since the 1981 amendment, <u>the</u>

PIFUA restrictions on natural gas use do not apply to "existing" power plants at all. A power plant is "existing" if it was in service or under construction prior to November 9, 1978 (Bardin, 1985). Furthermore, exemptions are available to post-1978 power plants. Pre-1978 power plants contribute the bulk of total SO_2 emissions because a) most generating units were built prior to 1978, and b) older plants are subject to less restrictive pollution control regulations.

V. THE SEASONAL GAS SUBSTITUTION MODEL

V.1. General Description

The analysis in this paper relies upon a model developed to evaluate the annual wet sulfate deposition reduction that would result from substituting natural gas for coal and residual oil in utility boilers during April through September. The model does not consider load dispatching as a means of reducing emissions, i.e. generating more power from an existing gas-fired plant or turbine that has excess capacity in summer and wheeling that electricity, rather than seasonally substituting gas in coal- or oil-fired plants. The inclusion of load dispatching strategies is left for future analyses. The seasonal gas substitution model <u>estimates the corresponding annual control costs and fuel substitution amounts for any level of deposition reduction</u>.

The model's SO2 emission sources are 387 utility plants burning coal or residual oil as a primary boiler fuel in the eastern 31 states and D.C. The criteria for including a plant in the model were that it had to have a rated capacity of 50 megawatts or larger, and at least 10% of total btus had to be generated from either coal or oil. The names, locations, and fuel characteristics of these plants are listed in Appendix A. Refer to the guide at the beginning of the Appendix for column definitions.

The atmospheric transport model, known as the MIT acid deposition model (Fay et al., 1985; Golomb et al., 1985; Kumar, 1985), is an adaptation of the Fay-Rosenzweig climatological long-range transport model originally developed for estimating annual average SO2 concentrations in the U.S. (Fay et al., 1980). It is empirically determined in that the model parameters are derived by comparison with airborne concentrations and wet deposition measurements.

Because the physical and chemical processes that pollutants undergo is highly variable, the accuracy of long range atmospheric transport models is frequently questioned. Even among those scientists that develop them there is considerable variability in the estimation of the transfer coefficients. In spite of this, the MIT acid deposition model has been well received by those knowledgeable in the field. Therefore, it is justifiably appropriate to use for this analysis.

The MIT acid deposition model derives transfer coefficients which estimate the quantity of deposition at a receptor per unit of emission at a source. Transfer coefficients have been derived for both an annual and a seasonal (summer/winter) basis. The seasonal gas subsitution model uses the summer transfer coefficients to relate emissions reductions, as a result of substituting natural gas for coal and oil, to deposition reductions at an Adirondack receptor. Table 1 lists the values of the seasonal and annual transfer coefficients between the 31 eastern states plus D.C. and an Adirondack receptor. Table 1 shows that the summer transfer coefficients are on average nearly twice as large as the winter ones. In other words, <u>on average, summer emissions from the 31 eastern states cause nearly twice the deposition at an Adirondack receptor as an equal quantity of winter emissions</u>.

The transfer coefficient T_{ij} is the ratio of the amount of deposition at receptor j contributed by source i divided by the emission amount Q_i from source i. The total deposition D_j at receptor j equals the sum of the products of the transfer coefficient T_{ij} times the emission Q_i :

$$D_j = \Sigma_i T_{ij} Q_i \tag{1}$$

When seasonal transfer coefficients are used, the annual deposition is obtained by summing seperately the product of the transfer coefficient and emissions for summer (April- September) and winter (March-October):

$$(D_j)_{an} = \Sigma_i (T_{ij} Q_i)_{wi} + \Sigma_i (T_{ij} Q_i)_{su} \tag{2}$$

In the seasonal gas substitution model the emission-deposition relationship takes the functional form,

$$(D_j)_{su} = \Sigma_i (T_{ij} Q_i)_{su} \tag{3}$$

where the transfer coefficients $(T_{ij})_{su}$ are constants, the summer deposition $(D_i)_{su}$ is the independent variable, and summer emissions $(Q_i)_{su}$ are dependent variables. By selecting a desired summer deposition quantity, the required level of emissions is determined, which in turn determines the amount of gas substitution necessary to achieve the desired deposition quantity for the April-September period.

The same transfer coefficient is used for all emission sources within a state. This is valid for states distant from the receptor, but may be questionable for states close to the Adirondacks. For instance, New York state has emission sources both to the west and south of the Adirondacks. The higher the variation in direction and range from the sources within a state to the receptor, the less appropriate it is to use a single transfer coefficient for all sources within that state. The use of single transfer coefficients within a state was chosen for this analysis because: 1) the bulk of deposition at an Adirondack receptor comes from distant states, and 2) it simplifies the presentation of the analysis. The use of multiple transfer coefficients within a state is left for future analysis.

V. 2. Functional Form

The model is in fact a linear program (LP) which seeks to minimize the incremental spending on natural gas as a result of substitution. For each electric power plant i, there is a cost differential between a given btu quantity of gas and coal and/or gas and oil. Multiplying this cost differential by the quantity of gas substituted equals the incremental spending on fuel by the power plant.

Minimization of the incremental spending on natural gas is performed subject to two types of constraints. The first constraint specifies the desired level of deposition and has already been described above by Eq. (3). The second type of constraint requires that the same quantity of btus are produced by each power plant under the gas substitution strategy as were actually produced when no substitution occured. The btu output of each source is equal to the btu content of the coal, oil, or gas multiplied by the quantity of coal, oil, or gas consumed. Actual btu output was determined from fuel heat content and consumption data (EIA, 1984a).

The LP model in its functional form seeks to minimize the sum of the products:

$$\mathrm{MIN}\ \Sigma_i F_i G_i \tag{4}$$

subject to:

$$D_{su}(\mathrm{target}) = \Sigma_i (T_{ij} Q_i)_{su} \tag{5}$$

$$(\mathrm{btu})_i = H^c{}_i C_i + H^o{}_i O_i + H^g G_i \tag{6}$$

where the symbols are:

$(\mathrm{btu})_i$ = seasonal (April-September) total btu output for power plant i,

C_i = seasonal quantity of coal burned by power plant i,

D_{su} = target seasonal deposition quantity for a specified receptor,

F_i = fuel cost differential between gas and coal and/or gas and oil at power plant i,

G_i = seasonal quantity of natural gas substituted for coal and/or oil at power plant i.

H^c_i = heat content of coal consumed by power plant i,

H^g = heat content of natural gas (one cubic foot= 1000 btu assumed for all power plants),

H^o_i= heat content of oil consumed by power plant i.

The Adirondacks receptor is used in the model because it is environmentally sensitive and centrally located with respect to other environmentally sensitive areas in the U.S. and Canada. By adding additional deposition constraints, the model could be made to consider more than one receptor. This would require the use of a unique set of transfer coefficients for each additional receptor. For simplicity of presentation, the model has been limited to a single receptor.

However, it is possible to speculate as to the effect of multple receptors. For instance, if a Southern Applachian receptor were used in addition to an Adirondack receptor, more substitution would occur in southern states. Increased substitution in southern states in order to reduce Southern Applachian deposition would also reduce Adirondacks deposition by a small amount. As a result, less substitution would be required in northern states in order to achieve the same deposition reduction in the Adirondacks. Thus, there is a spillover effect when multiple receptors are used. The inclusion of multiple receptors is left for future analyses.

V. 3. Emissions

Most legislative proposals to date have focused on a 31 state region encompassing the states east of, and bordering on, the Mississippi River. Of the 26 to 27 million tons of sulfur dioxide emitted in the continental United States in 1980, about 22 million tons came from this 31 state region. The model uses 22 million tons as the base level when calculating percentage reductions in emissions. This paper calculates that the electric utilities included in this analysis are responsible for approximately 16 million tons of S02 emissions (Table 2), or 73% of the 22 million ton total (assuming 1983 total emissions were equal to those in 1980).

Table 2 lists 1983 emissions of S02 attributable to the burning of coal and residual oil in electric power plant boilers in the 31 easternmost states and DC, i.e. the power plants in Appendix A. Emissions were calculated from annual electric utility coal and oil consumption data (EIA, 1984a) neglecting any sulfur removal processes which may have been used in that year. These emissions are used by the model for calculating deposition at an Adirondack receptor.

Since in most states sulfur emission rates are fairly constant throughout the year (NAPAP, 1985), the model assumes that fuel consumption during April through September is equal to one-half of annual fuel consumption. Therefore, emissions during April through September are assumed to equal to one-half of annual emissions. To assess this assumption, net generation data (trillion kilowatthours of output) was compiled for coal-fired plants in the eastern 31 state region (Figure 2). Figure 2 shows that monthly variations in net generation do occur. However, if the monthly figures are summed for the periods April-September and October-March, the former period accounts for 51% of annual net generation. From this, it can be safely inferred that emissions during April through September are equal to one-half of annual emissions in the eastern 31 state region. This does not necessarily hold true for individual states; future analyses may wish to account for state-level variations in seasonal fuel consumption and SO2 emissions.

V.4. Deposition

The amount of wet sulfate deposition at a receptor can be linearly related to the amounts of sulfur emissions from sources using transfer coefficients. These transfer coefficients, and the MIT acid deposition model from which they were derived, were discussed earlier. Total annual wet sulfate deposition at an Adirondack receptor was estimated to be 27.5 kilograms sulfate per hectare per year (kg SO4 $ha^{-1}y^{-1}$)(Fay et al., 1985). This figure is used as the base for calculating percentage reductions in total annual wet sulfate deposition at an Adirondack receptor. Table 3 contains the summer and annual deposition amounts, at an Adirondack receptor, which were calculated to have been contributed by the sources included in this analysis. (Note: It is necessary to multiply the figures in Table 3 by a factor of three in order to convert sulfur (S) to sulfate (SO4). SO4 is three times the molecular weight of S.) <u>This paper calculates that electric utilities in the eastern 31 states contribute 14.2 kg SO4 ha^{-1} annually to an Adirondack receptor, or 52% of the 27.5 kg SO4 ha^{-1} total</u>. Of this 14.2 kg annual total, 11.2 kg or 79% is calculated to be deposited between April and October. Summer deposition is disproportionately higher because the summer transfer coefficients are nearly twice as large on average as winter ones (see Table 1).

V.5. Calculating the Cost of Seasonal Gas Substitution

Incremental spending on natural gas by utilities is assumed to equal the incremental quantity of natural gas consumed at a power plant as a result of substitution, multiplied by the cost differential between gas and coal, or gas and oil, at that plant, summed for all such power plants. It should be noted that the costs derived here for seasonal gas substitution are solely the result of the price differentials between gas and coal or oil. Preliminary estimates of the incremental capital and operating costs associated with seasonal gas substitution indicate that the fuel price differential is by far the major cost. Because capital and operating costs for seasonal gas substitution are uncertain and relatively small, this paper will leave the inclusion of these factors to future analyses.

The coal and oil prices used in the analysis are actual average prices per million btu paid by the power plants in 1983 (EIA, 1984a). These prices are listed in Appendix A, columns 5 and 10. The gas prices used are the state-average cost per million btu paid by electric utilities in that state (Table 4). If no electric utility burned gas in a state, then the average price paid by industrial consumers was used (EIA, 1984b). From the gas prices listed in Table 4, it can be seen that prices vary significantly from state to state. Using the data in Appendix A and Table 4, the plant-level price differentials have been calculated, and are shown in Appendix B.

The actual coal and oil prices, as well as the state-average gas prices, are not necessarily indicative of present and future prices, and therefore of price differentials, for these fuels. A fall in oil prices, which are determined in the world market, could be expected to produce a decrease in natural gas prices because the two fuels are to some extent substitutes. Coal prices are affected to a greater extent by production costs, and to a lesser extent by the prices of oil and gas because these fuels are not close substitutes. Hence, a fall in oil prices and a subsequent fall in gas prices should be accompanied by a relatively smaller decrease in coal prices. The result is that in a period of lower oil prices, a smaller price differential between gas and coal could be expected.

To test this hypothesis informally, it is useful to look at gas, coal, and oil prices and price differentials over time (Figure 3). (Prices have been taken from EIA, 1985 and are adjusted to 1983 dollars using the U.S. Bureau of Labor Statistics producer price index for crude energy materials.) During the period 1983 to 1985, the price of oil rose fairly steadily throughout 1983 and into mid-1984, and then declined during the remainder of 1984 and throughout 1985. The price of gas followed a similar pattern to that of oil, but the rise and fall are less pronounced. The price of coal remained relatively stable throughout the period. So, the hypothesis is substantiated, at least during this short period.

The implications of this for fuel price differentials are shown in Figures 4a and b. Figure 4a shows that the gas/coal price differential rose and fell with the same pattern as the price of gas itself. Thus, the direction of the price of gas reveals the direction of the gas/coal price differential. In the current environment of lower gas prices, seasonal gas substitution for coal is equally, if not more, economical than it was in 1983.

In regard to the gas/oil price differential, Figure 4b shows that seasonal gas substitution for oil becomes more attractive when the oil price is rising and less attractive when it falls. In the current environment of lower oil prices, the gas/oil price differential is smaller, but it is still negative. Hence, there is still an economic incentive for gas substitution.

The historic prices are used here as a first approximation and illustration of the fuel price differential trends in current years. More detailed explanations and forecasts of fuel prices are left to future analyses.

V.6. Using the Seasonal Gas Substitution Model

The model, described earlier, is a linear program which seeks to minimize the incremental spending on natural gas subject to constraints on deposition and btu output. The model is exercised by selecting various target levels of deposition reduction and then solving the model. The model selects a power plant to use seasonal gas substitution based on: 1) the rate at which it contributes to deposition, and 2) the fuel price differential it faces. The rate at which a plant contributes to deposition is a function of the sulfur content of the fuel per million btu and the transfer coefficient between the power plant and the receptor. Power plants where these two factors are relatively large will be selected first for gas substitution. Similarly, power plants that have smaller fuel price differentials will be selected first.

Beyond the cost of seasonal gas substitution, the model shows which plants switch, how much gas consumption increases, and how much coal and oil consumption decrease; from which the effect on emissions can be calculated.

VI. RESULTS OF THE MODEL

Appendix C is a sequential list of the 387 plants as they enter the solution. Plant-level and cumulative data are also provided. To use the Appendix, look in column 14 for the desired percentage reduction in deposition. This and all preceding plants have been selected for gas substitution. Reading horizontally, columns 5 and 7 indicate the cumulative amount of coal and oil displaced, column 10 indicates the amount of gas substituted, column 11 indicates the sulfur emission reduction, and column 17 indicates the total cost. Refer to the guide at the beginning of the Appendix for definitions of all the columns.

Each time the model was exercised, total annual deposition was reduced in 5% increments. Corresponding levels of gas substitution, coal and oil displacement, emission reductions, and resultant cost were calculated for each 5% decrement. These results are summarized in Table 5. For example, in the case of a 20% sulfate deposition reduction, 909 billion cubic feet (bcf) of natural gas are substituted for 53 million tons of coal and 87 million barrels of oil at a cost of $2.929 billion (1983$), with a resulting emission reduction of 2.9 million tons of $SO2$. For a 30% sulfate deposition reduction, these quantities increase to 1440 bcf of gas being substituted for 97 million tons of coal and 94 million barrels of oil at a cost of $5.858 billion, with a resulting emission reduction of 4.8 million tons of $SO2$.

From this data, the total, average, and marginal cost curves for seasonal gas substitution with respect to deposition can be derived (Figures 5, 6, and 7). Total cost starts at negative $0.204 billion for a 5% deposition reduction, and rises nonlinearly to $10.931 billion for a 40% deposition reduction. Cost is initially negative because a negative price differential exists between gas and oil at some plants. Because its objective is to minimize cost, the seasonal gas substitution model chooses the plants with negative price differentials first. This condition raises the question of why these plants do not convert from oil to gas regardless of pollution concerns. Some oil-fired plants have converted since 1983, e.g. Boston Edison's Mystic #7 burns gas seasonally. The others have not for reasons that the model fails to consider. Perhaps gas supply is unavailable or insufficient, or perhaps utility management has no incentive to convert given its monopoly power.

Total, average, and marginal cost curves are useful for comparing the costs of various control methods and strategies. They will be used later in the paper when seasonal gas substitution is compared with another proposed control strategy.

VI. 1. The Effectiveness of Seasonal Control Strategies

For evaluating the effectiveness of emission reduction schemes, Golomb et al. (1985) defined a gain factor (GF) as the ratio of the fractional deposition decrement at a chosen receptor (here, Adirondacks), to the fractional emission decrement in the eastern 31 state region that occurs as a result of the reduction scheme. Dividing the fractional deposition decrement at an Adirondack receptor by the corresponding fractional emission reduction at the various levels of gas substitution produces a series of gain factors for this strategy. For each level of percentage decrease in deposition, there is a corresponding percentage reduction in emissions as a result of seasonal gas substitution. The GF is calculated from the model results and is a measure of the overall effectiveness of any deposition control strategy.

To show the increased effectiveness of seasonal over year-round controls, a comparison of the gain factors from these two strategies is made. Using Eq.(2), it is possible to calculate the annual deposition reduction that would result at each level of gas substitution if the same quantity of gas were substituted year-round instead of during April through September. When a given quantity of gas is substituted, the SO_2 emission reduction remains the same regardless of whether substitution occured seasonally or year-round. Substituting a given quantity of gas for coal or oil will reduce emissions by some constant amount regardless of when during the year substitution occurs; the same is not true with respect to deposition. The annual deposition reduction is smaller in the case of year-round controls because the winter transfer coefficients are smaller. Table 6 presents the GF for each of several levels of seasonal and year-round gas substitution. For example, for a 25% reduction in deposition, there is a corresponding 3.9 million ton or 18% (if a 22 million ton base is assumed) reduction in SO_2 emissions, (due to 1176 bcf of natural gas being substituted for coal and oil). If this same quantity of gas were evenly substituted year-round, emissions would still be reduced by 18%, but, because both summer and winter transfer coefficients are used, the deposition reduction is now 16%. The GF for seasonal substitution is (25%/18%)=1.40, while that of year-round substitution is (16%/18%)=0.88. Hence, seasonal substitution is 59% [(1.40%/0.88%)=1.59] <u>more effective</u> than year-round substitution at this level. Figure 8 is a graphical comparison of the gain factors for seasonal and year-round controls. The effectiveness varies somewhat because the relative amount of gas substitution occuring in each state varies at different levels of deposition reduction.

The GFs for both seasonal and annual controls are diminished at higher levels of deposition reduction. This is because plants further from the receptor are included in the solution as the deposition reduction becomes larger. The distance between the two lines in Figure 6 represents the superiority of seasonal over annual gas substitution. This distance remains relatively stable regardless of the level of deposition reduction. <u>In general, a seasonal control strategy is 32-60% more effective than an annual control strategy for reducing deposition at an Adirondack receptor.</u>

VI. 2. The Effect of Substitution on Fuel Consumption

Each plant in the model burns a known quantity of coal or oil annually (EIA, 1984a). It has been assumed that half this quantity is consumed during April through September. This is supported by evidence that net generation by coal-fired plants during April through September is 51% of annual net generation in the eastern 31 state region during 1983 (Figure 2).

When a plant is chosen by the model for gas substitution, the coal or oil it would burn during April through September is replaced by natural gas. The quantity of gas substituted is determined by calculating the quantity of gas that would be needed to replace the btu output that the coal or oil would produce. The average heat content for coal and oil at each plant is used for this calculation (EIA, 1984a).

For natural gas, a heat content of 1000 btu per cubic foot is assumed. Acutal average heat content for natural gas in the U.S. is approximately 1050 btu/cubic foot (EIA, 1984b); a 5% reduction to 1000 btu/cubic foot has been allowed to account for boiler derating, i.e. a 5% loss in boiler output. Basically, derating occurs because a boiler designed to burn coal or oil does not burn gas with equal effectiveness because of differences in the combustion characteristics of the fuels. Experience with derating due to gas substitution is meager, since gas substitution in coal and oil burners is very limited at present. Five percent is a reasonable allowance, based on experience with substituting natural gas for oil at Boston Edison's Mystic #7 unit (Boston Edison, 1985). Detailed work on derating and inefficiencies caused by burning gas in boilers designed for coal or oil is left to future analyses.

The model calculates the quantities of gas substituted and coal and oil displaced for the various levels of deposition reduction that the model was exercised for, as shown in the bottom half of Table 5. These quantities were mentioned earlier in the case of 20% and 30% deposition reductions. Figures 9, 10, and 11 show curves of these quantities.

Initially most of the gas is substituted for oil. However, because oil's contribution to deposition is very small, coal quickly becomes the object of substitution. To illustrate, Figure 11 shows that for a 5% deposition reduction, gas displaces 79 million out of a possible 97 million barrels of oil, i.e. 80%. For coal, Figure 10 shows that 8 million out of a possible 176 million tons, i.e. less than 5%, is displaced. For a 20% deposition reduction, the respective percentages for oil and coal are 90% and 30%, oil's percentage rises only slightly while coal's percentage increases by a factor of six. Hence, beyond the lowest levels of deposition reduction, substituting gas for coal is nearly completely responsible for further reductions.

VI. 3. The Average Cost of Emission Reduction

Figure 12 shows the reductions in SO2 emissions for various reductions in deposition. Using this and the total cost data, the average cost of emission reductions at various levels of deposition reduction can be calculated (Figure 13). The average cost of reducing SO2 emissions via seasonal gas substitution ranges from a negative $340 per ton SO2 at the 5% deposition reduction level (from Figure 12 this corresponds to a 0.6 million ton reduction in emissions), to a positive $1584 per ton SO2 at the 40% deposition reduciton level (a corresponding 6.9 million ton emission reduction). (The cost of emission reduction is negative when there is a negative price differential, i.e. when oil is more expensive per btu than natural gas). For comparison, the SO2 removal cost by limestone flue gas desulfurization (scrubber) was reported to be in the range $576-1126 per ton (Miller, 1985). From the sixth column in Table 5, it can be seen that the average cost of seasonal gas substitution is in or below the average cost range for scrubbing, for up to a 25% reduction in total annual deposition at the Adirondack receptor. The conclusion is that there are a substantial number of plants where the cost of seasonal gas substitution is competitive with that of scrubbing.

As noted earlier, the costs of seasonal gas substitution are based on 1983 fuel price differentials. Future price differentials may vary, consequently, future costs may be different.

VI. 4. The Average Cost of Deposition Reduction

The debate over alternative strategies for controlling acid rain has focused mainly on the expected costs of reducing SO_2 emissions. Total cost and $/ton of SO_2 removed are frequently used to compare alternative control strategies. In making these comparisons, a distinction should be made between receptor-oriented (or targeted) strategies that maximize the amount of deposition reduction at a receptor(s) for a unit of emission reduction, and source-oriented strategies aimed solely at reducing total emissions. A direct comparison of the cost of receptor- and source-oriented strategies can be misleading; these strategies will not result in equal deposition reductions at a given receptor for equal emission reductions.

In order to facilitate a direct comparison, it is useful to define a cost per unit of deposition reduction at a particular receptor. Dividing the total cost for seasonal gas substitution by the corresponding quantity of deposition reduction at a receptor, produces a measure of the average cost of reducing deposition at that receptor. The average cost of deposition reduction at an Adirondack receptor, expressed in terms of billions of dollars per kg SO_4 per hectare per year (B$/kg SO_4 ha^{-1} yr^{-1}), is shown in Table 5, column 4. The average cost for deposition reduction ranges from a negative $0.165 billion/ kg SO_4 ha^{-1} yr^{-1} for a 5% deposition reduction to $1.002 billion/ kg SO_4 ha^{-1} yr^{-1} for a 40% deposition reduction.

After first determining the resulting deposition reduction, the average cost of deposition reduction may be calculated for any source-oriented emission control strategy. Cost comparisons, based on the cost of deposition reduction rather than the cost of emission reduction, can then be made between seasonal gas substitution and source-oriented control strategies. The following section illustrates such a comparison.

Morrison and Rubin (1985) developed a model that computes the emission reduction and cost that would result from emission caps of 1.5 and 1.2 lbs. SO_2 per million btu on utility emissions using optimized combinations of switching to lower sulfur coal and flue gas desulfurization (FGD). The 1.5 and 1.2 lbs. emission caps resulted in annual emission reductions of 8 and 10 million tons SO_2 respectively. Based on the distribution of emission reductions across the eastern 31 states, these emission reductions would respectively yield 7.2 and 8.2 kg SO_4 ha^{-1} yr^{-1} deposition reductions at an Adirondack receptor (calculated using the MIT acid deposition model annual transfer coefficients). These quantities of deposition reduction are respectively equivalent to 26% and 30% reductions from the 27.5 kg SO_4 ha^{-1} base deposition level at an Adirondack receptor.

Table 7 summarizes the following comparisons. Morrison and Rubin calculated total cost ranges of $1.5-2.6 and 3.2-4.7 billion (1980$) for the 8 and 10 million tons of SO_2 emission reductions, respectively. Using a GNP deflator of 1.2 to adjust to 1983 dollars makes the cost ranges $1.8-3.1 and 3.8-5.6 billion, respectively. Dividing the cost by the deposition reductions gives $0.25-0.43 and 0.46-0.68 billion per kg SO_4 deposition removed, respectively, for the two cases. Referring to Table 5, column 4, the average cost of deposition reduction for similar (25% and 30%) reductions via seasonal gas substitution is $0.64 and 0.72 billion per kg. The conclusion is that, for 25% and 30% deposition reductions aat an Adirondack receptor, Morrison and Rubin's optimized strategy has a lower average cost per kilogram of SO_4 reduced than does seasonal gas substitution. This is not to say that seasonal gas substitution is not cost-competitive with other control strategies, in this case an optimized combination of switching to lower sulfur coal and FGD. I respectfully submit that Morrison and Rubin's is but one control strategy; other control strategies will have different costs, some higher and some lower. The purpose of the preceding comparison is primarily to show that cost comparisons with respect to deposition can be made between source- and receptor-oriented strategies.

Using the data in Appendix C, state-level average costs were computed for 25% and 30% deposition reductions (Table 8). Figures 14 and 15 show this data ranked from lowest to highest, plotted against the cumulative percentage deposition reduction of the states. For example, in Figure 14, Ohio's (OH) average cost is $0.724 billion per kg SO_4 ha^{-1}, at the 25% deposition reduction level; it accounts for an approximate 5% deposition reduction by itself, and together with preceding states accounts for a 12% deposition reduction.

While the average costs for seasonal gas substitution in the entire eastern 31 state region are higher than those derived from Morrison and Rubin's two cases for equivalent deposition reductions, there are several states that do have average costs of achieving deposition reduction via seasonal gas substitution that are within the ranges of Morrison and Rubin's cases. The following states, DC, FL, MA, NJ, NY, RI, and VA, have average costs that are in or below the ranges specified by Morrison and Rubin, namely $0.25-0.43 billion (25% reduction) and $0.46-0.68 billion (30% reduction) per kg SO_4 ha^{-1} reduced. Thus, it appears that seasonal gas substitution may be cost-competitive with other control methods, in this case an optimized combination of switching to low-sulfur coal and FGD, in some states.

VII. GAS SUPPLY FOR SUBSTITUTION

The seasonal gas substitution model has not considered gas deliverability constraints which may limit the amount of substitution that occurs within a state as specified by the model. A gas deliverability constraint would occur whenever the gas supply infrastructure lacks the necessary capacity to meet the incremental demand imposed by a level of gas substitution, or if total gas production is exceeded by the incremental demand. In order to utilize gas substitution, the utility must access its gas supply from a gas distribution company's or gas transmission company's high-pressure pipeline. Transmission capacity can be expanded, but this may increase fuel costs, which may make gas substitution less competitive relative to other control strategies.

Because the primary use of natural gas is for space heating, summer demand is lower than winter demand in nearly all states. This condition favors seasonal gas substitution, but not in an unlimited or universal pattern. The ratio of summer sales volume to winter sales volume averaged 49% and ranged from 33% to 103% in the 31 eastern states and DC in 1984 (Table 9). The winter/summer sales ratio is only an indicator of general capacity and cannot be relied upon as a definitive measure of excess capacity available to every generating unit within a state. For the purposes of this study it is assumed that the difference between winter and summer consumption is an approximate measure of available capacity. The aggregate difference between summer and winter volume is 2050 billion cubic feet, which would provide approximately enough gas substitution for a 37% reduction in deposition (from Figure 7). However, not every state has the necessary surplus summer gas required at all levels of deposition reduction. For example, for a 25% deposition reduction, only 14 states have the surplus needed to supply their share of the model's solution. The summer surplus is estimated from Table 9, column 4; the incremental demand for gas in each state sufficient for a 25% reduction in deposition is shown in Table 10.

While the availability of natural gas is a significant factor, gas supply constraints are not included in the model. This simplification is made because the availability of gas is difficult to estimate within a state or at a given plant. The determination of availability is left to those considering gas substitution. A general approximation of gas availability can be made by comparing seasonal sales volumes for selected gas transmission and distribution companies. Table 11a shows the ratio of summer to winter sales volumes for major interstate transmission companies operating in the eastern U.S.; Table 11b shows the ratios for several gas distribution companies. It can be seen that excess summer capacity is generally available, but the amount varies greatly between companies and regions.

VIII. OTHER COSTS

Preliminary findings concerning incremental capital and operating costs for seasonal gas substitution reveal two significant points. First, capital costs are low and implementation is quick. Using as an example the Boston Edison Mystic *7 unit, an oil-fired generating unit that converted to seasonal gas use, the boiler modification and gas supply construction cost $3.5 million for the 565 MW unit and was completed in approximately one year (Boston Edison, 1985). This is approximately $6/kW. In contrast, capital costs for limestone flue gas desulfurization (scrubbing) are between $175 and $317/kW (Miller, 1985), and have much longer lead times. Second, ash generation is reduced. If the variable component of ash disposal is significant, there is a potential cost saving from seasonal gas substitution. For example, a 500 MW coal-fired unit might produce 130,000 tons of bottom and flyash annually. If variable disposal costs are $10/ton, the ash disposal cost is $1.3 million annually. Seasonal gas substitution could save one-half of this sum. The present value of these savings are close to or may exceed the capital costs associated with seasonal gas substitution.

The crucial determinant of the cost-competitiveness of gas substitution is the price differential between gas and coal and gas and oil. Since long term prices are impossible to predict with certainty, gas substitution is regarded as being financially risky when compared with other control methods. Actually, gas substitution may be less risky than more capital intensive control methods. Because there is relatively small capital investment associated with gas substitution, a utility could easily abandon it if a more cost-effective solution became available without forfeiting a large investment. Because of the large capital outlay needed for scrubbing equipment, a utility saddled with an expensive scrubber is financially limited if it wants to exploit less expensive control methods that may become available.

IX. CONCLUSIONS

Nearly all of the "acid rain" policy and policy analyses have focused on emission reductions and the cost of controlling emissions. But it is deposition, not emissions per se, that matters. Monitoring has shown that deposition rates are significantly higher during April through September than during October through March for equal emission rates. Based on this evidence, it is more efficient to control emissions (and hence deposition) during the summer half of the year.

Seasonal substitution of gas for coal or oil is a reasonable option for utilities to control SO_2 emissions and is well suited to comply with policies which focus on controlling deposition. However, it is not a panacea for reducing SO_2 emissions. The quantities of gas needed for substitution in order to make total emission reductions of more that a few million tons per year in SO_2 emissions would exceed existing capacity in many states. Some generating units are located too far from a gas supply or face fuel cost differentials that are too large to make gas substitution economically competitive with other control methods. On the other hand, many generating units do have access to sufficient quantities of gas at costs that make gas substitution competitive with other emission control methods.

The cost-effectiveness of any control method should be related to its effect on deposition rather than its effect on emissions. One ton of SO_2 removed in the summer half of the year has a greater effect on deposition than reducing that ton year-round. It was shown that in terms of equal deposition reductions in the Adirondacks, that the costs of seasonal gas substitution and some year-round controls may be comparable in some states.

Conclusions:

* In some states seasonal gas substitution may be economically competitive with other control methods for achieving equal annual deposition reductions in sensitive areas.

* In some states gas deliverability and supply may limit the amount of gas substituted.

* Capital costs for gas substitution are very low relative to FGD systems.

References

Bardin, D. J., 1985. "Real and Imagined Restrictions on Electric Utility Fuel Use of Natural Gas," Public Utilities Fortnightly, March 21, 1985.

Boston Edison, 1985. Personal communication with Mr. Paul Kingston, Operations Supervisor, Mystic *7 unit, July 1985.

Bowersox, V. C. and G. J. Stensland, 1985. "Seasonal Variations in the Chemistry of Precipitation in the United States," Paper 85-6A.2 presented at the 78th Annual Meeting of the Air Pollution Control Association, Detroit, MI.

Elkins, C. L., 1985. "Acid Rain Policy Development," Journal of the Air Pollution Control Association, 35, No.3.

Energy Information Administration (EIA), 1984a. Cost and Quality of Fuels for Electric Utility Plants 1983.

Energy Information Administration (EIA), 1984b. Natural Gas Monthly, January -December 1984.

Energy Infromation Administration (EIA), 1985. Electric Power Monthly, January 1985.

Fay, J. A., D. Golomb, and J. Gruhl, 1983. "Controlling Acid Rain," MIT-EL 83-004, Energy Laboratory, Massachusetts Institute of Technology, Cambridge, MA 02139.

Fay, J. A., D. Golomb, and S. Kumar, 1985. "Source Apportionment of Wet Sulfate Deposition in Eastern North America," Atmospheric Environment, 19, pp. 1773.

Fay, J. A. and J. J. Rosenzweig, 1980. "Analytical Diffusion Model for Long Distance Transport of Air Pollutants," Atmospheric Environment, 14, pp. 355-365.

Golomb, D., J. A. Fay, and S. Kumar, 1985. "Seasonal Control of Sulfate Deposition," Paper 85-1B.8 presented at the 78th Annual Meeting of the Air Pollution Control Association, Detroit, MI.

Kumar, S., 1985. "Modeling Acid Deposition in Eastern North America," Sc.D. Thesis, Massachusetts Institute of Technology, Cmabridge, MA 02139.

Miller, M. J., 1985. "Retrofit S02 and NOx Control Technologies for Coal-Fired Power Plants," Paper 85-1A.2 presented at the 78th Annual Meeting of the Air Pollution Control Association, Detroit, MI.

Morrison, M. B. and E. S. Rubin, 1985. "Linear Programming Model for Acid Rain Policy Analysis," Journal of the Air Pollution Control Association, 35, No. 11.

National Acid Precipitation Program (NAPAP), 1985. "Historic Emissions of Sulfur and Nitrogen Oxides in the U.S. from 1900 to 1980," EPA-600/7-85-009a.

Office of Technology Assessment (OTA), 1985. U.S. Natural Gas Availability: Gas Supply Through the Year 2000, Washington, D.C., U.S. Congress, Office of Technology Assessment, OTA-E-245, February 1985.

Raynor, G. S. and J. V. Hayes, 1982. "Concentrations of Some Ionic Species in Long Island, NY Precipitation in Relation to Meteorological Variables," Water, Air, and Soil Pollution, 17, pp. 309-335.

Wilkinson, P., 1984. "Seasonal Fuel Switching to Natural Gas: A Logical Approach to Reduce Sulfur Dioxide," Gas Energy Review, 12, pp. 11-17.

Table 1. Transfer Coefficients for Adirondack Receptor[a]
(kilograms sulfur per hectare deposited per teragram sulfur emitted)

State	$(T_{ij})_{WI}$	$(T_{ij})_{SU}$	$(T_{ij})_{AN}$
	(kg S ha^{-1} / Tg S emitted)		
AL	0.2579	0.5908	0.407
AR	0.1742	0.3627	0.264
CT	0.7903	1.8720	1.198
DC	0.6007	1.6180	0.995
DE	0.6274	1.6360	1.198
FL	0.2300	0.4323	0.330
GA	0.2988	0.6938	0.473
IL	0.2805	0.7104	0.470
IN	0.3117	0.8085	0.524
IA	0.1852	0.4153	0.297
KY	0.3356	0.8671	0.560
LA	0.1650	0.3120	0.237
MA	0.7230	1.6480	1.086
MD	0.6287	1.6780	1.033
ME	0.5225	1.0410	0.758
MI	0.4045	1.0980	0.688
MN	0.1373	0.2772	0.214
MS	0.2068	0.4390	0.315
MO	0.2033	0.4641	0.325
NC	0.4397	1.1200	0.723
NH	0.8752	1.7890	1.217
NJ	0.7373	1.8810	1.167
NY	0.9127	2.1840	1.366
OH	0.4641	1.2940	0.792
PA	0.6339	1.7750	1.061
RI	0.7230	1.6480	1.086
SC	0.3486	0.8223	0.556
TN	0.3027	0.7463	0.494
VA	0.5310	1.4130	0.882
VT	1.2950	2.6180	1.654
WV	0.4979	1.3710	0.842
WI	0.2500	0.6106	0.415

(a) Kumar (1985)

Table 2. Annual Sulfur Emissions from Coal- and Oil-Fired Power Plants in the 31 Eastern States and DC 1983

State	Million Metric Tons Sulfur			Million Tons SO2		
	Coal	Oil	Total	Coal	Oil	Total
AL	0.241	0	0.241	0.536	0	0.536
AR	0.032	0	0.032	0.070	0	0.070
CT	0	0.024	0.024	0	0.054	0.054
DC	0	0.001	0.001	0	0.001	0.001
DE	0.027	0.007	0.034	0.060	0.016	0.076
FL	0.206	0.096	0.302	0.458	0.213	0.671
GA	0.379	0	0.379	0.843	0	0.843
IA	0.088	0	0.088	0.197	0	0.197
IL	0.544	0.004	0.548	1.210	0.010	1.220
IN	0.690	0	0.690	1.534	0	1.534
KY	0.551	0	0.551	1.225	0	1.225
LA	0.014	0	0.014	0.032	0	0.032
MA	0.035	0.067	0.101	0.077	0.149	0.226
MD	0.088	0.007	0.095	0.197	0.015	0.212
ME	0	0.005	0.005	0	0.011	0.011
MI	0.273	0	0.273	0.606	0.001	0.607
MN	0.071	0	0.071	0.157	0	0.157
MO	0.548	0.001	0.549	1.218	0.002	1.220
MS	0.041	0	0.041	0.091	0	0.091
NC	0.165	0	0.165	0.367	0	0.367
NH	0.023	0.008	0.031	0.512	0.017	0.068
NJ	0.039	0.007	0.047	0.088	0.016	0.104
NY	0.104	0.103	0.207	0.230	0.229	0.460
OH	0.932	0	0.932	2.071	0	2.071
PA	0.712	0.015	0.727	1.583	0.033	1.616
RI	0	0.001	0.001	0	0.002	0.002
SC	0.082	0	0.082	0.182	0	0.182
TN	0.303	0	0.303	0.674	0	0.674
VA	0.056	0.003	0.059	0.123	0.006	0.130
WI	0.205	0	0.205	0.456	0	0.456
WV	0.453	0	0.453	1.007	0	1.007
TOTAL	6.906	0.350	7.25	15.346	0.777	16.123

Source: EIA, 1984

Table 3. Summer and Annual Sulfur Deposition Contributed by Power Plants in the 31 Eastern States and DC
kilograms sulfur per hectare per year (kg S $ha^{-1}yr^{-1}$)

State	Summer Deposition		Annual Deposition	
	Coal	Oil	Coal	Oil
AL	0.071	0	0.098	0
AR	0.006	0	0.008	0
CT	0	0.023	0	0.029
DC	0	0.001	0	0.001
DE	0.022	0.006	0.028	0.007
FL	0.044	0.021	0.068	0.032
GA	0.132	0	0.179	0
IA	0.018	0	0.026	0
IL	0.193	0.001	0.256	0.002
IN	0.279	0	0.362	0
KY	0.239	0	0.309	0
LA	0.002	0	0.003	0
MA	0.029	0.055	0.038	0.073
MD	0.074	0.006	0.091	0.007
ME	0	0.003	0	0.004
MI	0.150	0	0.188	0
MN	0.010	0	0.015	0
MO	0.127	0	0.178	0
MS	0.009	0	0.012	0
NC	0.092	0	0.119	0
NH	0.021	0.007	0.028	0.009
NJ	0.037	0.007	0.046	0.008
NY	0.113	0.113	0.141	0.141
OH	0.603	0	0.738	0
PA	0.632	0.013	0.756	0.016
RI	0	0.001	0	0.001
SC	0.034	0	0.045	0
TN	0.113	0	0.150	0
VA	0.039	0.002	0.049	0.003
WI	0.063	0	0.085	0
WV	0.311	0	0.381	0
TOTALS	3.464	0.258	4.401	0.333

Source: Calculated from Tables 1 and 2

Table 4. Average Cost of Natural Gas at Electric Utilities in the 31 Eastern States and DC 1983

State	$ / 10^6 btu
AL	3.129
AR	3.211
CT	5.930(b)
DE	4.180
DC	4.480(a)
FL	2.529
GA	4.177
IL	5.291
IN	4.238
IA	3.747
KY	4.551
LA	3.150
MA	3.887
MD	4.480(a)
ME	7.660(b)
MI	4.388
MN	3.798
MS	3.325
MO	4.164
NC	4.860(a)
NH	6.000
NJ	4.046
NY	3.932
OH	5.169
PA	5.104
RI	3.753
SC	4.285
TN	3.870(a)
VT	4.220(a)
VA	4.202
WI	4.284
WV	4.546

(a) Average prices calculated from data reported on Form EIA-176.
(b) Average 1983 price paid by industrial consumers.
Source: EIA, 1984 and EIA, 1984a

Table 5. Summary of Results for Seasonal Gas Substitution Model

% Reduction[a] in Deposition	Reduction in SO2 Emissions (10^6 tons)	Total Cost of Deposition Reduction (10^9 \$1983)	Average Cost of Deposition Reduction (10^9 \$ per kg SO4 ha^{-1})	Marginal Cost of Deposition Reduction (10^9 \$ per kg SO4 ha^{-1})	Average Cost of Emissions Reduction (\$ per ton SO2 removed)
5%	0.6	-.204	-.165	.456	-340
10%	1.3	.610	.233	.708	469
15%	2.2	1.671	.418	.853	759
20%	2.9	2.929	.542	.938	1010
25%	3.9	4.403	.641	1.093	1129
30%	4.8	5.858	.721	1.231	1220
35%	5.9	7.867	.827	1.600	1333
40%	6.9	10.931	1.002	2.996	1584

% Reduction in Deposition	Gas Substituted (billion cubic ft.)	Coal Displaced (10^6 tons)	Oil Displaced (10^6 barrels)	\$ per 10^6 btu displaced
5%	337	8	79	-.303
10%	501	20	84	.609
15%	709	37	87	1.179
20%	909	53	87	1.611
25%	1176	76	87	1.873
30%	1440	97	94	2.035
35%	1795	127	95	2.192
40%	2396	176	97	2.281

(a) Calculated from 27.5 kg SO4 ha^{-1} base at Adirondack receptor (Fay et al., 1985).

Table 6. Gain Factors for Seasonal and Annual Gas Substitution

% Reduction in Deposition (summer controls)	% Reduction[a] in Emissions	% Reduction[b] in Deposition (year- round controls)	Summer[c] Gain Factor	Annual[d] Gain Factor	Effectiveness[e]
5	3.1	3.3	1.61	1.06	52%
10	6.7	6.5	1.49	0.97	54%
15	10.5	9.6	1.43	0.91	57%
20	13.6	12.7	1.47	0.93	58%
25	17.8	15.7	1.40	0.88	59%
30	22.1	18.8	1.36	0.85	60%
35	27.2	22.2	1.29	0.82	57%
40	31.9	25.4	1.25	0.80	56%

(a) Calculated from base of 22 million tons of SO_2 emitted annually.
(b) Calculated from Eq.(2).
(c) Equals % Reduction in Deposition(summer controls) divided by % Reduction in Emissions.
(d) Equals % Reduction in Deposition(year-round controls) divided by % Reduction in Emissions.
(e) Summer controls are XX% more effective than year-round controls for reducing deposition at an Adirondack receptor.

Table 7. Comparison of Costs of Deposition Reductions at an Adirondack Receptor

	SO4 Deposition Reduction		Avg. Cost of Deposition Reduction
	% [a]	kg SO4 $ha^{-1}y^{-1}$	(1983 10^9 \$ kg^{-1} ha^{-1})
Morrison and Rubin[b]-	26	7.2	0.250-.430[f]
Seasonal Gas Substitution[c]-	25	6.9	0.641
Morrison and Rubin[d]-	30	8.2	0.460-.680[f]
Seasonal Gas Substitution[e]-	30	8.2	0.721

(a) Based on modeled (uncontrolled) deposition of 27.5 kg SO4 ha^{-1} y^{-1}.

(b) Stafford Bill, state-wide emission cap of 1.5 lb./10^6 btu.

(c) Summer gas substitution model set to 25% deposition reduction.

(d) Mitchell Bill, state-wide emission cap of 1.2 lb./10^6 btu.

(e) Summer gas substitution model set to 30% deposition reduction.

(f) Calculated from Morrison and Rubin (1985).

Table 8. State-Level Average Costs for Achieving Reductions in S04 Deposition via Seasonal Gas Substitution in Electric Power Plants in the 31 Eastern States and DC

State	25% Deposition Reduction Avg. Cost Dep. Red. (10^9 \$ per kg S04 ha^{-1})	30% Deposition Reduction Avg. Cost Dep. Red. (10^9 \$ per kg S04 ha^{-1})
AL	.828	.851
CT	(a)	1.187
DC	-.882	-.882
DE	.777	.777
FL	-1.072	-1.072
GA	1.115	1.130
IA	.968	.968
IL	.854	1.024
IN	.911	1.009
KY	.837	.840
MA	.128	.128
MD	.814	.814
MI	.995	.995
MO	.949	.961
NH	.859	.859
NJ	.473	.473
NY	.066	.066
OH	.724	.768
PA	.796	.842
RI	-.403	-.403
TN	.830	.873
VA	-.235	-.235
WI	1.023	1.106
WV	.707	.806

(a) CT is not included at the 25% deposition reduction level.

Table 9. Natural Gas Deliveries to Residential, Commercial, and Electric Utility Consumers in 31 Eastern States and DC

State	Summer Volume[a] (bcf)	Winter Volume[b] (bcf)	Winter less Summer (bcf)	Summer Volume as a Percent of Winter Volume
AL	21.9	55.4	33.5	40
AR	37.9	68.7	30.8	55
CT	20.2	39.8	19.6	51
DE	8.1	9.5	1.4	85
DC	9.7	20.9	11.2	46
FL	112.4	109.1	-3.3	103
GA	43.8	107.9	64.1	41
IL	202.5	510.5	308.0	40
IN	65.6	173.0	107.4	38
IA	35.6	96.6	61.0	37
KY	28.5	78.4	49.9	36
LA	233.7	234.7	11.0	95
ME	0.5	1.1	0.6	45
MD	33.6	71.9	38.3	47
MA	73.8	115.1	41.3	64
MI	152.3	370.0	217.7	41
MN	46.6	134.3	87.7	35
MS	49.8	59.6	9.8	84
MO	51.3	137.0	85.7	37
NH	2.7	6.1	3.4	44
NJ	129.3	208.6	79.3	62
NY	256.1	410.5	154.4	62
NC	18.2	47.2	29.0	39
OH	141.1	377.6	236.5	37
PA	111.4	282.2	170.8	39
RI	10.1	16.1	6.0	62
SC	10.6	25.7	15.1	41
TN	21.1	63.5	42.4	33
VT	0.9	2.2	1.3	42
VA	24.1	51.5	27.4	47
WV	16.1	43.2	27.1	37
WI	48.1	119.1	71.8	40
Total	2007.6	4057.6	2050	49

Source: EIA, 1984b
(a) Summer--April through September
(b) Winter--October through March

Note: Industrial gas consumption is not included here as the data is not yet reported by the Energy Information Administration. Exclusion of this component probably causes the ratio of summer to winter volume to be slightly overstated here.

Table 10. Natural Gas Substituted for a 25% Reduction in Deposition

State	Gas (Bcf)	Sufficient Surplus[a]
AL	51	N
DC	1	Y
DE	19	N
FL	144	N
IA	3	Y
IL	20	Y
IN	73	Y
KY	61	N
MA	59	N
MD	40	N
MI	50	Y
MO	25	Y
MS	9	Y
NH	11	N
NJ	30	Y
NY	137	Y
OH	143	Y
PA	184	N
RI	1	Y
TN	41	Y
VA	3	Y
WI	2	Y
WV	68	N
	1176	

(a) The difference between winter and summer volume of sales in used as an approximate measure of summer capacity. If Table 9, column 4 is greater than the incremental demand shown above, then Y.

Table 11. Summer and Winter Gas Sales Volume[a]

a. Interstate Pipeline Companies	Summer Volume as a Percent of Winter Volume
Algonquin	86
Columbia Gas	50
Consolidated Gas	65
East Tennessee	65
El Paso	95
Florida Gas	90
Great Lakes Gas	177
Michigan Consolidated	46
Midwestern Gas	83
Natural Fuel	47
Natural Gas Pipeline	70
Northern Natural	50
Panhandle Eastern	57
Southern Natural	65
Tenneco Inc.	86
Texas Gas Transmission	73
Transcontinental	72
Trunkline Gas	58
United Gas	82
b. Selected Distribution Companies	
Northern Illinois Gas (IL)	41
Peoples Gas (IL)	38
N. Indiana Public Service (IN)	60
Indiana Gas Company (IN)	47
Louisville Gas and Electric (KY)	39
Columbia Gas of KY	34
Boston Gas Company (MA)	85
Michigan Consolidated (MI)	46
Consumers Power Company (MI)	44
PSE&G (NJ)	43
Brooklyn Union Gas (NY)	65
Consolidated Edison (NY)	54

(a) From EIA (1984b) and State Utility Commissions

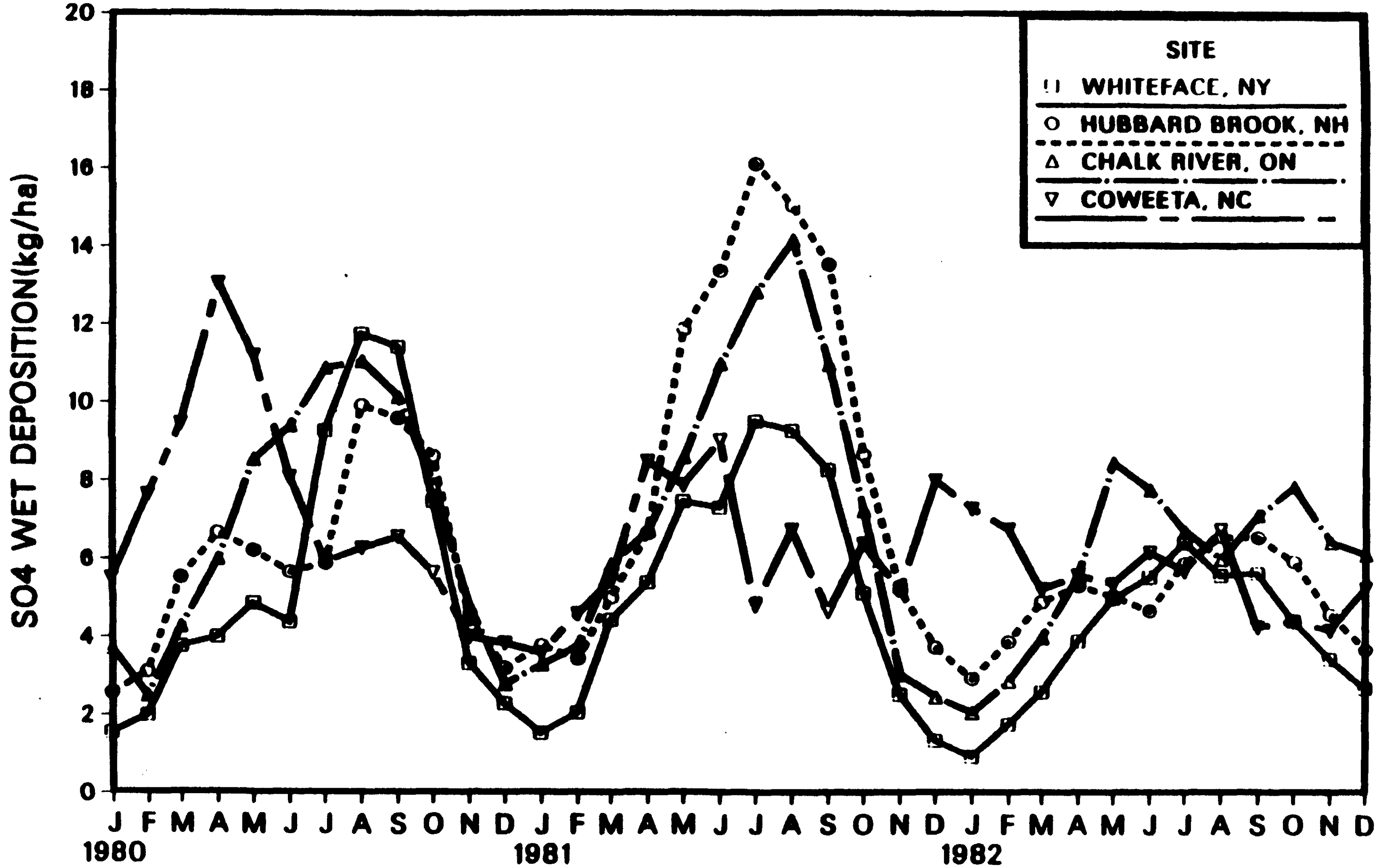

Figure 1. Seasonal Patterns Of Sulfate Deposition

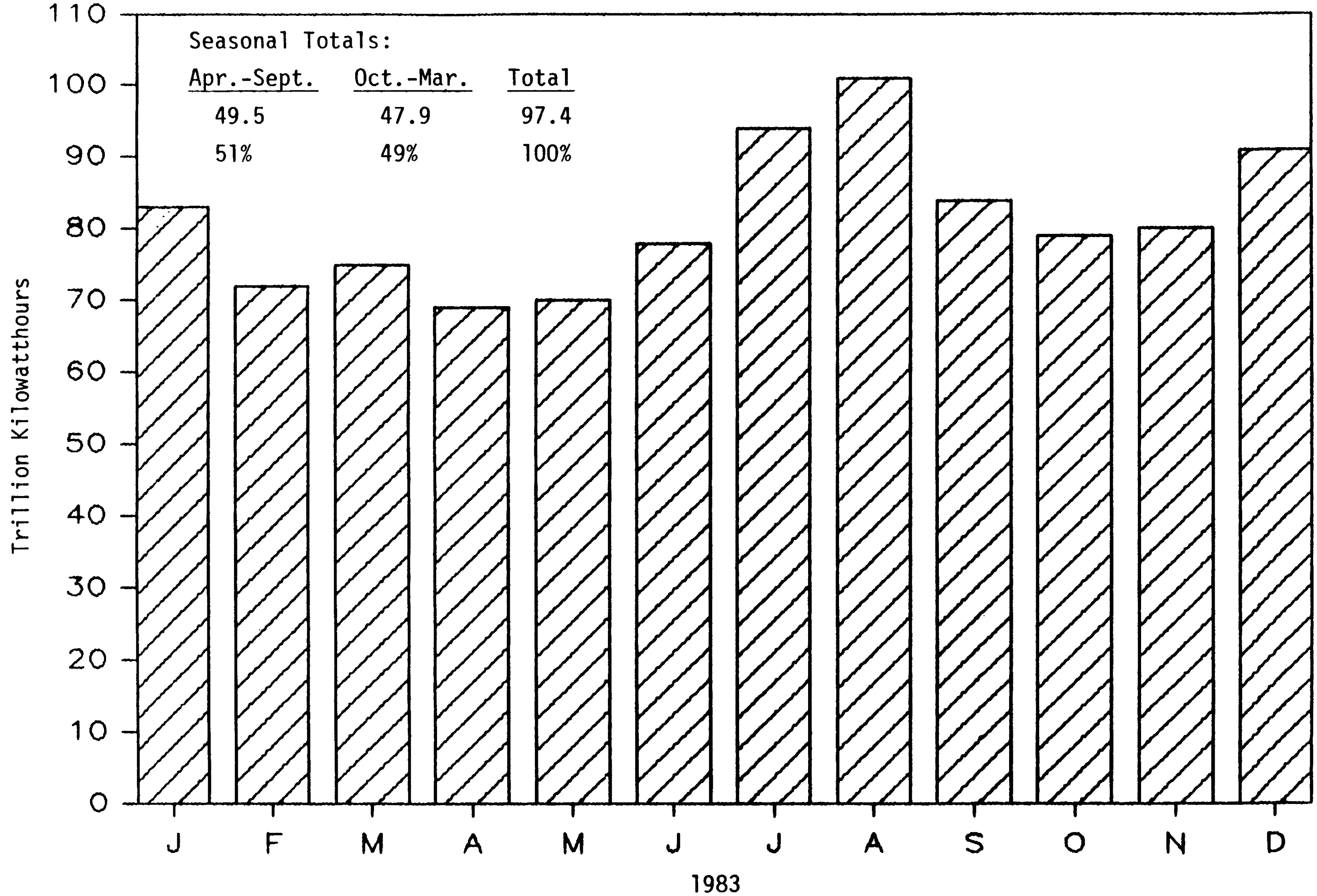

Figure 2. Net Generation By Coal For Power Plants In The Eastern 31 State Region 1983

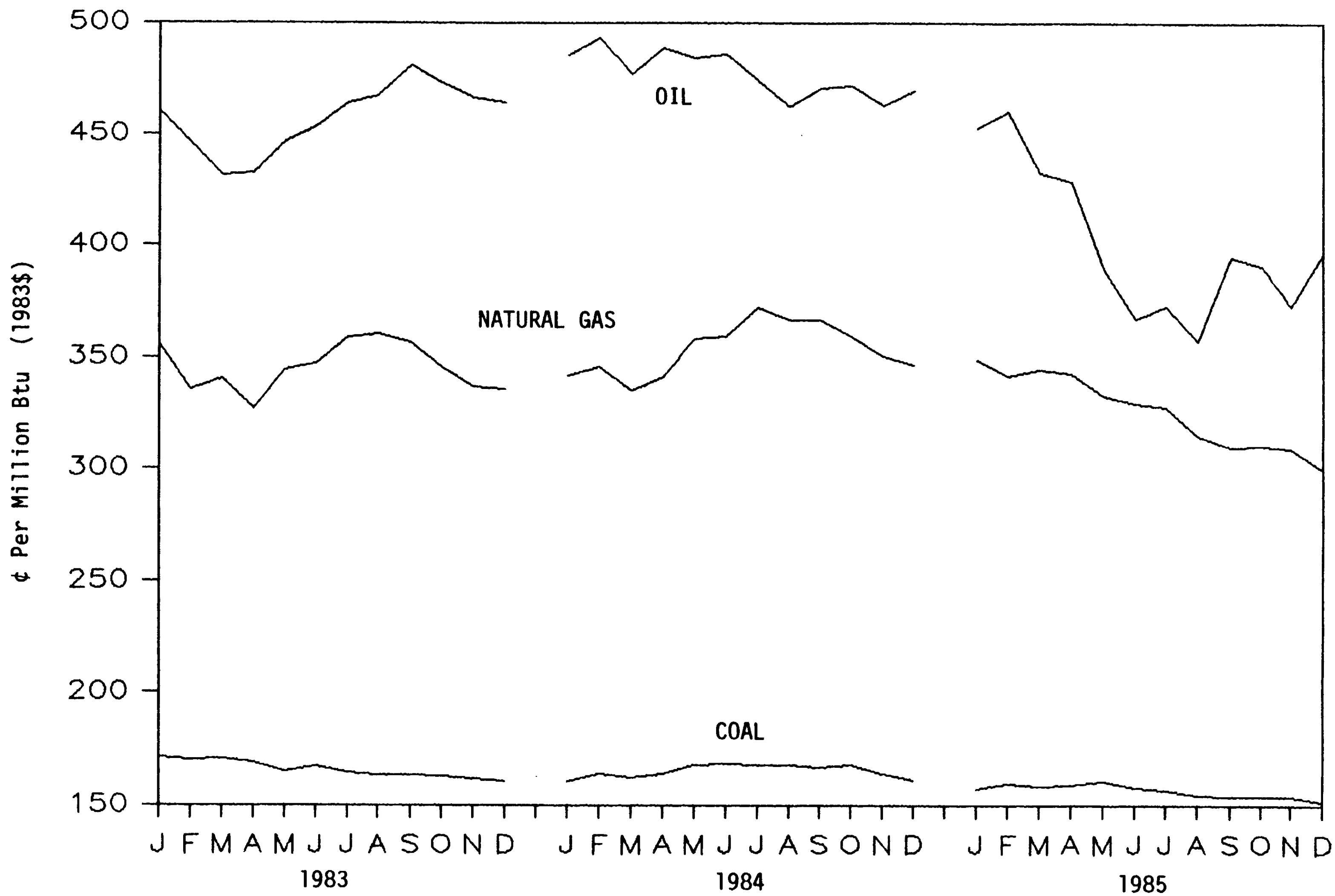

Figure 3. Average Cost Of Fuel At Electric Power Plants In The U.S.

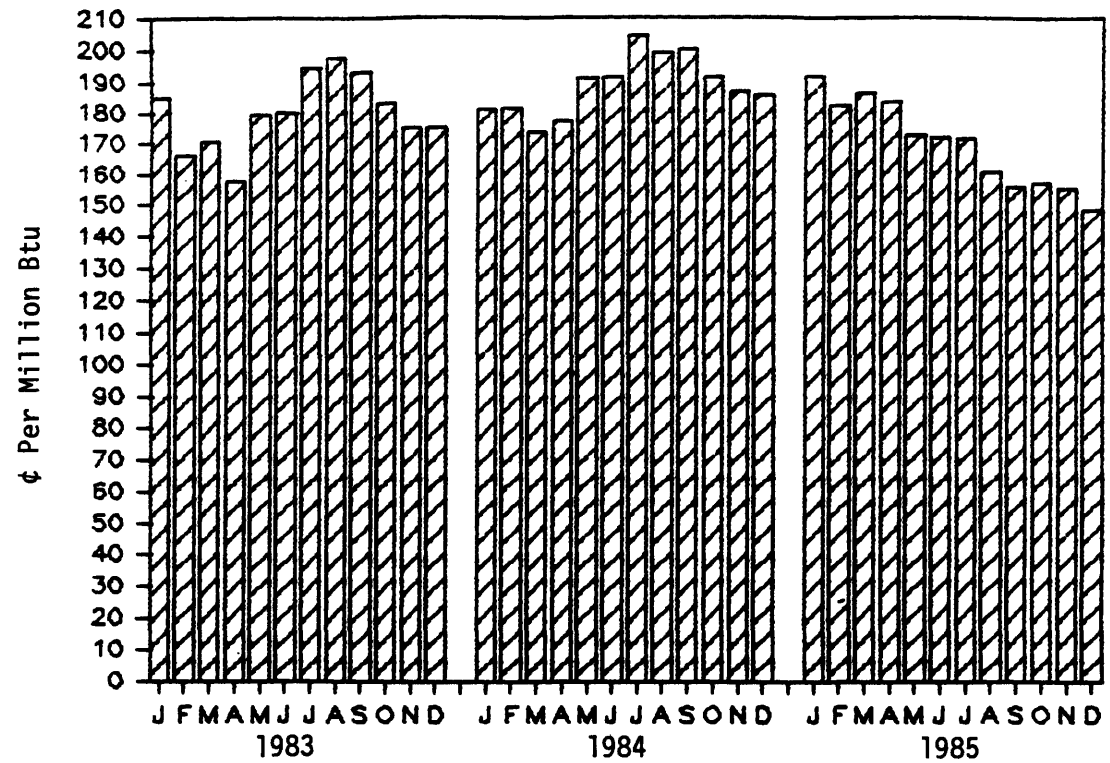

Figure 4a. Natural Gas / Coal Price Differentials

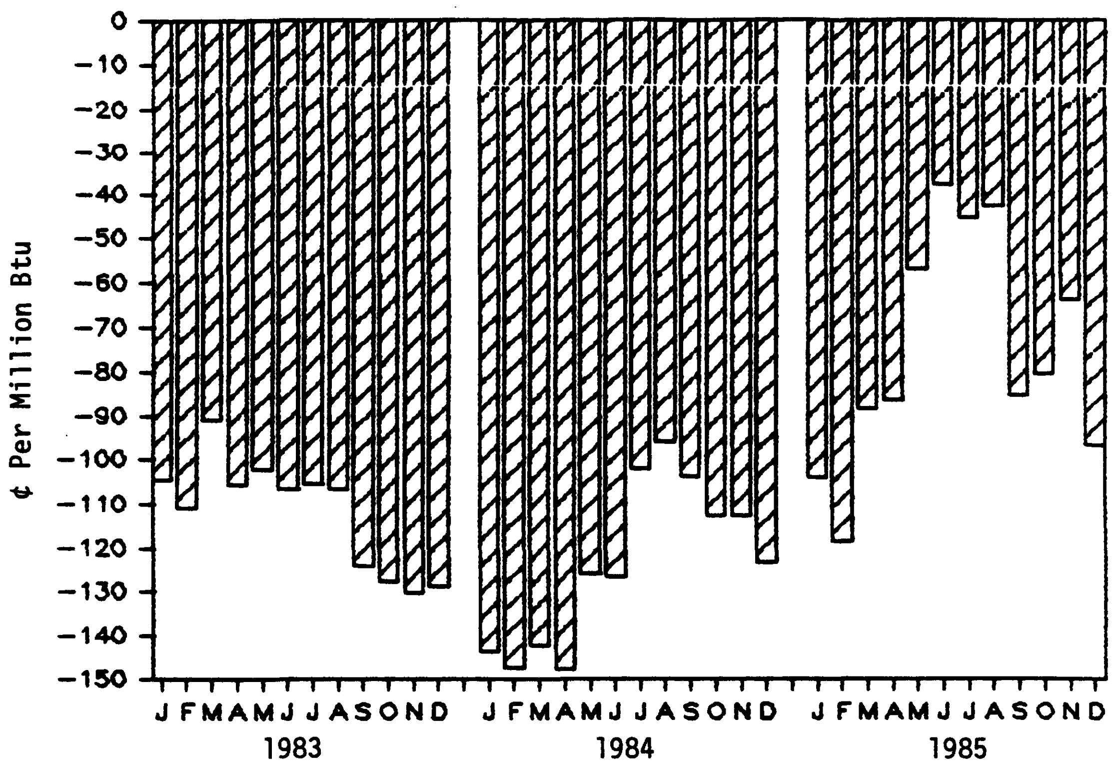

Figure 4b. Natural Gas / Oil Price Differentials

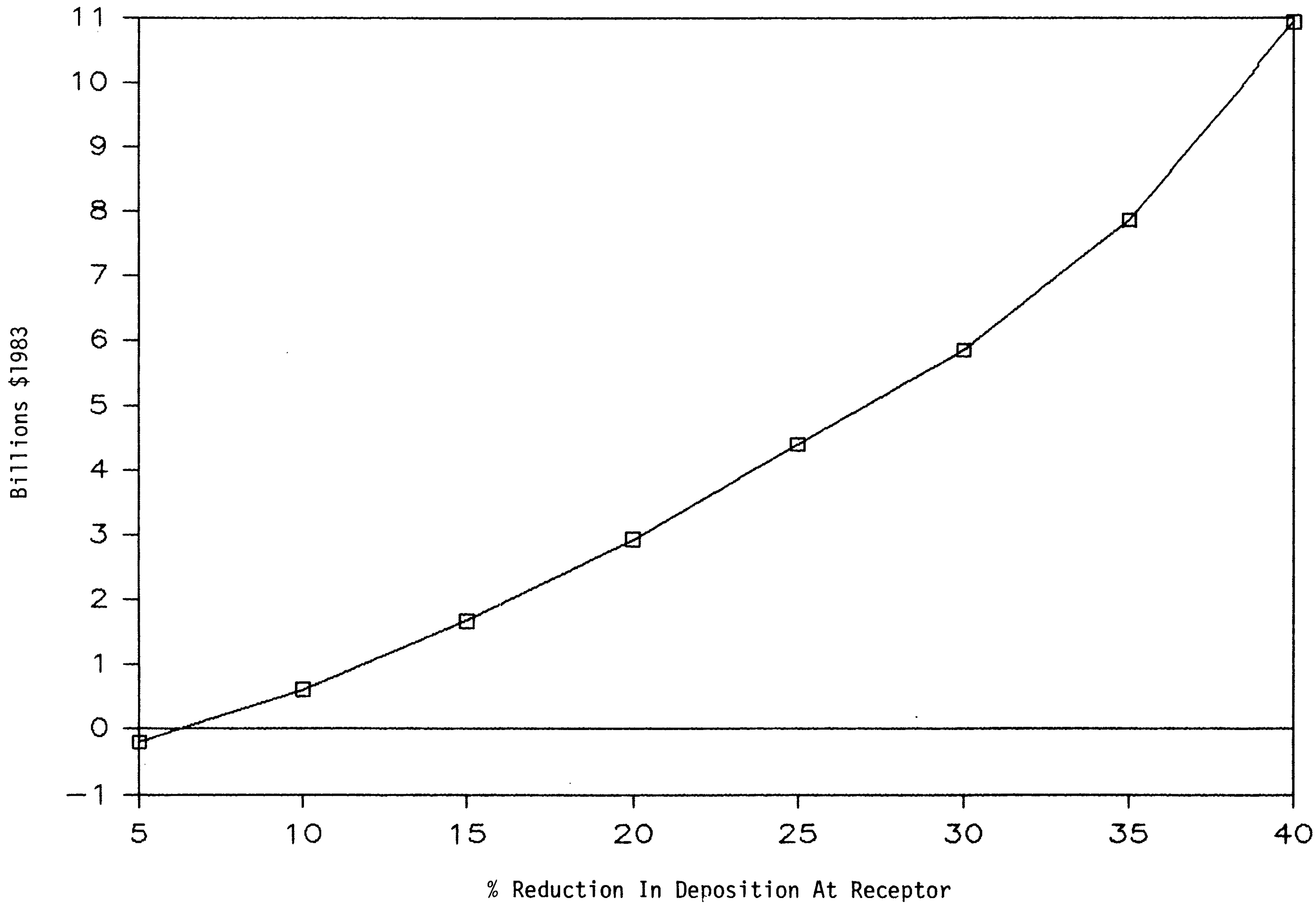

Figure 5. Total Cost Curve For Deposition Reduction With Seasonal Gas Substitution

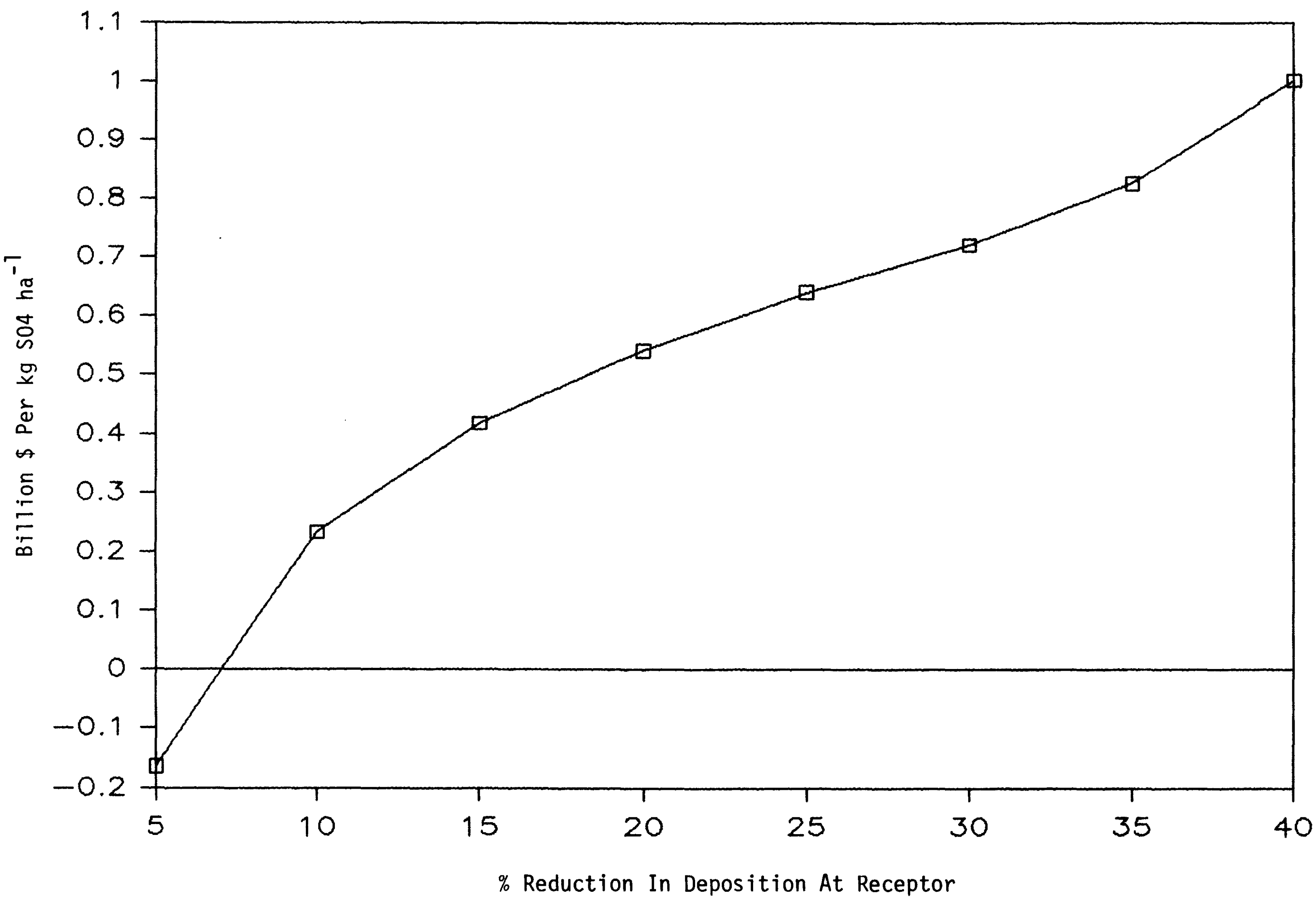

Figure 6. Average Cost Curve For Deposition Reduction With Seasonal Gas Substitution

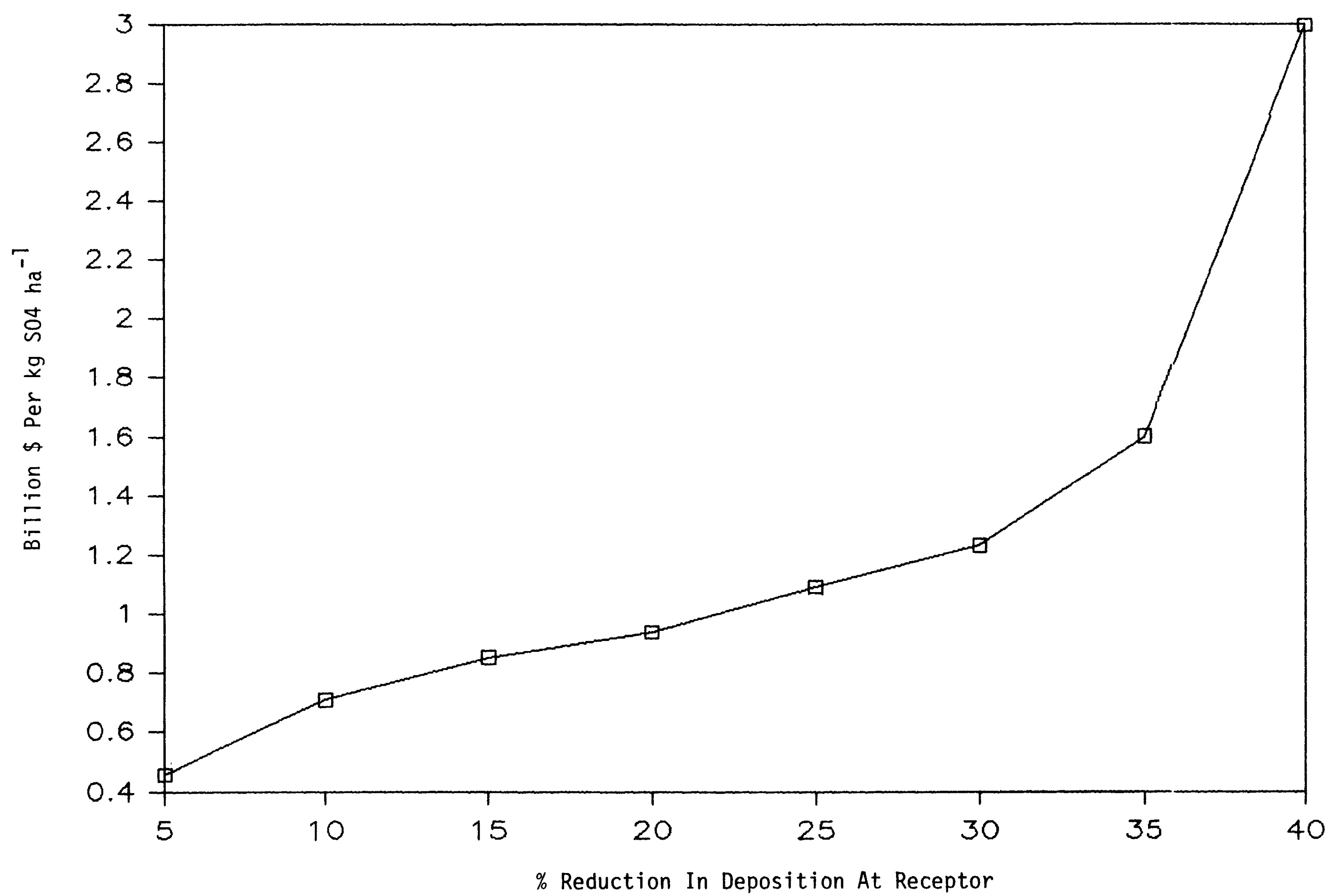

Figure 7. Marginal Cost Curve For Deposition Reduction With Seasonal Gas Substitution

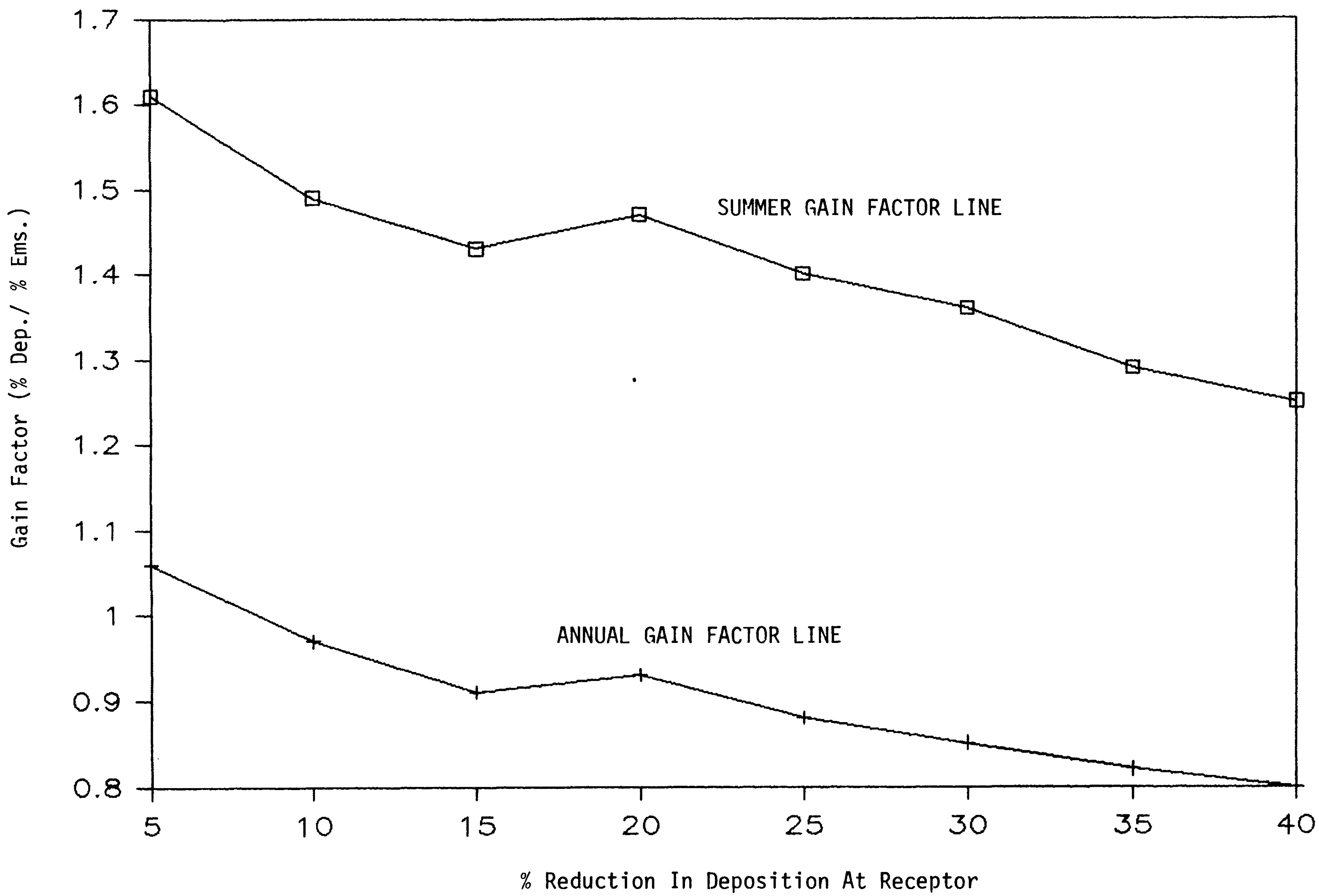

Figure 8. Gain Factors For Seasonal And Annual Gas Substitution

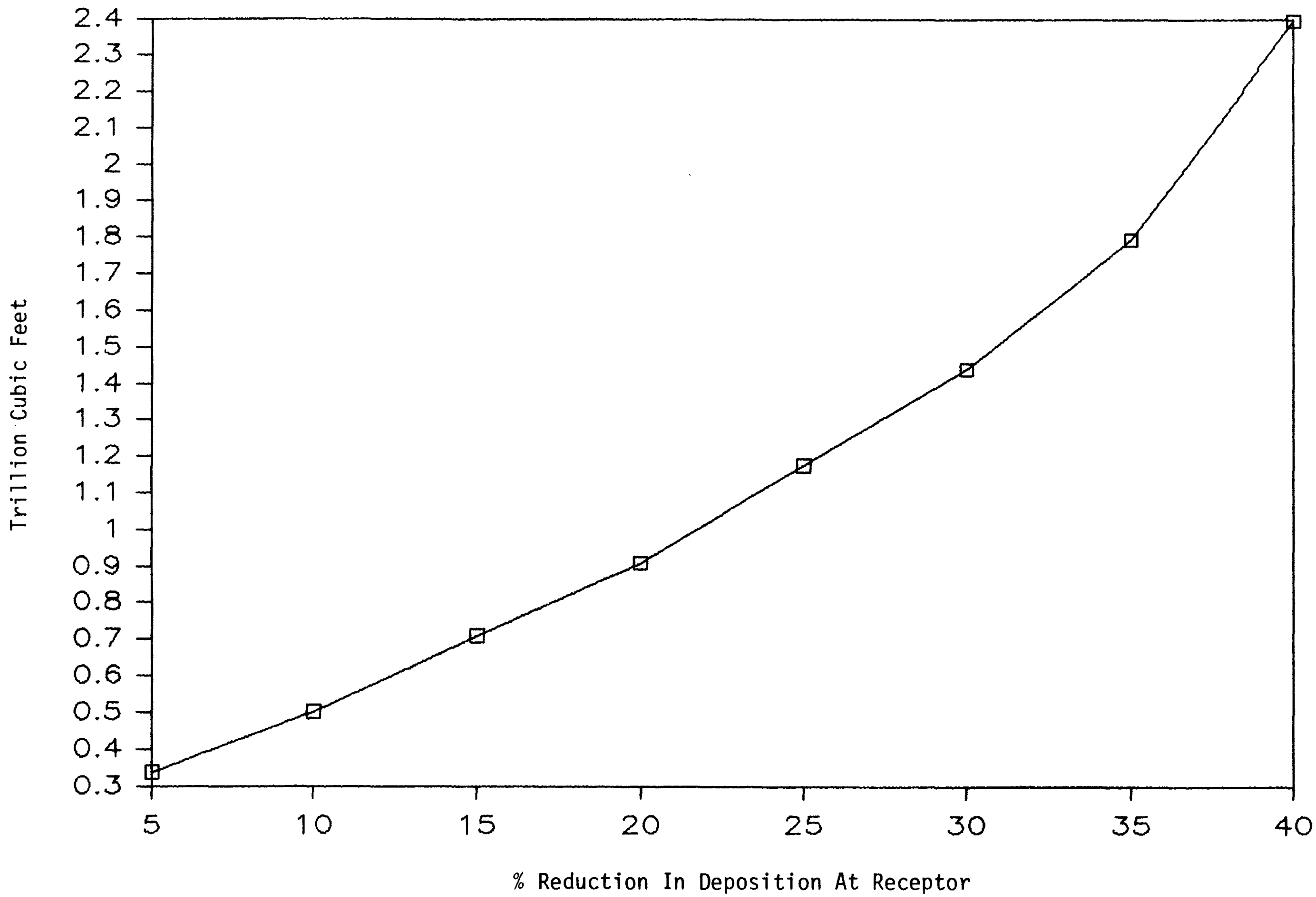

Figure 9. Natural Gas Substituted
With Seasonal Gas Substitution

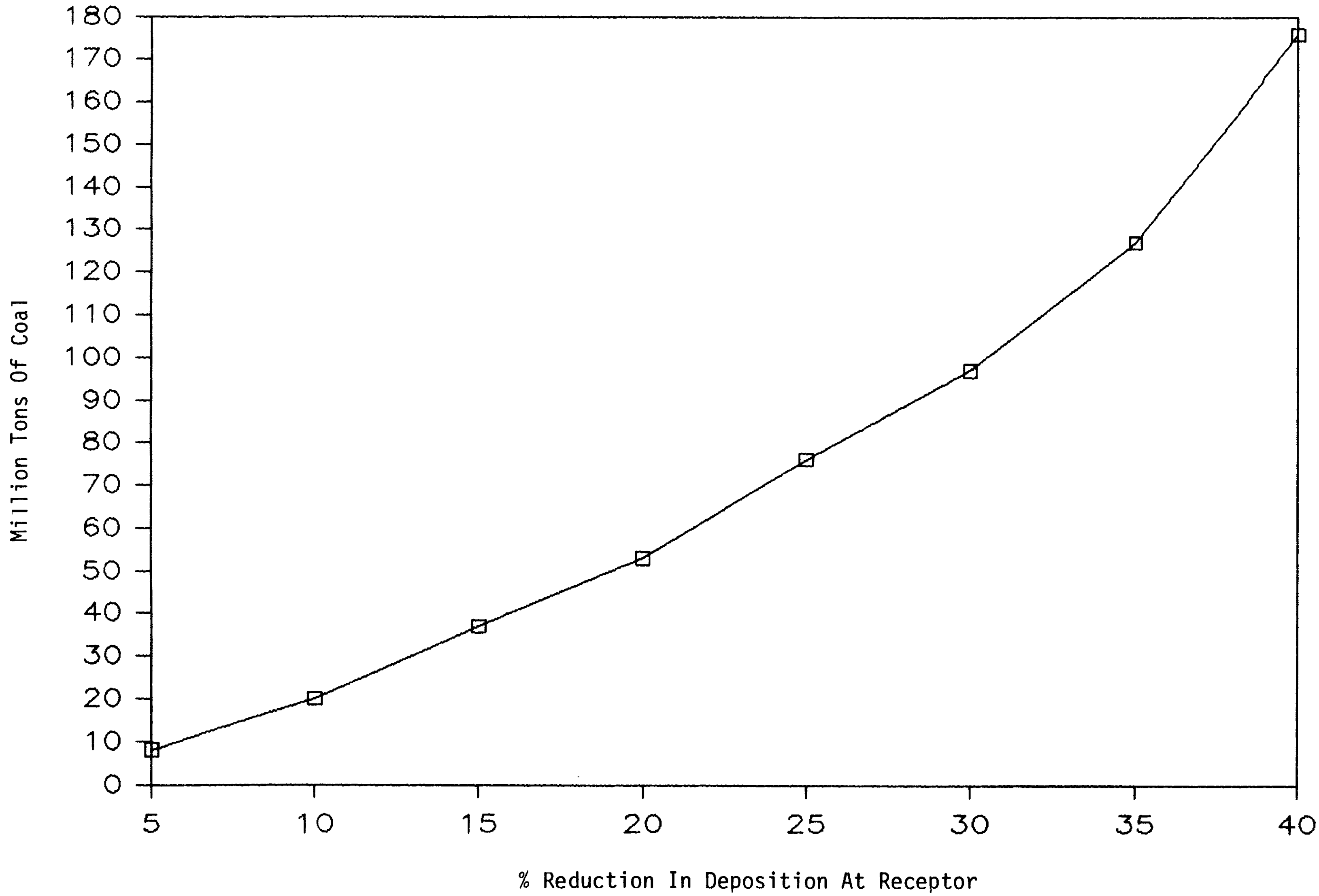

Figure 10. Coal Displaced By Seasonal Gas Substitution

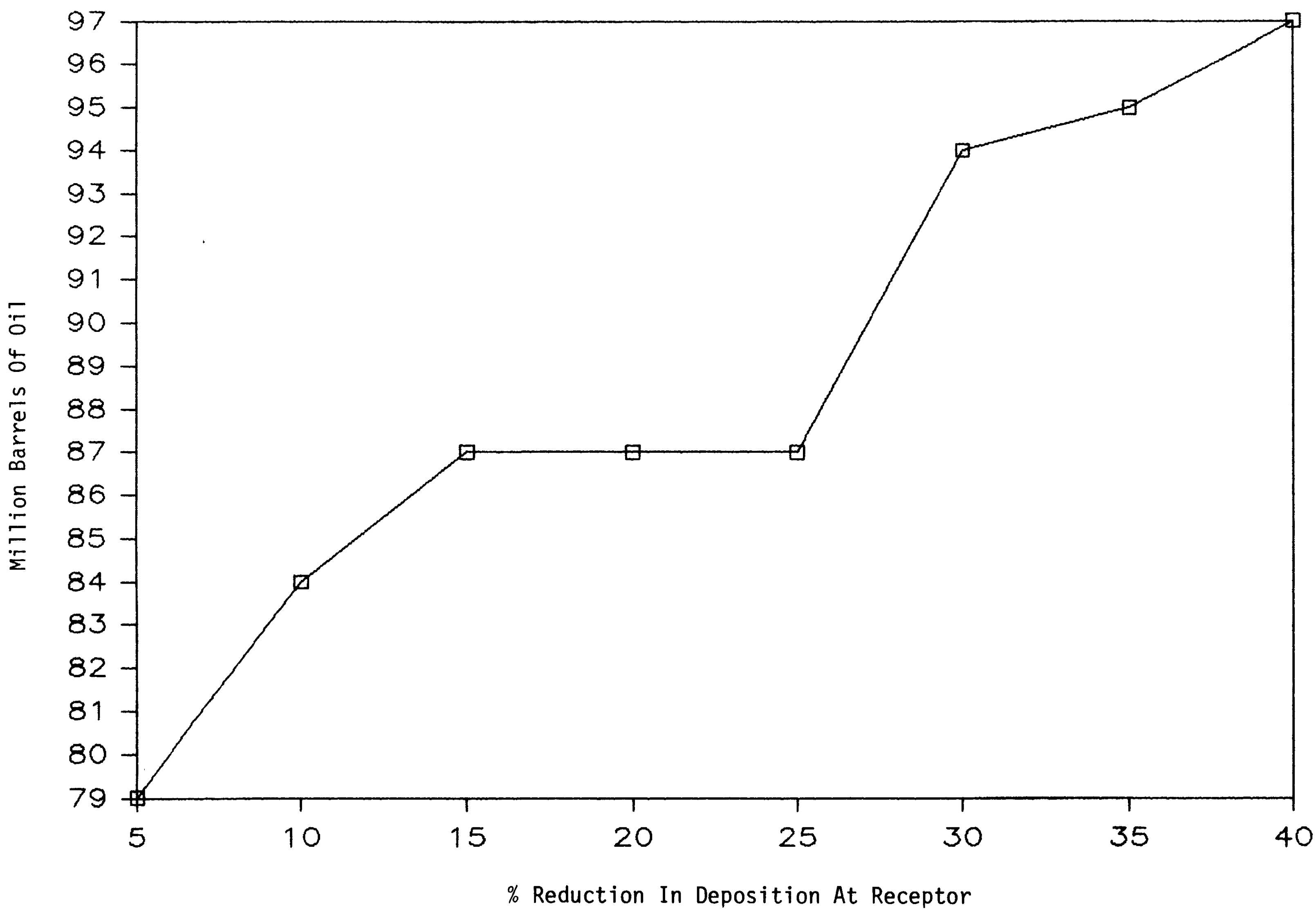

Figure 11. Oil Displaced By Seasonal Gas Substitution

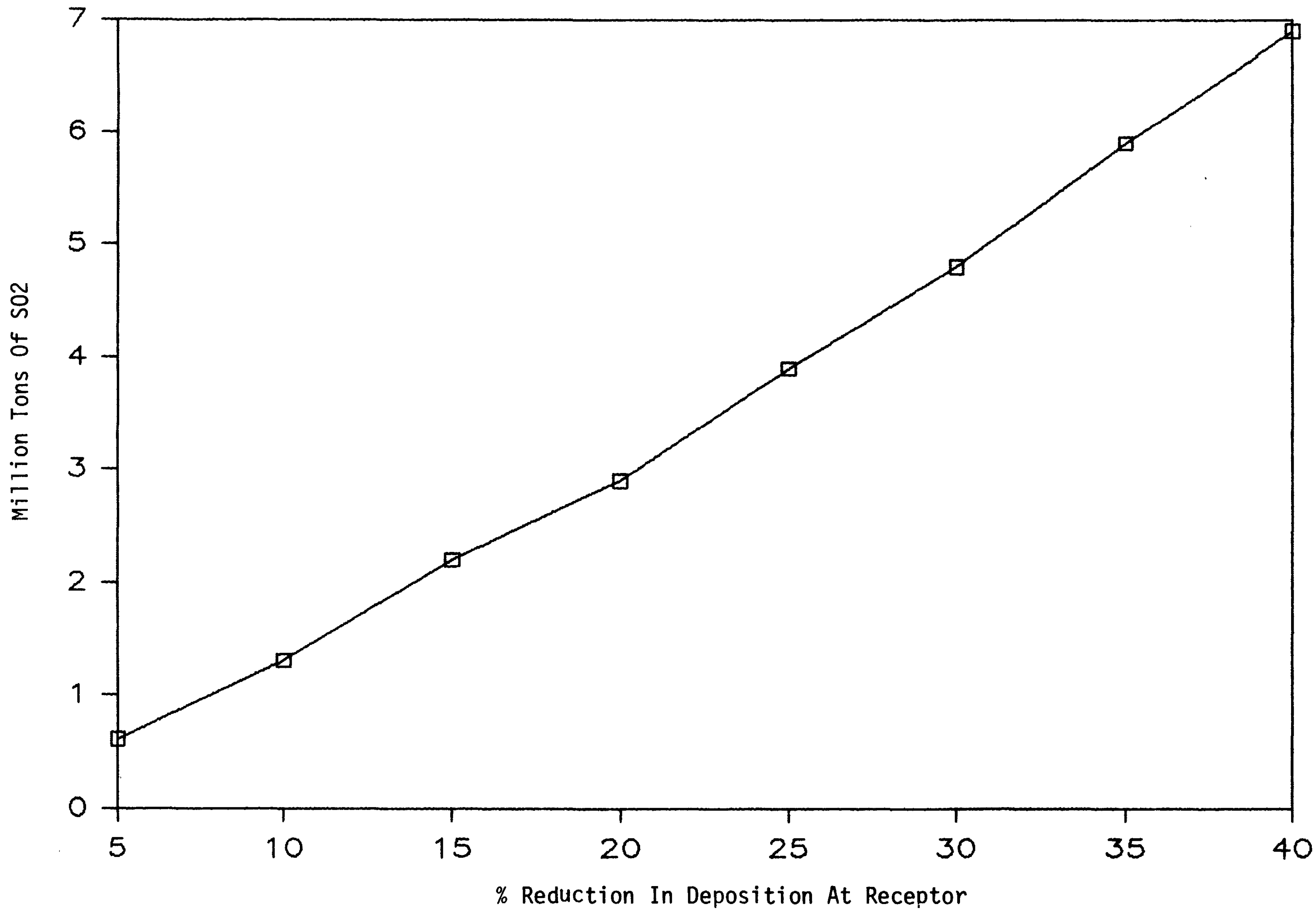

Figure 12. Reduction In SO2 Emissions With Seasonal Gas Substitution

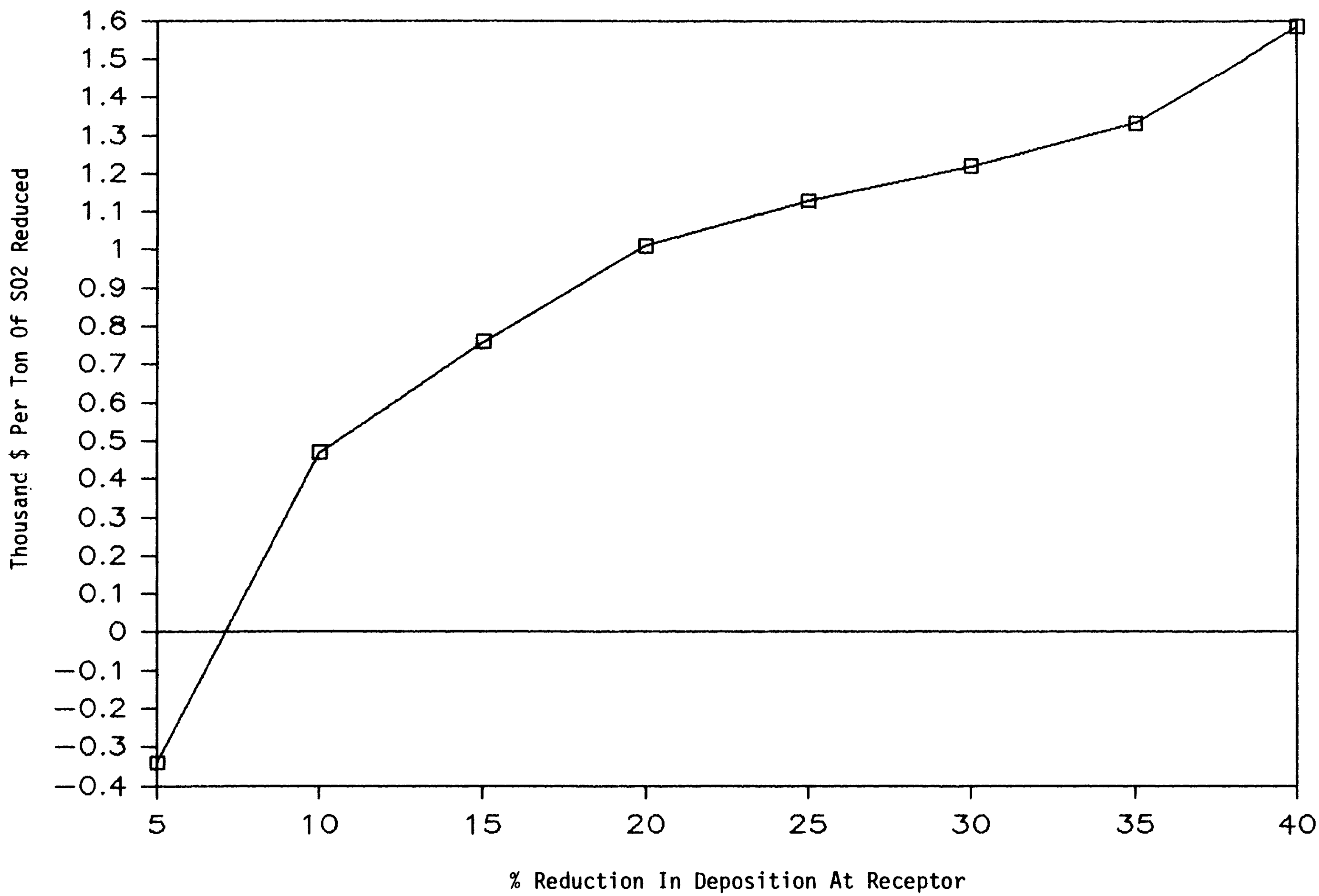

Figure 13. Average Cost Curve For SO_2 Emission Reductions With Seasonal Gas Substitution

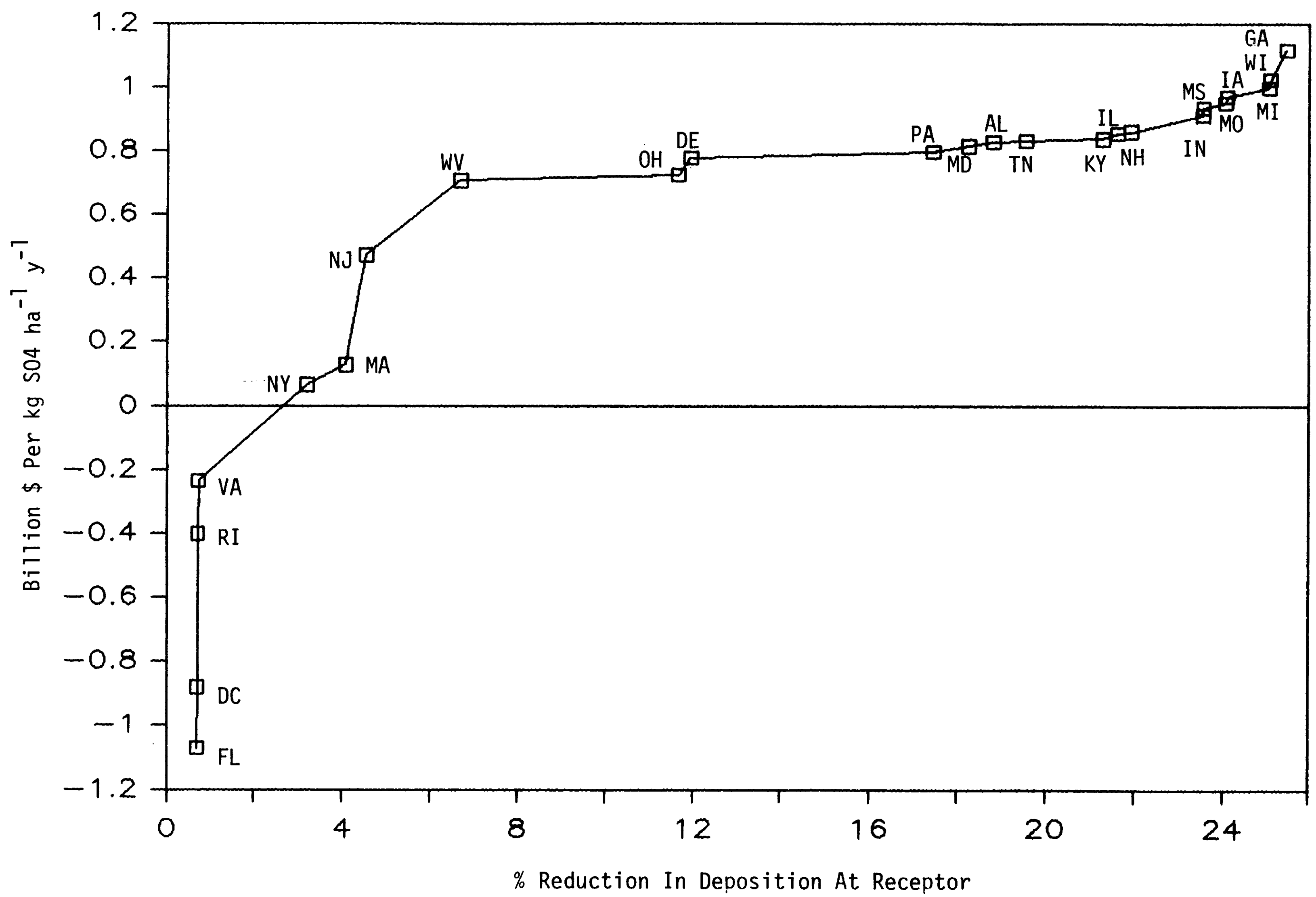

Figure 14. State-Level Average Cost vs. Cumulative Deposition Reduction For A 25% Deposition Reduction

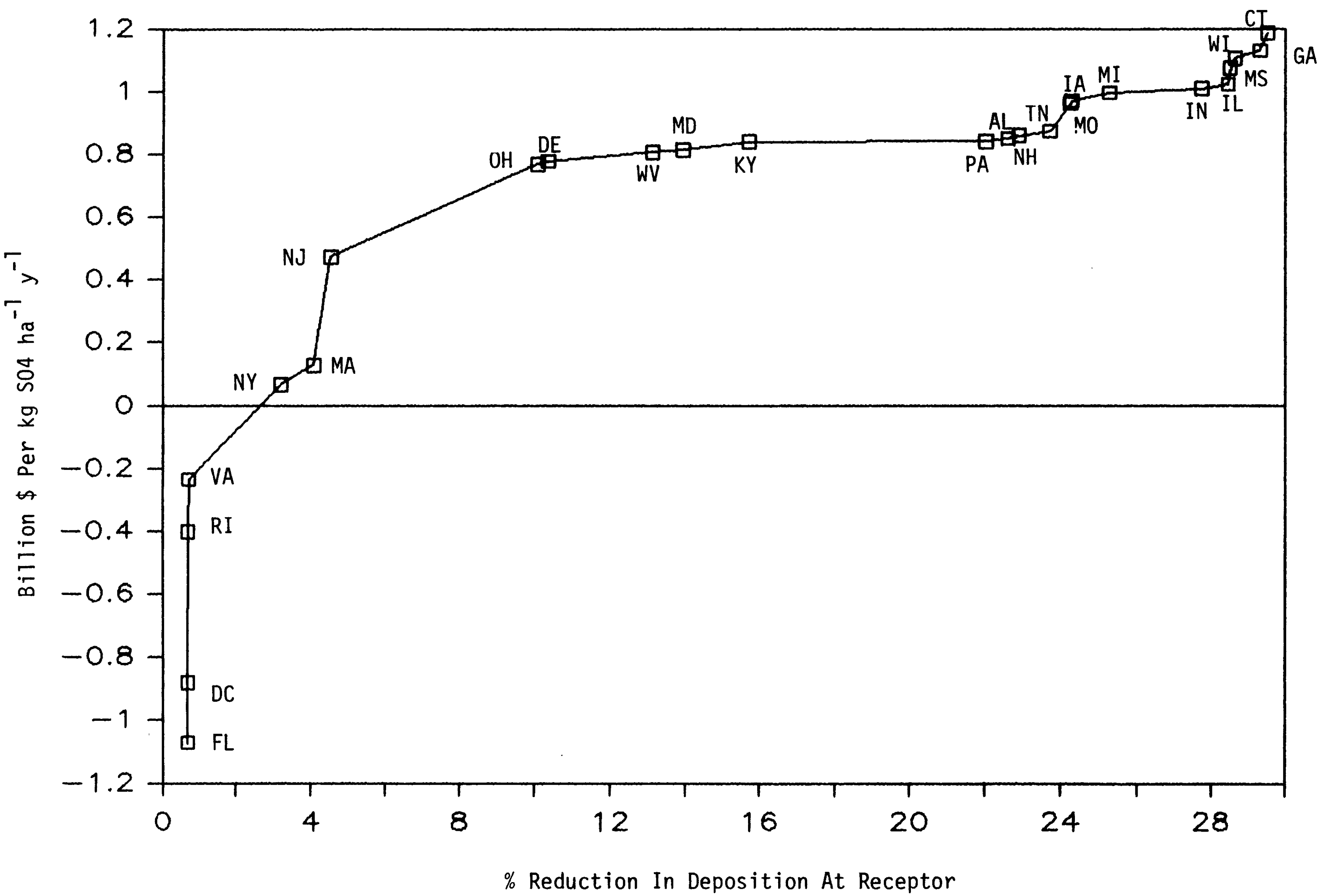

Figure 15. State-Level Average Cost vs. Cumulative Deposition Reduction For A 30% Deposition Reduction

APPENDIX A:

Data for Coal- and Oil-Fired Electric Utilities
in the 31 Eastern States and DC

Guide-
Column:

(1) Company name
(2) Plant name
(3) State where plant is located
(4) Annual coal consumption in thousands of tons
(5) Coal price $\$/10^6$ btu
(6) Coal price $/ ton
(7) Sulfur content of coal, percent by weight
(8) Coal heat content, btu per lb.
(9) Annual oil consumption, thousands of barrels
(10) Oil price $\$/10^6$ btu
(11) Oil price $/ barrel
(12) Sulfur content of oil, percent by weight

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
AL ELEC COOP	TOMBIGBEE	AL	833	1.016	43.37	1.60	11941				
AL POWER CO	GADSEN	AL	116	2.899	77.19	0.74	13313				
AL POWER CO	GORGAS 2,3	AL	5633	1.963	47.51	1.00	12101				
AL POWER CO	GREENE	AL	361	2.045	51.66	1.57	12631				
AL POWER CO	GASTON	AL	4394	2.017	48.06	1.76	11914				
AL POWER CO	JAMES MILLER	AL	1661	2.629	65.83	0.60	12520				
TENN VALLEY	WIDOWS CREEK	AL	1737	1.700	39.55	2.78	11632				
TENN VALLEY	COLBERT	AL	2356	1.967	45.57	2.37	11584				
AR POWER&LT	INDEPENDENCE	AR	3101	1.734	30.28	0.37	8731				
AR POWER&LT	WHITEBLUFF	AR	4007	1.027	32.48	0.44	8009				
SO.WEST.E PW	FLINT CREEK	AR	1686	1.419	23.70	0.36	8351				
CT L&P CO	NORWALK HARBO	CT						2951	4.455	27.84	0.96
CT L&P CO	DEVON	CT						2374	4.438	27.91	0.93
CT L&P CO	MONTVILLE	CT						1965	4.394	27.69	0.86
HARTFORD ELC	MIDDLETOWN	CT						3325	4.861	30.35	0.48
UNITED ILLUM	BRIDGEPRT HAR	CT						5034	4.504	28.43	0.91
UNITED ILLUM	NEW HAVEN HAR	CT						3942	4.514	28.34	0.91
POTOMAC E PO	BENNING	DC						485	5.414	32.50	0.89
DELMARVA P&L	DELAWARE CITY	DE						130	4.740	29.75	1.13
DELMARVA P&L	INDIAN RIVER	DE	2120	1.980	50.22	1.10	12682				
DELMARVA P&l	EDGEMOOR	DE	645	2.028	53.40	0.78	13166	2336	4.489	28.49	0.91
DOVER,CITYOF	MCKEE RUN	DE						864	4.241	26.80	2.79
FL P&L	TURKEY PT	FL						3799	4.451	28.26	0.95
FL P&L	PT EVERGLADES	FL						4652	4.113	25.86	2.17
FL P&L	MARTIN	FL						6121	4.676	29.31	0.65
FL P&L	SANFORD	FL						2003	4.130	26.20	1.36
FL P&L	MANATEE	FL						7106	4.322	27.49	0.95
FL P&L	CAPE CANAVERA	FL						3858	4.206	26.46	1.64
FL P&L	FORT MEYERS	FL						4796	4.144	26.28	1.52
FL P&L	RIVIERA	FL						1230	4.395	27.80	0.95
FL POWER COR	STOR FAC #1	FL						7129	4.030	25.58	2.13
FL POWERCORP	ANCLOTE	FL						22	6.333	36.86	0.16
FL POWERCORP	SUWANNEE	FL						65	4.609	28.58	1.43

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
FL POWERCORP	HIGGINS	FL						55	4.130	26.20	2.01
FL POWERCORP	CRYSTAL RIVER	FL	3447	2.599	64.20	1.04	12366				
FL POWERCORP	TURNER	FL						204	4.270	26.92	1.86
FL POWERCORP	BARTOW	FL						664	4.224	26.87	1.83
GAIN-ALACNTY	DEERHAVEN	FL	647	1.994	51.20	0.67	12059				
GULF POWER	CRIST	FL	1543	2.094	50.66	2.61	12096				
GULF POWER	SCHOLTZ	FL	95	2.270	56.47	2.94	12395				
GULF POWER	SMITH	FL	832	2.243	54.05	0.70	12049				
JACKSNVL EL	SOUTHSIDE	FL						627	4.121	26.42	0.90
JACKSNVL EL	NORTHSIDE	FL						718	4.228	27.94	1.67
JACKSNVL EL	KENNEDY	FL						863	4.209	27.29	0.87
LAKELAND,CTY	PLNT 3-MACINT	FL	912	2.144	50.29	2.00	11720	196	4.718	29.54	1.41
SEMINOLE EL	SEMINOLE	FL	545	2.014	50.77	2.79	12604				
TAMPA ELEC	BIG BEND	FL	3272	1.694	39.62	2.85	11694				
TAMPA ELEC	GANNON	FL	1161	2.500	65.29	1.13	13016	1493	4.370	27.84	0.95
TAMPA ELEC	HOOKERS PT	FL						538	4.367	27.78	0.99
GA POWER	HARLLEE BRANC	GA	2703	1.966	49.66	1.30	12630				
GA POWER	WANSLEY	GA	4049	1.754	39.52	2.64	11266				
GA POWER	HAMMOND	GA	1295	1.850	46.65	1.53	12600				
GA POWER	ARKWRIGHT	GA	220	1.908	47.51	1.65	12450				
GA POWER	BOWEN	GA	7525	1.815	44.00	1.91	12121				
GA POWER	ATKINSON-MCDO	GA	1367	1.777	41.41	2.48	11652				
GA POWER	SCHERER	GA	1096	2.966	77.90	0.67	13132				
GA POWER	MITCHELL	GA	400	1.940	49.89	1.32	12858				
GA POWER	YATES	GA	2406	1.895	42.74	2.42	11277				
SAVANNAH E&P	PT WENTWORTH	GA	419	1.784	46.90	1.00	13145				
SAVANNAH E&P	MCINTOSH	GA	375	1.824	47.71	0.90	13078				
EASTRN IAL&P	FAIR	IA	108	1.439	32.06	2.87	11140				
IA EL LT&POW	SUTHERLAND	IA	233	2.217	46.85	3.02	10566				
IA SO UTILS	BURLINGTON	IA	331	1.615	36.37	2.79	11260				
IA SO UTILS	OTTUMWA	IA	1012	1.420	23.96	0.32	8437				
IA-IL GAS&EL	LOUISA	IA	611	1.690	28.53	0.32	8441				
IA-IL GAS&EL	RIVERSIDE	IA	239	1.729	36.51	2.76	10558				
INTERSTATE P	LANSING	IA	790	1.932	33.20	0.57	8592				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
INTERSTATE P	DUBUQUE	IA	160	1.656	34.90	2.50	10537				
INTERSTATE P	KAPP	IA	435	1.712	36.04	2.36	10526				
IOWA POW&LT	DES MOINES	IA	29	1.467	24.80	0.72	8453				
IOWA POW&LT	COUNCIL BLUFF	IA	2483	1.237	20.69	0.35	8363				
IOWA PUB SER	GEO. NEAL 1-4	IA	2891	1.594	29.19	0.51	9156				
MUSCATINE P&	MUSCATINE	IA	487	1.800	41.63	3.23	11564				
IA EL LT&POW	PRAIRIE CREEK	IA	397	2.896	61.83	1.65	10675				
CENT IL LT	WALLACE	IL	115	2.073	55.16	0.68	13304				
CENT IL LT	DUCK CREEK	IL	587	2.219	46.88	3.37	10563				
CENT IL LT	EDWARDS	IL	1185	2.024	50.04	0.88	12362				
CENT IL PUBS	NEWTON	IL	1522	1.903	44.11	2.22	11590				
CENT IL PUBS	GRAND TOWER	IL	487	1.441	32.81	2.91	11384				
CENT IL PUBS	COFTEEN	IL	1891	1.529	31.45	3.86	10284				
CENT IL PUBS	HUTSONVILLE	IL	422	1.410	31.82	2.72	11220				
CENT IL PUBS	MEREDOSIA	IL	519	1.784	40.23	2.83	11275				
COMMONWTH ED	WAUKEGAN	IL	1522	3.137	59.87	0.56	9543				
COMMONWTH ED	WILL COUNTY	IL	1968	3.195	60.61	0.56	9485				
COMMONWTH ED	KINCAID	IL	3228	1.510	30.84	3.43	10212				
COMMONWTH ED	CRAWFORD	IL	947	3.183	60.46	0.54	9497				
COMMONWTH ED	COLLINS	IL						4299	6.196	39.32	0.69
COMMONWTH ED	JOLIET	IL	1660	3.318	63.44	0.56	9560				
COMMONWTH ED	FISK	IL	412	3.250	61.86	0.54	9517				
COMMONWTH ED	POWERTON	IL	4180	2.632	49.18	0.50	9343				
ELEC ENERGY	JOPPA	IL	2170	1.648	38.79	1.90	11769				
IL POWER	BALDWIN	IL	4886	1.358	29.06	2.80	10700				
IL POWER	WOOD RIVER	IL	359	2.515	54.07	0.55	10750				
IL POWER	HAVANA	IL	290	2.680	57.81	0.49	10785				
IL POWER	HENNEPIN	IL	946	1.483	32.40	2.84	10924				
IL POWER	VERMILION	IL	609	1.151	24.44	2.10	10617				
SO.ILL POW.C	MARION	IL	523	1.038	21.47	2.80	10342				
SPRNGFLD W,L	DALLMAN	IL	695	1.823	38.18	2.78	10472				
SPRNGFLD W,L	LAKESIDE	IL	84	1.825	40.08	2.90	10981				
COMMON ED-IN	STATE LINE	IN	1063	2.635	50.18	0.39	9522				
HOOSIER ENER	MEROM	IN	1158	1.485	32.96	2.74	11098				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
HOOSIER ENER	FRANK E RATTS	IN	616	1.157	24.83	2.86	10730				
IND & MICH	TANNERS CREEK	IN	1614	1.682	39.04	3.14	11605				
IND & MICH	BREED	IN	805	1.376	30.57	4.07	11108				
IND-KY EL CO	CLIFTY CREEK	IN	3940	1.283	29.41	3.21	11461				
INDNPLIS P&L	PRITCHARD	IN	493	1.459	32.67	2.45	11196				
INDNPLIS P&L	PETERSBURG	IN	3341	1.253	27.60	2.14	11014				
INDNPLIS P&L	STOUT	IN	1441	1.478	32.79	2.08	11093				
N. IND PS	MICHIGAN CTY	IN	081	2.040	43.33	2.59	10620				
N. IND PS	BAILLY	IN	708	1.928	41.94	2.95	10877				
N. IND PS	ROLLIN SCHAHF	IN	1945	2.780	61.89	1.05	11131				
N. IND PS	MITCHELL	IN	425	3.450	76.32	0.57	11061				
PS CO INDIAN	CAYUGA	IN	2457	1.323	27.50	2.43	10393				
PS CO INDIAN	EDWARDSPORT	IN	138	1.079	23.67	2.43	10968				
PS CO INDIAN	GALLAGHER	IN	1108	1.191	26.03	3.09	10928				
PS CO INDIAN	GIBSON STATIO	IN	6004	1.412	30.34	2.26	10744				
PS CO INDIAN	WABASH RIVER	IN	923	1.441	31.58	2.21	10958				
RICHMND P&LT	WHITEWATER	IN	162	2.068	46.20	2.09	11170				
SO.IND.G&EL	CULLEY	IN	1016	1.283	28.17	2.90	10978				
SO.IND.G&EL	A B BROWN	IN	545	1.916	43.88	3.77	11451				
SO.IND.G&EL	WARRICK	IN	337	1.266	27.53	3.28	10873				
BIG RIV REC	COLEMAN	KY	1479	1.566	35.56	1.99	11354				
BIG RIV REC	RD GREEN	KY	1733	1.162	24.38	3.48	10491				
BIG RIV REC	REID-HENDERSO	KY	877	1.265	29.48	2.27	11652				
CINCIN G&E C	EAST BEND	KY	1667	1.480	33.53	3.17	11328				
EAST KY REC	DALE	KY	153	1.190	28.55	0.86	11996				
EAST KY REC	COOPER	KY	504	1.208	29.58	1.68	12243				
EAST KY REC	SPURLOCK	KY	1024	1.790	42.95	1.18	11997				
HENDERSON MP	HENDERSON	KY	152	1.437	31.62	2.49	11002				
KENTUCKY POW	BIG SANDY	KY	2336	1.575	38.09	1.09	12092				
KENTUCKY UTI	GHENT	KY	2471	1.960	47.28	1.78	12061				
KENTUCKY UTI	GREEN RIVER	KY	365	1.329	30.51	2.04	11479				
KENTUCKY UTI	TYRONE	KY	16	1.607	41.26	1.00	12838				
KENTUCKY UTI	BROWN	KY	1130	1.353	32.37	1.92	11962				
LOUISVLL G&E	MILL CREEK	KY	2435	1.344	29.47	3.52	10964				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
LOUISVLL G&E	CANE RUN	KY	577	1.340	29.54	3.45	11022				
OWENSBORO MU	SMITH	KY	800	1.609	34.67	2.91	10774				
TENN VALLEY	SHAWNEE	KY	2598	2.162	53.78	1.28	12438				
TENN VALLEY	PARADISE	KY	3985	1.161	25.19	4.12	10848				
CAJUN EPC	BIG CAJUN NO2	LA	1807	2.399	39.21	0.43	8172				
CENT LA ELEC	RODEMACHER	LA	616	2.180	38.79	0.45	8897				
GULF STS UTI	NELSON	LA	1203	2.165	38.44	0.44	8878				
BOS EDISON	MYSTIC	MA						3688	4.197	26.22	1.60
BOS EDISON	NEW BOSTON	MA						6544	4.448	27.79	0.93
CAMBRI ELC	KENDALL SQ	MA						144	4.783	30.00	0.50
CANAL EL CO	CANAL	MA						7587	4.169	26.19	2.17
HOLYOKE WTRP	MT TOM	MA	384	2.119	55.57	1.40	13112				
MONTAUP ELEC	SOMERSET	MA	402	2.077	58.37	0.79	14052	587	4.264	27.00	1.00
NEW ENG POW	SALEM HARBOR	MA	644	2.444	65.16	1.33	13331	3050	4.054	25.50	2.09
NEW ENG POW	BRAYTON	MA	1807	2.253	59.29	1.20	13150	3581	4.134	25.97	2.10
TAUNTON MUN	CLEARY	MA						208	4.528	28.59	2.01
W. MASS ELEC	W.SPRINGFIELD	MA						604	4.531	28.63	1.27
BALT G&E	WESTPORT	MD						100	4.612	29.20	0.94
BALT G&E	RIVERSIDE	MD						531	4.531	28.62	0.95
BALT G&E	CRANE	MD	540	1.680	44.90	2.09	13300				
BALT G&E	WAGNER	MD	600	2.012	52.53	0.85	13054	1481	4.541	28.50	0.96
BALT G&E	GOULD ST	MD						253	4.404	28.22	0.96
DELMARVA P&L	VIENNA	MD						565	4.215	26.81	1.05
POTOMAC E PO	CHALK	MD	1427	1.740	43.05	1.71	12543	1227	5.058	31.30	0.91
POTOMAC E PO	MORGANTOWN	MD	2056	1.731	43.32	1.72	12513				
POTOMAC E PO	DICKERSON	MD	1265	1.665	42.02	1.62	12619				
POTOMAC ED C	SMITH	MD	192	1.733	43.96	0.91	12683				
CENT ME POW	WYMAN	ME						3306	4.670	29.35	1.05
CONSUMERS PO	CAMPBELL	MI	2734	2.002	48.45	1.42	12100				
CONSUMERS PO	WHITING	MI	756	1.687	41.56	0.81	12318				
CONSUMERS PO	KARN-WEADOCK	MI	1910	2.046	50.40	0.82	12336				
CONSUMERS PO	COBB-SANDUSKY	MI	662	1.739	41.89	2.31	12044				
DETROIT EDCO	CONNERS CREEK	MI	132	2.238	55.26	0.87	12346				
DETROIT EDCO	MONROE	MI	7440	1.675	40.88	2.21	12203				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
DETROIT EDCO	RIVER ROUGE	MI	1025	2.049	49.21	0.76	12000				
DETROIT EDCO	TRENTON CHANN	MI	1000	2.292	59.67	0.79	13017				
DETROIT EDCO	HARBOR BEACH	MI	38	2.304	55.58	0.82	12062				
DETROIT EDCO	ST CLAIR	MI	4190	1.890	37.41	0.62	9897				
DETROIT EDCO	MARYSVILLE	MI	182	2.288	57.31	0.86	12524				
DETRT PUBLTC	MISTERSKY	MI						337	4.481	27.90	0.84
GRHAVEN L&P	J B SIMMS	MI	120	1.760	38.94	2.92	11012				
HOLLAND BD	JAMES DE YOUN	MI	135	1.846	46.92	1.17	12709				
LANSING W&LT	OTTAWA	MI	24	2.136	56.54	0.89	13235				
LANSING W&LT	ERICKSON	MI	380	2.260	58.87	0.72	12978				
LANSING W&LT	ECKERT	MI	435	2.306	59.76	0.72	12958				
MARQUETTE L&	SHIRAS	MI	150	2.065	40.52	0.58	9811				
UPPER PEN GE	PRESQUE ISLE	MI	1006	2.152	41.01	0.56	9528				
INTERSTATE P	FOX LAKE	MN	45	2.290	39.83	0.68	8697				
MINN. P&LT	BOSWELL	MN	2546	1.209	20.90	0.80	8644				
NORTH STS PO	RIVERSIDE	MN	503	1.439	27.38	1.27	9514				
NORTH STS PO	BLACK DOG	MN	203	1.690	31.09	1.34	9198				
NORTH STS PO	KING	MN	1212	1.571	28.71	0.96	9137				
NORTH STS PO	SHERBURNE CNT	MN	4598	1.323	23.27	0.69	8794				
OTTER TAIL P	HOOT LAKE	MN	221	1.626	22.50	0.86	6919				
ROCH DPT PU	SILVER LAKE	MN	202	2.014	49.57	1.86	12306				
AS ELEC COOP	HILL	MO	3101	1.570	31.96	4.22	10170				
AS ELEC COOP	MADRID	MO	2331	1.486	32.00	3.17	10767				
CENT ELPOWCO	CHAMOIS	MO	8	1.162	24.04	3.59	10344				
COLUMBIA W&L	COLUMBIA	MO	67	1.644	34.93	4.13	10623				
EMPIRE DISEL	ASBURY	MO	625	1.121	23.78	5.41	10607				
INDEPNDNCE P	BLUE VALLEY	MO	170	1.518	36.26	3.49	11943				
KANS CTY P&L	IATAN	MO	2346	1.286	22.71	0.33	8830				
KANS CTY P&L	MONTROSE	MO	1075	1.576	33.27	5.18	10555				
KANS CTY P&L	GRAND AVE	MO	41	1.789	44.06	4.07	12314				
KANS CTY P&L	HAWTHORNE	MO	557	1.775	37.95	1.66	10688				
MISSOURI PS	SIBLEY	MO	755	1.799	39.18	3.24	10889				
SIKESTON MUN	SIKESTON	MO	667	1.826	41.51	2.60	11366				
SPRNGFLD UTI	JAMES RIVER	MO	379	1.495	36.53	3.92	12217				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
SPRNGFLD UTI	SOOUTHWEST	MO	150	1.770	42.78	3.90	12085				
ST JOE LT&PW	LAKEROAD	MO	101	1.450	36.53	4.69	12597				
UNION ELEC	MERAMEC	MO	811	1.825	43.07	1.25	11800				
UNION ELEC	SIOUX	MO	2004	1.474	32.14	2.76	10902				
UNION ELEC	RUSH ISLAND	MO	2663	1.385	29.47	0.99	10639				
UNION ELEC	LABADIE	MO	5309	1.431	32.40	2.41	11321				
UNION ELEC	ASHLEY	MO						285	4.192	26.54	1.75
MISS. POW	JCKSN CT-DANI	MS	1560	3.054	72.34	0.58	11843				
MISS. POW	WATSON	MS	1065	1.961	48.51	2.54	12369				
S MISS EL PO	R D MORROW	MS	970	2.204	54.43	0.99	12348				
CAROLINA P&L	MAYO	NC	1680	1.970	48.61	0.65	12338				
CAROLINA P&L	ASHEVILLE	NC	941	1.622	42.13	0.97	12987				
CAROLINA P&L	SUTTON	NC	704	1.927	47.03	0.84	12203				
CAROLINA P&L	CAPE FEAR	NC	396	1.770	43.59	1.16	12314				
CAROLINA P&L	ROXBORO	NC	5333	1.906	47.35	0.81	12421				
CAROLINA P&L	WEATHERSPOON	NC	162	1.762	43.53	1.12	12352				
CAROLINA P&L	LEE	NC	566	1.794	44.54	1.11	12414				
DUKE POWER	RIVERBEND	NC	140	1.792	45.29	1.01	12637				
DUKE POWER	ALLEN	NC	1210	1.976	49.23	0.92	12457				
DUKE POWER	BELEWS CREEK	NC	4835	1.849	46.04	0.95	12450				
DUKE POWER	BUCK	NC	87	1.570	38.27	0.87	12188				
DUKE POWER	MARSHALL	NC	3516	2.039	50.60	0.93	12408				
DUKE POWER	CLIFFSIDE	NC	912	1.613	40.56	1.04	12573				
DUKE POWER	DAN RIVER	NC	23	1.463	36.14	0.92	12351				
PS CO N.HAMP	NEWINGTON ST	NH						2402	4.185	26.52	1.93
PS CO N.HAMP	MERRIMACK	NH	1016	1.938	52.50	2.52	13545				
PS CO N.HAMP	SCHILLER	NH						264	4.302	27.27	1.80
ATLTC C ELEC	ENGLAND	NJ	730	1.767	45.60	2.93	12903	1515	4.479	28.22	1.74
DEEPWTR OPCO	DEEPWATER	NJ	170	1.904	49.89	0.78	13101	663	4.425	27.92	0.94
JERSEY C P&L	WERNER	NJ						285	5.010	30.87	0.28
JERSEY C P&L	GILBERT	NJ						149	4.269	27.07	0.93
PS E&G-NJ	HUDSON	NJ	836	1.924	50.75	1.01	13189	131	4.956	30.81	0.26
PS E&G-NJ	LINDEN	NJ						2237	4.905	30.70	0.28
PS E&G-NJ	BURLINGTON	NJ						1119	4.669	29.17	0.44

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
PS E&G-NJ	SEWAREN	NJ						293	4.942	30.45	0.27
PS E&G-NJ	MERCER	NJ	1222	2.130	57.37	1.03	13467				
PS E&G-NJ	KEARNY	NJ						777	4.912	30.17	0.27
CENT HUD G&E	ROSETON	NY						9504	4.261	26.90	1.00
CENT HUD G&E	DANSKAMMER	NY						3226	4.543	28.40	0.94
CONS EDCO NY	STOR FAC #3	NY						1015	4.865	29.91	0.27
CONS EDCO NY	HUDSON AVE	NY						5659	4.826	29.65	0.27
CONS EDCO NY	ASTORIA	NY						2104	4.806	29.55	0.28
CONS EDCO NY	STOR FAC #1	NY						2500	4.909	30.18	0.31
CONS EDCO NY	STOR FAC #2	NY						1326	4.924	30.15	0.24
CONS EDCO NY	STOR FAC #4	NY						3077	4.805	29.50	0.30
CONS EDCO NY	59TH ST	NY						103	4.817	29.60	0.29
CONS EDCO NY	EAST RIVER	NY						679	4.964	30.40	0.27
CONS EDCO NY	STOR FAC #6	NY						3116	4.812	29.74	0.30
CONS EDCO NY	STOR FAC #5	NY						2721	4.779	29.51	0.35
JMSTWN BD PU	S.A CARLSON	NY	124	1.459	37.36	2.04	12803				
LONG ISLND L	PT JEFFERSON	NY						3123	4.102	26.04	2.43
LONG ISLND L	BARRETT	NY						499	4.787	29.0	0.73
LONG ISLND L	GLENWOOD	NY						102	4.697	29.33	0.63
LONG ISLND L	NORTHPORT	NY						10515	4.140	26.33	2.15
NIAG-MOHAWK	HUNTLEY	NY	1014	1.979	51.45	1.55	12999				
NIAG-MOHAWK	OSWEGO	NY						4207	5.105	31.70	1.65
NIAG-MOHAWK	DUNKIK	NY	1132	1.769	45.01	2.15	12722				
NY ST E&GAS	GREENIDGE	NY	602	1.564	38.67	1.93	12363				
NY ST E&GAS	GOUDEY	NY	334	1.572	38.11	1.91	12122				
NY ST E&GAS	JENNISON	NY	204	1.668	37.56	0.94	11259				
NY ST E&GAS	HICKLING	NY	332	1.470	33.23	1.09	11303				
NY ST E&GAS	SOMERSET	NY	34	1.656	43.51	2.74	13137				
NY ST E&GAS	MILLIKEN	NY	930	1.822	43.00	1.75	11800				
ORNGE&RCKLND	BOWLINE	NY						5040	4.753	29.34	0.42
ORNGE&RCKLND	LOVETT	NY						316	4.745	29.28	0.35
POW AU NY ST	POLETTI	NY						3175	4.921	30.22	0.26
ROCH G&E COR	ROCHESTER 3	NY	199	1.796	46.99	2.08	13082	229	3.943	24.91	1.69
ROCH G&E COR	ROCHESTER 7	NY	632	1.779	45.69	2.28	12841				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
CARDINAL OC	CARDINAL	OH	4128	1.675	38.99	2.13	11639				
CINCIN G&E C	MIAMI FORT	OH	2774	1.723	39.62	1.91	11497				
CINCIN G&E C	BECKJORD	OH	1709	1.745	38.66	1.88	11077				
CLEVE ELILCO	ASHTABULA	OH	915	1.651	41.06	3.77	12435				
CLEVE ELILCO	AVON LAKE	OH	1712	1.795	44.50	2.63	12396				
CLEVE ELILCO	LAKE SHORE	OH	286	2.366	62.37	0.66	13180				
CLEVE ELILCO	EAST LAKE	OH	2437	1.824	44.73	3.03	12262				
COLUM DIV EL	REFUSE&COAL	OH	58	1.710	43.62	0.86	12754				
COLUM&SO OH	PICWAY	OH	184	1.247	28.64	3.67	11484				
COLUM&SO OH	POSTON	OH	299	1.142	26.20	3.17	11471				
COLUM&SO OH	CONESVILLE	OH	3285	1.617	38.28	3.51	11837				
DAYTON P&LCO	HUTCHINGS	OH	217	2.425	61.33	0.62	12645				
DAYTON P&LCO	KILLEN	OH	417	1.927	48.04	0.61	12465				
DAYTON P&LCO	STUART	OH	4826	1.869	43.36	1.24	11600				
HAMILTON,CTY	HAMILTON	OH	114	1.520	37.77	0.73	12424				
OH VAL EL CO	KYGER CREEK	OH	2318	1.374	32.99	3.60	12006				
OHIO EDISON	EDGEWATER	OH	252	1.627	39.57	1.79	12160				
OHIO EDISON	BURGER	OH	832	1.426	34.93	3.39	12248				
OHIO EDISON	SAMMIS	OH	4150	1.385	33.74	1.87	12181				
OHIO EDISON	NILES	OH	642	1.126	26.69	2.84	11852				
OHIO EDISON	GORGE STEAM	OH	147	1.375	33.15	2.00	12055				
OHIO EDISON	TORONTO	OH	318	1.096	26.23	3.32	11966				
OHIO POW	GAVIN	OH	4035	2.317	50.38	3.14	10872				
OHIO POW	MUSKINGUM	OH	3249	1.593	36.28	4.36	11387				
PAINESVLLE E	PAINESSVILLE	OH	81	1.420	35.18	2.46	12387				
TOLEDO EDISO	BAY SHORE	OH	1132	2.223	58.67	1.22	13196				
TOLEDO EDISO	ACME	OH	129	1.614	42.12	0.68	13048				
DUQUESNE LT	CHESWICK	PA	1247	1.729	42.89	1.52	12403				
DUQUESNE LT	ELRAMA	PA	719	1.691	40.43	1.84	11954				
DUQUESNE LT	PHILLIPS	PA	204	1.593	38.16	1.96	11977				
MET. EDISON	PORTLAND	PA	648	1.776	45.44	2.10	12793				
MET. EDISON	TITUS	PA	484	1.791	46.57	1.45	13001				
NORTH STS PO	HIGH BRIDGE	PA	203	1.709	32.69	1.06	9564				
PENN P&LT	MARTINS CREEK	PA	758	1.899	47.75	1.88	12572				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
PENN P&LT	HOLTWOOD	PA	259	1.048	20.41	1.66	9730				
PENN P&LT	SUNBURY	PA	1313	1.318	29.51	1.74	11195				
PENN P&LT	STORAGE FAC#1	PA						8720	4.495	28.29	0.91
PENN P&LT	MONTOUR	PA	3750	1.671	41.53	1.52	12427				
PENN P&LT	BRUNNER ISLND	PA	3041	1.732	43.12	1.86	12448				
PENN POW	NEW CASTLE	PA	692	1.334	32.56	1.37	12204				
PENN POW	BRUCE MANSFIE	PA	4143	2.076	50.86	3.46	12250				
PENN. ELEC	SHAWVILLE	PA	1532	1.388	34.26	2.04	12341				
PENN. ELEC	HOMER CTY	PA	4921	1.300	29.70	1.90	11423				
PENN. ELEC	KEYSTONE	PA	4116	1.149	28.50	1.46	12402				
PENN. ELEC	CONEMAUGH	PA	3564	1.283	31.41	2.26	12241				
PENN. ELEC	FRONT ST	PA	264	1.403	34.92	1.92	12445				
PENN. ELEC	SEWARD	PA	403	1.124	27.30	1.52	12144				
PENN. ELEC	WARREN	PA	240	1.265	30.89	1.94	12209				
PHIL ELEC	SOUTHWARK	PA						357	4.791	30.02	0.44
PHIL ELEC	CROMBY	PA	322	1.611	42.82	1.59	13290				
PHIL ELEC	DELAWARE	PA						929	4.719	29.65	0.47
PHIL ELEC	RICHMOND	PA						444	4.683	29.45	0.43
PHIL ELEC	EDDYSTONE	PA	574	1.624	42.11	1.69	12965	3279	4.679	29.43	0.47
WEST PENN PW	MITCHELL	PA	503	1.334	33.74	2.01	12646				
WEST PENN PW	HATFIELD	PA	3422	1.558	40.53	2.19	13007				
WEST PENN PW	ARMSTRONG	PA	807	1.404	35.37	1.76	12596				
NARRAGANSETT	SOUTH ST	RI						199	4.421	27.96	1.67
NARRAGANSETT	MANCHESTER ST	RI						304	4.298	27.07	0.99
CAROLINA P&L	ROBINSON	SC	217	1.686	41.82	1.32	12402				
DUKE POWER	LEE	SC	191	1.766	45.51	1.05	12885				
S.C.PUB SERV	WINYAH	SC	2204	1.877	45.71	1.00	12176				
S.C.PUB SERV	GRAINGER	SC	257	1.872	45.18	1.77	12067				
S.C.PUB SERV	JEFFERIES	SC	455	1.863	45.46	1.70	12201				
S.C.PUB SERV	CROSS	SC	235	1.853	44.83	1.09	12097				
SO.CAR.E&GAS	CANADYS	SC	794	2.094	53.95	1.52	12882				
SO.CAR.E&GAS	URQUHART	SC	446	2.035	52.83	1.27	12980				
SO.CAR.E&GAS	MCMEEKIN	SC	536	1.950	49.52	1.01	12697				
SO.CAR.E&GAS	WATEREE	SC	1634	2.093	53.84	1.22	12862				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
TENN VALLEY	BULL RUN	TN	2009	1.710	39.48	0.85	11490				
TENN VALLEY	GALLATIN	TN	2400	1.712	42.73	2.91	12480				
TENN VALLEY	CUMBERLAND	TN	4471	1.904	44.07	2.89	11573				
TENN VALLEY	ALLEN	TN	1297	1.667	39.76	2.23	11926				
TENN VALLEY	SEVIER	TN	1575	1.704	41.56	1.74	12195				
TENN VALLEY	JOHNSONVILLE	TN	2090	1.360	30.56	1.75	11170				
TENN VALLEY	KINGSTON	TN	2569	1.722	40.89	1.10	11873				
APPAL POWER	CLINCH RIVER	VA	1317	1.707	43.09	0.71	12622				
APPAL POWER	GLEN LYN	VA	344	1.961	47.80	0.81	12188				
POTOMAC E PO	POTOMAC RIVER	VA	922	1.791	46.75	0.81	13051				
VIRGINIA E&P	POSSUM PT	VA	632	1.656	42.01	1.20	12684				
VIRGINIA E&P	PORTSMOUTH	VA	820	1.750	43.97	0.96	12563				
VIRGINIA E&P	BREMO BLUFF	VA	531	1.844	46.08	0.81	12495				
VIRGINIA E&P	STORAGE FAC#1	VA						1710	4.475	28.22	1.16
VIRGINIA E&P	CHESTERFIELD	VA	2211	1.576	39.90	1.02	12659				
DAIRYL POCO	ALMA-MADGETT	WI	1210	1.804	31.69	0.84	8783				
DAIRYL POCO	GENOA NO3	WI	803	1.656	32.52	2.31	9819				
DAIRYL POCO	STONEMAN	WI	49	1.557	34.22	3.36	10989				
MADISON G&E	BLOUNT	WI	75	1.833	41.55	1.19	11334				
MANITOWAC PU	MANITOWAC	WI	92	2.036	49.85	0.89	12242				
WISC EL PWR	OAK CREEK	WI	3071	1.674	39.65	2.05	11843				
WISC EL PWR	PLEASANT PRAI	WI	1730	1.600	26.16	0.33	8175				
WISC EL PWR	STORAGE FAC#1	WI						102	5.959	34.29	0.25
WISC EL PWR	VALLEY	WI	21	1.885	40.47	1.32	12857				
WISC EL PWR	PT WASHINGTON	WI	432	1.704	43.11	2.70	12650				
WISC PUB SER	WESTON	WI	982	2.109	38.15	0.72	9045				
WISC PUB SER	PULLIAM	WI	528	1.937	46.44	2.12	11988				
WISC PWR&LT	NELSON DEWEY	WI	575	1.376	29.14	2.70	10589				
WISC PWR&LT	COLUMBIA	WI	3206	1.703	29.16	0.57	8561				
WISC PWR&LT	ROCK RIVER	WI	293	1.697	38.90	3.34	11461				
WISC PWR&LT	EDGEWATER	WI	956	1.730	37.40	2.91	10759				
WISC PWR&LT	BLACKHAWK	WI	16	1.783	40.13	3.31	11254				
APPAL POWER	AMOS	WV	4667	1.900	40.80	0.75	12274				
APPAL POWER	KANAWHA RIVER	WV	549	1.793	41.37	0.77	11537				

1 COMPANY	2 PLANT	3 STATE	4 COAL KTONS	5 COAL $/MBTU	6 COAL $/TON	7 COAL %SULFUR	8 COAL BTU/LB.	9 OIL KBBLS	10 OIL $/MBTU	11 OIL $/BBL	12 OIL %SULFUR
APPAL POWER	MOUNTAINEER	WV	2359	2.065	51.43	0.60	12453				
CENT OPER CO	SPORN	WV	1744	2.005	50.40	0.95	12006				
MONONGAHELA	WILLOW ISLAND	WV	342	1.666	41.17	1.27	12356				
MONONGAHELA	HARRISON	WV	4299	1.492	39.25	2.90	13153				
MONONGAHELA	FT MARTIN	WV	2111	1.607	40.33	1.91	12548				
MONONGAHELA	RIVESVILLE	WV	235	1.571	39.12	1.01	12451				
MONONGAHELA	PLEASANTS	WV	2446	1.531	38.34	2.94	12521				
MONONGAHELA	ALBRIGHT	WV	795	1.219	29.79	1.77	12219				
OHIO POW	MITCHELL	WV	2400	1.942	45.58	1.46	11735				
OHIO POW	KAMMER	WV	1806	1.349	32.70	4.17	12120				

APPENDIX B:

Price Differentials for Plants and States

Guide-

Column:

(1) Company names organized by state

(2) Plant name

(3) Type of fuel burned, C=coal and O=oil

(4) $ per million btu price differential between the state-average natural gas price (from Table 4) and the price of coal or oil burned at each plant

(5) Billions of btus of coal or oil displaced, or conversely gas substituted, at each plant

(6) Weighted (by Total BBtu) average price differential ($\$/10^6$ btu) for each state

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
ALABAMA					
AL ELEC COOP	TOMBIGBEE	C=COAL	1.313	9947	
AL POWER CO	GADSEN	C	0.230	1539	
AL POWER CO	GORGAS 2,3	C	1.166	68162	
AL POWER CO	GREENE	C	1.084	4561	
AL POWER CO	GASTON	C	1.112	52354	
AL POWER CO	JAMES MILLER	C	0.500	20801	
TENN VALLEY	WIDOWS CREEK	C	1.429	20207	
TENN VALLEY	COLBERT	C	1.162	27285	
					1.108
ARKANSAS					
AR POWER&LT	INDEPENDENCE	C	1.477	27071	
AR POWER&LT	WHITEBLUFF	C	1.384	35613	
SO.WEST.E PW	FLINT CREEK	C	1.792	14080	
					1.492
CONNECTICUT					
CT L&P CO	NORWALK HARBO	O=OIL	1.475	9220	
CT L&P CO	DEVON	O	1.492	7464	
CT L&P CO	MONTVILLE	O	1.536	6191	
HARTFORD ELC	MIDDLETOWN	O	1.069	10379	
UNITED ILLUM	BRIDGEPRT HAR	O	1.426	15888	
UNITED ILLUM	NEW HAVEN HAR	O	1.416	12374	
					1.390
DISTRICT OF COLUMBIA					
POTOMAC E PO	BENNING	O	-0.934	1456	
					-0.934
DELAWARE					
DELMARVA P&L	DELAWARE CITY	O	-0.560	407	
DELMARVA P&L	INDIAN RIVER	C	2.200	26889	
DELMARVA P&1	EDGEMOOR	C	2.152	8491	
DELMARVA P&1	EDGEMOOR	O	-0.309	7413	
DOVER,CITYOF	MCKEE RUN	O	-0.061	2738	
					1.627

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
FLORIDA					
FL P&L	TURKEY PT	O	-1.922	12060	
FL P&L	PT EVERGLADES	O	-1.584	14624	
FL P&L	MARTIN	O	-2.147	19184	
FL P&L	SANFORD	O	-1.609	6341	
FL P&L	MANATEE	O	-1.793	22599	
FL P&L	CAPE CANAVERA	O	-1.677	12135	
FL P&L	FORT MEYERS	O	-1.615	15207	
FL P&L	RIVIERA	O	-1.866	3901	
FL POWER COR	STOR FAC #1	O	-1.509	22579	
FL POWERCORP	ANCLOTE	O	-3.804	63	
FL POWERCORP	SUWANNEE	O	-2.080	200	
FL POWERCORP	HIGGINS	O	-1.601	174	
FL POWERCORP	CRYSTAL RIVER	C	-0.070	42629	
FL POWERCORP	TURNER	O	-1.749	642	
FL POWERCORP	BARTOW	O	-1.695	2112	
GAIN-ALACNTY	DEERHAVEN	C	0.535	8322	
GULF POWER	CRIST	C	0.435	18666	
GULF POWER	SCHOLTZ	C	0.251	1171	
GULF POWER	SMITH	C	0.286	10029	
JACKSNVL EL	SOUTHSIDE	O	-1.592	2010	
JACKSNVL EL	NORTHSIDE	O	-1.699	2372	
JACKSNVL EL	KENNEDY	O	-1.680	2798	
LAKELAND,CTY	PLNT 3-MACINT	C	0.385	10696	
LAKELAND,CTY	PLNT 3-MACINT	O	-2.189	613	
SEMINOLE EL	SEMINOLE	C	0.515	6869	
TAMPA ELEC	BIG BEND	C	0.835	38265	
TAMPA ELEC	GANNON	C	0.021	15115	
TAMPA ELEC	GANNON	O	-1.849	4746	
TAMPA ELEC	HOOKERS PT	O	-1.838	1712	
					-0.680
GEORGIA					
GA POWER	HARLLEE BRANC	C	2.211	34138	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
GA POWER	WANSLEY	C	2.423	45614	
GA POWER	HAMMOND	C	2.327	16325	
GA POWER	ARKWRIGHT	C	2.269	2742	
GA POWER	BOWEN	C	2.362	91217	
GA POWER	ATKINSON-MCDO	C	2.400	15928	
GA POWER	SCHERER	C	1.211	14306	
GA POWER	MITCHELL	C	2.237	5148	
GA POWER	YATES	C	2.282	27137	
SAVANNAH E&P	PT WENTWORTH	C	2.393	5510	
SAVANNAH E&P	MCINTOSH	C	2.353	4903	
					2.279
IOWA					
EASTRN IAL&P	FAIR	C	2.308	1199	
IA EL LT&POW	SUTHERLAND	C	1.530	2462	
IA SO UTILS	BURLINGTON	C	2.132	3721	
IA SO UTILS	OTTUMWA	C	2.327	15288	
IA-IL GAS&EL	LOUISA	C	2.057	5157	
IA-IL GAS&EL	RIVERSIDE	C	2.018	2523	
INTERSTATE P	LANSING	C	1.815	6789	
INTERSTATE P	DUBUQUE	C	2.091	1688	
INTERSTATE P	KAPP	C	2.035	4579	
IOWA POW&LT	DES MOINES	C	2.280	246	
IOWA POW&LT	COUNCIL BLUFF	C	2.510	20765	
IOWA PUB SER	GEO. NEAL 1-4	C	2.153	26472	
MUSCATINE P&	MUSCATINE	C	1.947	5629	
IA EL LT&POW	PRAIRIE CREEK	C	0.851	4238	
					2.135
ILLINOIS					
CENT IL LT	WALLACE	C	3.218	1530	
CENT IL LT	DUCK CREEK	C	3.072	6201	
CENT IL LT	EDWARDS	C	3.267	14649	
CENT IL PUBS	NEWTON	C	3.388	17634	
CENT IL PUBS	GRAND TOWER	C	3.850	4633	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
CENT IL PUBS	COFTEEN	C	3.762	19444	
CENT IL PUBS	HUTSONVILLE	C	3.873	4739	
CENT IL PUBS	MEREDOSIA	C	3.507	5846	
COMMONWTH ED	WAUKEGAN	C	2.154	14524	
COMMONWTH ED	WILL COUNTY	C	2.096	18666	
COMMONWTH ED	KINCAID	C	3.781	32964	
COMMONWTH ED	CRAWFORD	C	2.108	8994	
COMMONWTH ED	COLLINS	O	-0.905	13641	
COMMONWTH ED	JOLIET	C	1.973	15870	
COMMONWTH ED	FISK	C	2.041	3921	
COMMONWTH ED	POWERTON	C	2.659	39053	
ELEC ENERGY	JOPPA	C	3.643	25543	
IL POWER	BALDWIN	C	3.933	52280	
IL POWER	WOOD RIVER	C	2.776	3854	
IL POWER	HAVANA	C	2.611	3123	
IL POWER	HENNEPIN	C	3.808	10335	
IL POWER	VERMILION	C	4.140	6470	
SO.ILL POW.C	MARION	C	4.253	5409	
SPRNGFLD W,L	DALLMAN	C	3.468	7279	
SPRNGFLD W,L	LAKESIDE	C	3.466	927	
					3.085
INDIANA					
COMMON ED-IN	STATE LINE	C	1.603	10122	
HOOSIER ENER	MEROM	C	2.753	12850	
HOOSIER ENER	FRANK E RATTS	C	3.081	6606	
IND & MICH	TANNERS CREEK	C	2.556	18732	
IND & MICH	BREED	C	2.862	8946	
IND-KY EL CO	CLIFTY CREEK	C	2.955	45158	
INDNPLIS P&L	PRITCHARD	C	2.779	5520	
INDNPLIS P&L	PETERSBURG	C	2.985	36796	
INDNPLIS P&L	STOUT	C	2.760	15985	
N. IND PS	MICHIGAN CTY	C	2.198	9358	
N. IND PS	BAILLY	C	2.310	8569	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
N. IND PS	ROLLIN SCHAHF	C	1.458	21645	
N. IND PS	MITCHELL	C	0.788	4703	
PS CO INDIAN	CAYUGA	C	2.915	25539	
PS CO INDIAN	EDWARDSPORT	C	3.159	1514	
PS CO INDIAN	GALLAGHER	C	3.047	12983	
PS CO INDIAN	GIBSON STATIO	C	2.826	64504	
PS CO INDIAN	WABASH RIVER	C	2.797	10114	
RICHMND P&LT	WHITEWATER	C	2.170	1813	
SO.IND.G&EL	CULLEY	C	2.955	11152	
SO.IND.G&EL	A B BROWN	C	2.322	6240	
SO.IND.G&EL	WARRICK	C	2.972	3661	
					2.673
KENTUCKY					
BIG RIV REC	COLEMAN	C	2.985	16789	
BIG RIV REC	RD GREEN	C	3.389	18180	
BIG RIV REC	REID-HENDERSO	C	3.286	10213	
CINCIN G&E C	EAST BEND	C	3.071	18888	
EAST KY REC	DALE	C	3.361	1831	
EAST KY REC	COOPER	C	3.343	6173	
EAST KY REC	SPURLOCK	C	2.761	12285	
HENDERSON MP	HENDERSON	C	3.114	1672	
KENTUCKY POW	BIG SANDY	C	2.976	28247	
KENTUCKY UTI	GHENT	C	2.591	29800	
KENTUCKY UTI	GREEN RIVER	C	3.222	4193	
KENTUCKY UTI	TYRONE	C	2.944	202	
KENTUCKY UTI	BROWN	C	3.198	13517	
LOUISVLL G&E	MILL CREEK	C	3.207	26700	
LOUISVLL G&E	CANE RUN	C	3.211	6359	
OWENSBORO MU	SMITH	C	2.942	9482	
TENN VALLEY	SHAWNEE	C	2.389	32308	
TENN VALLEY	PARADISE	C	3.390	43230	
					3.019
LOUISIANA					

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
CAJUN EPC	BIG CAJUN NO2	C	0.751	14767	
CENT LA ELEC	RODEMACHER	C	0.970	5480	
GULF STS UTI	NELSON	C	0.985	10680	
					0.871
MASSACHUSET					
BOS EDISON	MYSTIC	O	-0.310	11520	
BOS EDISON	NEW BOSTON	O	-0.561	20444	
CANBRI ELC	KENDALL SQ	O	-0.896	452	
CANAL EL CO	CANAL	O	-0.282	23831	
HOLYOKE WTRP	MT TOM	C	1.768	5030	
MONTAUP ELEC	SOMERSET	C	1.810	5649	
MONTAUP ELEC	SOMERSET	O	-0.377	1606	
NEW ENG POW	SALEM HARBOR	C	1.443	8580	
NEW ENG POW	SALEM HARBOR	O	-0.167	9592	
NEW ENG POW	BRAYTON	C	1.634	23780	
NEW ENG POW	BRAYTON	O	-0.247	11248	
TAUNTON MUN	CLEARY	O	-0.641	657	
W. MASS ELEC	W.SPRINGFIELD	O	-0.644	1907	
					0.334
MARYLAND					
BALT G&E	WESTPORT	O	-0.132	570	
BALT G&E	RIVERSIDE	O	-0.051	1677	
BALT G&E	CRANE	C	2.792	7182	
BALT G&E	WAGNER	C	2.468	7833	
BALT G&E	WAGNER	O	-0.061	4647	
BALT G&E	GOULD ST	O	-0.004	796	
DELMARVA P&L	VIENNA	O	0.265	1797	
POTOMAC E PO	CHALK	C	2.732	17899	
POTOMAC E PO	CHALK	O	-0.578	3796	
POTOMAC E PO	MORGANTOWN	C	2.749	25727	
POTOMAC E PO	DICKERSON	C	2.815	15963	
POTOMAC ED C	SMITH	C	2.747	2436	
					2.308

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
MAINE					
CENT ME POW	WYMAN	O	2.990	10389	*********
					2.990
MICHIGAN					
CONSUMERS PO	CAMPBELL	C	2.386	33076	
CONSUMERS PO	WHITING	C	2.701	9316	
CONSUMERS PO	KARN-WEADOCK	C	2.342	23566	
CONSUMERS PO	COBB-SANDUSKY	C	2.649	7976	
DETROIT EDCO	CONNERS CREEK	C	2.150	1627	
DETROIT EDCO	MONROE	C	2.713	90791	
DETROIT EDCO	RIVER ROUGE	C	2.339	12305	
DETROIT EDCO	TRENTON CHANN	C	2.096	13011	
DETROIT EDCO	HARBOR BEACH	C	2.084	458	
DETROIT EDCO	ST CLAIR	C	2.498	41543	
DETROIT EDCO	MARYSVILLE	C	2.100	2277	
DETRT PUBLTC	MISTERSKY	O	-0.093	1048	
GRHAVEN L&P	J B SIMMS	C	2.620	1320	
HOLLAND BD	JAMES DE YOUN	C	2.542	1711	
LANSING W&LT	OTTAWA	C	2.252	322	
LANSING W&LT	ERICKSON	C	2.120	4925	
LANSING W&LT	ECKERT	C	2.082	5642	
MARQUETTE L&	SHIRAS	C	2.323	1546	
UPPER PEN GE	PRESQUE ISLE	C	2.236	10344	
					2.485
MINNESOT					
INTERSTATE P	FOX LAKE	C	1.508	389	
MINN. P&LT	BOSWELL	C	2.589	22003	
NORTH STS PO	RIVERSIDE	C	2.359	4783	
NORTH STS PO	BLACK DOG	C	2.108	1868	
NORTH STS PO	KING	C	2.227	11072	
NORTH STS PO	SHERBURNE CNT	C	2.475	40432	
OTTER TAIL P	HOOT LAKE	C	2.172	1530	
ROCH DPT PU	SILVER LAKE	C	1.784	2481	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
					2.427
MISSOURI					
AS ELEC COOP	HILL	C	2.594	31558	
AS ELEC COOP	MADRID	C	2.678	25103	
CENT ELPOWCO	CHAMOIS	C	3.002	83	
COLUMBIA W&L	COLUMBIA	C	2.520	714	
EMPIRE DISEL	ASBURY	C	3.043	6631	
INDEPNDNCE P	BLUE VALLEY	C	2.646	2120	
KANS CTY P&L	IATAN	C	2.878	20710	
KANS CTY P&L	MONTROSE	C	2.588	11346	
KANS CTY P&L	GRAND AVE	C	2.375	502	
KANS CTY P&L	HAWTHORNE	C	2.389	5954	
MISSOURI PS	SIBLEY	C	2.365	8226	
SIKESTON MUN	SIKESTON	C	2.338	7581	
SPRNGFLD UTI	JAMES RIVER	C	2.669	4629	
SPRNGFLD UTI	SOOUTHWEST	C	2.394	1816	
ST JOE LT&PW	LAKEROAD	C	2.714	1268	
UNION ELEC	MERAMEC	C	2.339	9570	
UNION ELEC	SIOUX	C	2.690	21848	
UNION ELEC	RUSH ISLAND	C	2.779	28332	
UNION ELEC	LABADIE	C	2.733	60102	
UNION ELEC	ASHLEY	O	-0.028	902	
					2.662
MISSISSIPPI					
MISS. POW	JCKSN CT-DANI	C	0.271	18479	
MISS. POW	WATSON	C	1.364	13166	
S MISS EL PO	R D MORROW	C	1.121	11979	
					0.834
NORTH CAROLINA					
CAROLINA P&L	MAYO	C	2.890	20823	
CAROLINA P&L	ASHEVILLE	C	3.238	12218	
CAROLINA P&L	SUTTON	C	2.933	8586	
CAROLINA P&L	CAPE FEAR	C	3.090	4877	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
CAROLINA P&L	ROXBORO	C	2.954	66242	
CAROLINA P&L	WEATHERSPOON	C	3.098	1997	
CAROLINA P&L	LEE	C	3.066	7029	
DUKE POWER	RIVERBEND	C	3.068	1769	
DUKE POWER	ALLEN	C	2.884	15070	
DUKE POWER	BELEWS CREEK	C	3.011	60189	
DUKE POWER	BUCK	C	3.290	1064	
DUKE POWER	MARSHALL	C	2.821	43623	
DUKE POWER	CLIFFSIDE	C	3.247	11465	
DUKE POWER	DAN RIVER	C	3.397	280	
					2.971
NEW HAMPSHIRE					
PS CO N.HAMP	NEWINGTON ST	O	1.815	7610	
PS CO N.HAMP	MERRIMACK	C	4.062	13762	
PS CO N.HAMP	SCHILLER	O	1.698	837	
					3.203
NEW JERSEY					
ATLTC C ELEC	ENGLAND	C	2.279	9523	
ATLTC C ELEC	ENGLAND	O	-0.433	4773	
DEEPWTR OPCO	DEEPWATER	C	2.142	2225	
DEEPWTR OPCO	DEEPWATER	O	-0.379	2092	
JERSEY C P&L	WERNER	O	-0.964	876	
JERSEY C P&L	GILBERT	O	-0.223	471	
PS E&G-NJ	HUDSON	C	2.122	11024	
PS E&G-NJ	HUDSON	O	-0.910	397	
PS E&G-NJ	LINDEN	O	-0.939	6888	
PS E&G-NJ	BURLINGTON	O	-0.623	3496	
PS E&G-NJ	SEWAREN	O	-0.896	903	
PS E&G-NJ	MERCER	C	1.916	16458	
PS E&G-NJ	KEARNY	O	-0.866	2386	
					1.068
NEW YORK					
CENT HUD G&E	ROSETON	O	-0.329	30089	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
CENT HUD G&E	DANSKAMMER	O	-0.611	10112	
CONS EDCO NY	STOR FAC #3	O	-0.933	3120	
CONS EDCO NY	HUDSON AVE	O	-0.894	17384	
CONS EDCO NY	ASTORIA	O	-0.874	6468	
CONS EDCO NY	STOR FAC #1	O	-0.977	7709	
CONS EDCO NY	STOR FAC #2	O	-0.992	4060	
CONS EDCO NY	STOR FAC #4	O	-0.873	9471	
CONS EDCO NY	59TH ST	O	-0.885	316	
CONS EDCO NY	EAST RIVER	O	-1.032	2079	
CONS EDCO NY	STOR FAC #6	O	-0.880	9629	
CONS EDCO NY	STOR FAC #5	O	-0.847	8401	
JMSTWN BD PU	S.A CARLSON	C	2.473	1584	
LONG ISLND L	PT JEFFERSON	O	-0.170	9913	
LONG ISLND L	BARRETT	O	-0.855	1553	
LONG ISLND L	GLENWOOD	O	-0.765	568	
LONG ISLND L	NORTHPORT	O	-0.216	33373	
NIAG-MOHAWK	HUNTLEY	C	1.953	23580	
NIAG-MOHAWK	OSWEGO	O	-1.173	13062	
NIAG-MOHAWK	DUNKIK	C	2.163	14401	
NY ST E&GAS	GREENIDGE	C	2.368	7447	
NY ST E&GAS	GOUDEY	C	2.360	4050	
NY ST E&GAS	JENNISON	C	2.264	3195	
NY ST E&GAS	HICKLING	C	2.462	3754	
NY ST E&GAS	SOMERSET	C	2.276	441	
NY ST E&GAS	MILLIKEN	C	2.110	11066	
ORNGE&RCKLND	BOWLINE	O	-0.821	15580	
ORNGE&RCKLND	LOVETT	O	-0.813	976	
POW AU NY ST	POLETTI	O	-0.989	9749	
ROCH G&E COR	ROCHESTER 3	C	2.136	2606	
ROCH G&E COR	ROCHESTER 3	O	-0.811	724	
ROCH G&E COR	ROCHESTER 7	C	2.153	8116	
					0.164

OHIO

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
CARDINAL OC	CARDINAL	C	3.494	48047	
CINCIN G&E C	MIAMI FORT	C	3.446	31888	
CINCIN G&E C	BECKJORD	C	3.424	18926	
CLEVE ELILCO	ASHTABULA	C	3.518	11378	
CLEVE ELILCO	AVON LAKE	C	3.374	21221	
CLEVE ELILCO	LAKE SHORE	C	2.803	3770	
CLEVE ELILCO	EAST LAKE	C	3.345	29881	
COLUM DIV EL	REFUSE&COAL	C	3.459	740	
COLUM&SO OH	PICWAY	C	3.922	2108	
COLUM&SO OH	POSTON	C	4.027	3430	
COLUM&SO OH	CONESVILLE	C	3.552	38888	
DAYTON P&LCO	HUTCHINGS	C	2.744	2745	
DAYTON P&LCO	KILLEN	C	3.242	5193	
DAYTON P&LCO	STUART	C	3.300	55985	
HAMILTON,CTY	HAMILTON	C	3.649	1410	
OH VAL EL CO	KYGER CREEK	C	3.795	27828	
OHIO EDISON	EDGEWATER	C	3.542	3864	
OHIO EDISON	BURGER	C	3.743	10184	
OHIO EDISON	SAMMIS	C	3.784	50544	
OHIO EDISON	NILES	C	4.043	7608	
OHIO EDISON	GORGE STEAM	C	3.794	1771	
OHIO EDISON	TORONTO	C	4.073	3799	
OHIO POW	GAVIN	C	2.852	43867	
OHIO POW	MUSKINGUM	C	3.576	36994	
PAINESVLLE E	PAINESSVILLE	C	3.749	1003	
TOLEDO EDISO	BAY SHORE	C	2.946	14934	
TOLEDO EDISO	ACME	C	3.555	1686	
					3.449
PENNSYLVANIA					
DUQUESNE LT	CHESWICK	C	3.375	15467	
DUQUESNE LT	ELRAMA	C	3.413	8595	
DUQUESNE LT	PHILLIPS	C	3.511	2443	
MET. EDISON	PORTLAND	C	3.328	8295	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
DUKE POWER	LEE	C	2.519	2461	
S.C.PUB SERV	WINYAH	C	2.408	26839	
S.C.PUB SERV	GRAINGER	C	2.413	3099	
S.C.PUB SERV	JEFFERIES	C	2.422	5556	
S.C.PUB SERV	CROSS	C	2.432	2837	
SO.CAR.E&GAS	CANADYS	C	2.191	10226	
SO.CAR.E&GAS	URGUHART	C	2.250	5789	
SO.CAR.E&GAS	MCMEEKIN	C	2.335	6803	
SO.CAR.E&GAS	WATEREE	C	2.192	21011	
					2.325
TENNESSEE					
TENN VALLEY	BULL RUN	C	2.152	23085	
TENN VALLEY	GALLATIN	C	2.158	29955	
TENN VALLEY	CUMBERLAND	C	1.966	51744	
TENN VALLEY	ALLEN	C	2.203	15461	
TENN VALLEY	SEVIER	C	2.166	19209	
TENN VALLEY	JOHNSONVILLE	C	2.502	23345	
TENN VALLEY	KINGSTON	C	2.148	30497	
					2.150
VIRGINIA					
APPAL POWER	CLINCH RIVER	C	2.495	16616	
APPAL POWER	GLEN LYN	C	2.241	4197	
POTOMAC E PO	POTOMAC RIVER	C	2.411	12033	
VIRGINIA E&P	POSSUM PT	C	2.546	8016	
VIRGINIA E&P	PORTSMOUTH	C	2.452	10302	
VIRGINIA E&P	BREMO BLUFF	C	2.358	6635	
VIRGINIA E&P	STORAGE FAC#1	O	-0.273	5392	
VIRGINIA E&P	CHESTERFIELD	C	2.626	27988	
					2.338
WISCONSIN					
DAIRYL POCO	ALMA-MADGETT	C	2.480	10696	
DAIRYL POCO	GENOA NO3	C	2.628	7882	
DAIRYL POCO	STONEMAN	C	2.727	536	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
MET. EDISON	TITUS	C	3.313	6293	
NORTH STS PO	HIGH BRIDGE	C	3.395	1937	
PENN P&LT	MARTINS CREEK	C	3.205	9530	
PENN P&LT	HOLTWOOD	C	4.056	2522	
PENN P&LT	SUNBURY	C	3.786	14699	
PENN P&LT	STORAGE FAC#1	O	0.609	27440	
PENN P&LT	MONTOUR	C	3.433	46700	
PENN P&LT	BRUNNER ISLND	C	3.372	47813	
PENN POW	NEW CASTLE	C	3.770	8445	
PENN POW	BRUCE MANSFIE	C	3.028	50744	
PENN. ELEC	SHAWVILLE	C	3.716	18907	
PENN. ELEC	HOMER CTY	C	3.804	56213	
PENN. ELEC	KEYSTONE	C	3.955	51047	
PENN. ELEC	CONEMAUGH	C	3.821	43626	
PENN. ELEC	FRONT ST	C	3.701	3285	
PENN. ELEC	SEWARD	C	3.980	5866	
PENN. ELEC	WARREN	C	3.839	2930	
PHIL ELEC	SOUTHWARK	O	0.313	1118	
PHIL ELEC	CROMBY	C	3.493	4279	
PHIL ELEC	DELAWARE	O	0.385	2919	
PHIL ELEC	RICHMOND	O	0.421	1396	
PHIL ELEC	EDDYSTONE	C	3.480	7442	
PHIL ELEC	EDDYSTONE	O	0.425	10312	
WEST PENN PW	MITCHELL	C	3.770	7373	
WEST PENN PW	HATFIELD	C	3.546	44506	
WEST PENN PW	ARMSTRONG	C	3.700	11172	
					3.323
RHODE ISLAND					
NARRAGANSETT	SOUTH ST	O	-0.668	629	
NARRAGANSETT	MANCHESTER ST	O	-0.545	957	
					-0.059
SOUTH CAROLINA					
CAROLINA P&L	ROBINSON	C	2.599	2691	

1 COMPANY	2 PLANT	3 FUEL BURNED	4 PRICE DIFF.	5 TOTAL BBTU	6 WGHTD. AVG. PRICE DIFF.
MADISON G&E	BLOUNT	C	2.451	851	
MANITOWAC PU	MANITOWAC	C	2.248	1131	
WISC EL PWR	OAK CREEK	C	2.610	36374	
WISC EL PWR	PLEASANT PRAI	C	2.604	14206	
WISC EL PWR	STORAGE FAC#1	O	-1.675	293	
WISC EL PWR	VALLEY	C	2.399	274	
WISC EL PWR	PT WASHINGTON	C	2.580	5460	
WISC PUB SER	WESTON	C	2.175	8881	
WISC PUB SER	PULLIAM	C	2.347	6334	
WISC PWR&LT	NELSON DEWEY	C	2.900	6084	
WISC PWR&LT	COLUMBIA	C	2.581	28135	
WISC PWR&LT	ROCK RIVER	C	2.587	3360	
WISC PWR&LT	EDGEWATER	C	2.546	10284	
WISC PWR&LT	BLACKHAWK	C	2.501	178	
					2.557
WEST VIRGINIA					
APPAL POWER	AMOS	C	2.558	57277	
APPAL POWER	KANAWHA RIVER	C	2.753	6330	
APPAL POWER	MOUNTAINEER	C	2.481	29381	
CENT OPER CO	SPORN	C	2.461	21080	
MONONGAHELA	WILLOW ISLAND	C	2.88	4229	
MONONGAHELA	HARRISON	C	3.054	56546	
MONONGAHELA	FT MARTIN	C	2.939	26486	
MONONGAHELA	RIVESVILLE	C	2.975	2926	
MONONGAHELA	PLEASANTS	C	3.015	30626	
MONONGAHELA	ALBRIGHT	C	3.327	9715	
OHIO POW	MITCHELL	C	2.604	28167	
OHIO POW	KAMMER	C	3.197	21880	
VIRGINIA E&P	MOUNT STORM	C	3.061	42298	
					2.842

APPENDIX C:

Output of Seasonal Gas Substitution Model

Guide-

Column:

(1) State where plant is located

(2) Company name

(3) Plant name

(4) Coal displaced by gas substitution at plant, thousands of tons

(5) Cumulative coal displacement, thousands of tons

(6) Oil displaced by gas substitution at plant, thousands of barrels

(7) Cumulative oil displacement, thousands of barrels

(8) Gas/coal or gas/oil price differential at each plant; calculated from gas prices in Table 4 less coal and oil prices in Appendix A.

(9) Billions of btus of coal or oil displaced, or conversely, gas substituted at each plant

(10) Cumulative gas substituted, millions of cubic feet

(11) Cumulative emissions of S02 removed, millions of tons

(12) Reduction in deposition of S04 at Adirondack receptor as a result of gas substitution at each plant, kg S04 ha^{-1} y^{-1}

(13) Cumulative reduction in sulfate deposition at Adirondack receptor, kg S04 ha^{-1} y^{-1}

(14) Percent change in sulfate (S04) deposition as measured from 27.5 kg S04 ha^{-1} base

(15) Cost in millions of dollars per kg S04 ha^{-1} reduced for each plant, i.e. the marginal cost with respect to deposition of seasonal gas substitution

(16) Total cost in millions of dollars for gas substitution

(17) Cumulative cost in millions of dollars

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
FL	FL POWERCORP	ANCLOTE	0	0	11	11	-3.004	31	31	.00000	.00000	.00000	0	-79337	-0.2	-0.2
WI	WISC EL PWR	STORAGE	0	0	51	62	-1.675	147	178	0.00004	0.00003	0.00004	0	-14896	-0.5	-0.7
FL	FL P&L	MARTIN	0	0	3061	3122	-2.147	9592	9770	0.00583	0.00375	0.00379	0	-10975	-41.2	-41.9
FL	FL P&L	TURKEY	0	0	1900	5022	-1.922	6030	15800	0.01115	0.00345	0.00724	0	-6719	-23.2	-65.1
FL	JACKSNVL EL	KENNEDY	0	0	432	5453	-1.680	1399	17199	0.01226	0.00072	0.00796	0	-6556	-4.7	-69.8
FL	FL P&L	RIVIERA	0	0	615	6068	-1.866	1951	19150	0.01398	0.00112	0.00907	0	-6623	-7.3	-77.1
FL		GANNON OI	0	0	746	6815	-1.849	2373	21523	0.01607	0.00135	0.01043	0	-6486	-8.8	-85.9
FL	FL P&L	MANATEE	0	0	3553	10368	-1.793	11299	32822	0.02602	0.00645	0.01688	0	-6279	-40.5	-126.4
FL	TAMPA ELEC	HOOKERS	0	0	269	10637	-1.838	856	33678	0.02680	0.00051	0.01739	0	-6205	-3.1	-129.5
FL	JACKSNVL EL	SOUTHSI	0	0	314	10950	-1.592	1005	34683	0.02763	0.00054	0.01792	0	-5959	-3.2	-132.7
FL		PLNT 3 OI	0	0	90	11040	-2.109	307	34990	0.02805	0.00027	0.01819	0	-4972	-1.3	-134.1
FL	FL POWERCORP	SUWANNE	0	0	32	11081	-2.000	100	35090	0.02819	0.00009	0.01828	0	-4622	-0.4	-134.5
FL	FL P&L	SANFORD	0	0	1002	12082	-1.609	3171	38260	0.03231	0.00267	0.02095	0	-3821	-10.2	-144.7
FL	FL P&L	FORT ME	0	0	2390	14480	-1.615	7604	45864	0.04333	0.00715	0.02810	0	-3437	-24.6	-169.2
FL	JACKSNVL EL	NORTHSI	0	0	359	14839	-1.699	1186	47050	0.04514	0.00117	0.02927	0	-3436	-4.0	-173.3
FL	FL P&L	CAPE CA	0	0	1929	16768	-1.677	6068	53118	0.05471	0.00620	0.03547	0	-3282	-20.4	-193.6
FL	FL POWERCORP	TURNER	0	0	102	16870	-1.749	321	53439	0.05528	0.00037	0.03584	0	-3021	-1.1	-194.7
FL	FL POWERCORP	BARTOW	0	0	332	17202	-1.695	1056	54495	0.05712	0.00119	0.03704	0	-3006	-3.6	-198.3
NY	CONS EDCO NY	STOR FA	0	0	663	17865	-0.992	2030	56525	0.05757	0.00150	0.03853	0	-2690	-4.0	-202.4
IL	COMMONWTH ED	COLLINS	0	0	2150	20015	-0.905	6820	63345	0.06109	0.00460	0.04313	0	-2684	-12.3	-214.7
NJ	JERSEY C P&L	WERNER	0	0	142	20157	-0.964	438	63783	0.06200	0.00032	0.04345	0	-2632	-0.8	-215.5
NJ		HUDSON OI	0	0	66	20222	-0.910	198	63982	0.06205	0.00014	0.04359	0	-2615	-0.4	-215.9
FL	FL POWERCORP	HIGGINS	0	0	27	20250	-1.601	87	64069	0.06222	0.00011	0.04370	0	-2572	-0.3	-216.2
NJ	PS E&G-NJ	LINDEN	0	0	1119	21368	-0.939	3444	67513	0.06312	0.00254	0.04624	0	-2540	-6.5	-222.6
NJ	PS E&G-NJ	SEWAREN	0	0	147	21515	-0.896	451	67964	0.06323	0.00032	0.04655	0	-2543	-0.8	-223.5
NY	CONS EDCO NY	EAST RI	0	0	340	21854	-1.032	1040	69004	0.06349	0.00086	0.04742	0	-2492	-2.1	-225.6
NY	POW AU NY ST	POLETTI	0	0	1588	23442	-0.909	4074	73078	0.06467	0.00388	0.05130	0	-2404	-9.6	-235.2
NJ	PS E&G-NJ	KEARNY	0	0	389	23830	-0.866	1193	75071	0.06497	0.00085	0.05215	0	-2434	-2.1	-237.3
FL	FL P&L	PT EVER	0	0	2326	26156	-1.504	7312	82383	0.08043	0.01002	0.06217	0	-2312	-23.2	-260.5
NY	CONS EDCO NY	STOR FA	0	0	508	26664	-0.933	1560	83943	0.08082	0.00129	0.06345	0	-2262	-2.9	-263.4
FL	FL POWER COR	STOR FA	0	0	3564	30228	-1.509	11290	95233	0.10406	0.01507	0.07853	0	-2261	-34.1	-297.5
NY	CONS EDCO NY	HUDSON	0	0	2830	33058	-0.894	8692	103925	0.10626	0.00719	0.08571	0	-2162	-15.5	-313.0
NY	CONS EDCO NY	STOR FA	0	0	1254	34312	-0.977	3855	107780	0.10737	0.00366	0.08937	0	-2060	-7.5	-320.5
NY	CONS EDCO NY	ASTORIA	0	0	1052	35364	-0.874	3234	111014	0.10822	0.00277	0.09214	0	-2039	-5.7	-326.2

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
NY	CONS EDCO NY	59TH ST	0	0	52	35415	-0.085	150	111172	0.10826	0.00014	0.09228	0	-2029	-0.3	-326.5
NY	CONS EDCO NY	STOR FA	0	0	1558	36973	-0.080	4815	115987	0.10960	0.00440	0.09668	0	-1927	-8.5	-334.9
NY	CONS EDCO NY	STOR FA	0	0	1539	38512	-0.073	4736	120722	0.11093	0.00434	0.10102	0	-1985	-8.3	-343.2
NY	CONS EDCO NY	STOR FA	0	0	1361	39872	-0.847	4200	124923	0.11229	0.00448	0.10550	0	-1589	-7.1	-350.3
MA	CAMBRI ELC	KENDALL	0	0	72	39944	-0.896	226	125148	0.11240	0.00026	0.10576	0	-1568	-0.4	-350.7
NY	ORNGE&RCKLND	LOVETT	0	0	158	40102	-0.813	488	125637	0.11256	0.00052	0.10628	0	-1529	-0.8	-351.5
NY	ORNGE&RCKLND	BOWLINE	0	0	2524	42626	-0.821	7790	133427	0.11560	0.00998	0.11625	0	-1282	-12.8	-364.3
NJ	PS E&G-NJ	BURLING	0	0	560	43186	-0.623	1740	135174	0.11631	0.00200	0.11825	0	-1092	-2.2	-366.5
DC	POTOMAC E PO	BENNING	0	0	243	43428	-0.934	728	135902	0.11694	0.00154	0.11979	0	-882	-1.4	-367.9
NY	LONG ISLND L	GLENWOO	0	0	91	43519	-0.765	284	136186	0.11711	0.00055	0.12033	0	-796	-0.4	-368.3
NY	LONG ISLND L	BARRETT	0	0	250	43769	-0.055	777	136963	0.11764	0.00173	0.12207	0	-766	-1.3	-369.6
MD		CHALK OIL	0	0	614	44382	-0.578	1898	138861	0.11928	0.00414	0.12621	0	-530	-2.2	-371.8
MA	BOS EDISON	NEW BOS	0	0	3272	47654	-0.561	10222	149083	0.12026	0.02218	0.14839	1	-517	-11.5	-383.3
RI	NARRAGANSETT	MANCHES	0	0	152	47806	-0.545	479	149562	0.12070	0.00110	0.14948	1	-476	-0.5	-383.8
NY	NIAG-MOHAWK	OSWEGO	0	0	2104	49910	-1.173	6531	156093	0.13919	0.03438	0.10387	1	-446	-15.3	-399.1
MA	W. MASS ELEC	W.SPRIN	0	0	302	50212	-0.644	953	157046	0.14035	0.00286	0.10673	1	-429	-1.2	-400.3
DE	DELMARVA P&L	DELAWAR	0	0	65	50276	-0.560	204	157250	0.14057	0.00054	0.10727	1	-424	-0.2	-400.6
NY	CENT HUD G&E	DANSKAM	0	0	1613	51889	-0.611	5056	162386	0.14504	0.01464	0.20191	1	-422	-6.2	-406.8
RI	NARRAGANSETT	SOUTH S	0	0	100	51989	-0.668	315	162620	0.14554	0.00124	0.20315	1	-338	-0.4	-407.2
MA		SOMERSET	0	0	254	52243	-0.377	803	163423	0.14629	0.00185	0.20500	1	-328	-0.6	-407.8
NJ		DEEPWATER	0	0	332	52574	-0.379	1046	164469	0.14720	0.00259	0.20759	1	-306	-0.8	-408.6
DE		EDGEMOOR	0	0	1168	53742	-0.309	3706	168175	0.15034	0.00769	0.21528	1	-298	-2.3	-410.9
MA	TAUNTON MUN	CLEARY	0	0	104	53846	-0.641	329	168504	0.15098	0.00158	0.21686	1	-266	-0.4	-411.3
VA	VIRGINIA E&P	STORAGE	0	0	855	54701	-0.273	2696	171200	0.15394	0.00628	0.22314	1	-235	-1.5	-412.8
NJ		ENGLAND O	0	0	758	55459	-0.433	2386	173586	0.15792	0.01124	0.23438	1	-184	-2.1	-414.8
NJ	JERSEY C P&L	GILBERT	0	0	74	55533	-0.223	236	173822	0.15812	0.00057	0.23495	1	-183	-0.1	-414.9
MA	BOS EDISON	MYSTIC	0	0	1844	57377	-0.310	5760	179582	0.16704	0.02205	0.25701	1	-162	-3.6	-418.5
FL	FL POWERCORP	CRYSTAL	1724	1724	0	57377	-0.070	21315	200897	0.19931	0.02092	0.27793	1	-143	-3.0	-421.5
MI	DETRT PUBLTC	MISTERS	0	1724	168	57545	-0.093	524	201420	0.19972	0.00068	0.27861	1	-142	-0.1	-421.6
MD	BALT G&E	WESTPOR	0	1724	90	57635	-0.132	285	201705	0.19997	0.00063	0.27924	1	-120	-0.1	-421.7
NY	CENT HUD G&E	ROSETON	0	1724	4752	62387	-0.329	15044	216750	0.22699	0.08850	0.36774	1	-112	-9.9	-431.6
MA	CANAL EL CO	CANAL	0	1724	3794	66181	-0.282	11916	228665	0.25219	0.06230	0.43005	2	-108	-6.7	-438.3
MA		BRAYTON O	0	1724	1791	67971	-0.247	5624	234289	0.26370	0.02046	0.45051	2	-98	-2.8	-441.1
MA		SALEM OIL	0	1724	1525	69496	-0.167	4796	239086	0.27346	0.02412	0.48263	2	-66	-1.6	-442.7

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
NY	LONG ISLND L	NORTHPO	0	1724	5258	74754	-0.216	16686	255772	0.30007	0.11338	0.59601	2	-64	-7.2	-449.9
MO		WAGNER OI	0	1724	741	75494	-0.061	2324	258096	0.31016	0.00527	0.60128	2	-54	-0.3	-450.1
MO	UNION ELEC	ASHLEY	0	1724	143	75637	-0.028	451	258547	0.31092	0.00052	0.60180	2	-48	.0	-450.2
MD	BALT G&E	RIVERSI	0	1724	266	75902	-0.051	839	259385	0.31166	0.00187	0.60367	2	-46	-0.1	-450.3
NY	LONG ISLND L	PT JEFF	0	1724	1562	77464	-0.170	4956	264341	0.32327	0.03806	0.64173	2	-44	-1.7	-451.9
DE	DOVER,CITYOF	MCKEE R	0	1724	432	77896	-0.061	1369	265711	0.32701	0.00917	0.65090	2	-18	-0.2	-452.1
NY		ROCHESTER	0	1724	115	78010	-0.011	362	266073	0.32759	0.00192	0.65281	2	-4	.0	-452.1
MD	BALT G&E	GOULD S	0	1724	127	78137	-0.004	398	266471	0.32795	0.00090	0.65371	2	-4	.0	-452.1
FL	TAMPA ELEC	GANNON	581	2304	0	78137	0.021	7557	274028	0.33976	0.00766	0.66137	2	41	0.3	-451.8
MD	DELMARVA P&L	VIENNA	0	2304	282	78419	0.265	898	274926	0.34134	0.00398	0.66534	2	120	0.5	-451.3
FL	GULF POWER	SCHOLTZ	47	2351	0	78419	0.251	586	275512	0.34384	0.00162	0.66696	2	181	0.3	-451.0
FL	GULF POWER	CRIST	772	3123	0	78419	0.435	9333	284845	0.38008	0.02350	0.69047	3	345	8.1	-442.9
NY	NY ST E&GAS	SOMERSE	17	3140	0	78419	2.276	221	285066	0.38091	0.00271	0.69318	3	370	1.0	-441.9
FL	LAKELAND,CTY	PLNT 3-	456	3596	0	78419	0.305	5348	290414	0.39733	0.01064	0.70382	3	387	4.1	-437.8
NJ	ATLTC C ELEC	ENGLAND	369	3965	0	78419	2.279	4761	295175	0.41679	0.05491	0.75873	3	395	21.7	-416.1
FL	SEMINOLE EL	SEMINOL	273	4237	0	78419	0.515	3435	298610	0.43047	0.00887	0.76760	3	399	3.5	-412.6
NY	ROCH G&E COR	ROCHEST	316	4553	0	78419	2.153	4058	302668	0.44344	0.04248	0.81009	3	411	17.5	-395.1
NY	NIAG-MOHAWK	DUNKIK	566	5119	0	78419	2.163	7201	309868	0.46534	0.07176	0.88184	3	434	31.1	-363.9
PA	PENN POW	BRUCE M	2071	7191	0	78419	3.020	25372	335240	0.59434	0.34346	1.22530	4	447	153.7	-210.3
NY	ROCH G&E COR	ROCHEST	100	7290	0	78419	2.136	1303	336543	0.59807	0.01222	1.23752	5	456	5.6	-204.7
NY	NY ST E&GAS	MILLIKE	469	7759	0	78419	2.110	5533	342076	0.61284	0.04839	1.28590	5	483	23.3	-181.4
WV	OHIO POW	KAMMER	903	8662	0	78419	3.197	10944	353020	0.68061	0.13938	1.42528	5	502	70.0	-111.4
NY	NY ST E&GAS	GOUDEY	167	8829	0	78419	2.360	2025	355045	0.68635	0.01881	1.44410	5	508	9.6	-101.8
NY	NY ST E&GAS	GREENID	301	9130	0	78419	2.368	3724	358768	0.69682	0.03428	1.47837	5	514	17.6	-84.2
AL	AL POWER CO	GADSEN	58	9188	0	78419	0.230	770	359538	0.69758	0.00068	1.47905	5	520	0.4	-83.8
NY	JMSTWN BD PU	S.A CAR	62	9250	0	78419	2.473	792	360330	0.69985	0.00744	1.48649	5	526	3.9	-79.9
OH	OHIO POW	MUSKING	1624	10874	0	78419	3.576	10497	370827	0.82733	0.24743	1.73393	6	535	132.3	52.4
PA	PENN P&LT	STORAGE	0	10874	4360	82779	0.609	13720	392547	0.83903	0.03115	1.76507	6	537	16.7	69.1
NY	NIAG-MOHAWK	HUNTLEY	907	11781	0	82779	1.953	11790	404337	0.86433	0.08290	1.84797	7	556	46.1	115.1
OH	OHIO POW	GAVIN	2017	13799	0	82779	2.052	21933	426270	0.97036	0.22132	2.06930	8	565	125.1	240.2
PA	PHIL ELEC	SOUTHWA	0	13799	179	82958	0.313	559	426830	0.97058	0.00060	2.06990	8	583	0.4	240.6
FL	TAMPA ELEC	BIG BEN	1636	15435	0	82958	0.835	19132	445962	1.06251	0.05442	2.12432	8	587	32.0	272.5
IN	SO.IND.G&EL	A B BRO	272	15707	0	82958	2.322	3120	449082	1.08100	0.02242	2.14674	8	646	14.5	287.0
MA	NEW ENG POW	SALEM H	322	16029	0	82958	1.443	4290	453371	1.08870	0.01904	2.16578	8	650	12.4	299.4

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
OH	CLEVE ELILCO	ASHTABU	450	16487	0	82958	3.510	5689	459060	1.11975	0.06026	2.22604	8	664	40.0	339.4
MI	GRHAVEN L&P	J B SIM	60	16546	0	82958	2.620	660	459721	1.12290	0.00519	2.23123	8	667	3.5	342.9
PA	PHIL ELEC	DELAWAR	0	16546	465	83422	0.385	1459	461180	1.12352	0.00167	2.23289	8	674	1.1	344.0
OH	COLUM&SO OH	CONESVI	1643	18189	0	83422	3.552	19444	480624	1.22731	0.20145	2.43434	9	686	138.1	482.1
WV	MONONGAHELA	PLEASAN	1223	19412	0	83422	3.015	15313	495937	1.29202	0.13309	2.56743	9	694	92.3	574.5
OH	COLUM&SO OH	PICWAY	92	19504	0	83422	3.922	1054	496991	1.29809	0.01177	2.57920	9	703	8.3	582.8
PA	WEST PENN PW	MITCHEL	292	19795	0	83422	3.770	3686	500677	1.31283	0.03926	2.61846	10	708	27.8	610.5
AL	TENN VALLEY	COLBERT	1178	20973	0	83422	1.162	13643	514320	1.36307	0.04452	2.66298	10	712	31.7	642.3
IN	IND & MICH	BREED	403	21376	0	83422	2.862	4473	518793	1.39257	0.03577	2.69875	10	716	25.6	667.9
OH	OH VAL EL CO	KYGER C	1159	22535	0	83422	3.795	13914	532707	1.46767	0.14577	2.84453	10	724	105.6	773.5
NH	PS CO N.HAMP	NEWINGT	0	22535	1201	84623	1.015	3805	536512	1.47477	0.01904	2.86357	10	725	13.8	787.3
WV	MONONGAHELA	HARRISO	2149	24684	0	84623	3.054	28273	564785	1.59007	0.23711	3.10067	11	728	172.7	960.0
PA	NORTH STS PO	HIGH BR	101	24786	0	84623	3.395	968	565753	1.59345	0.00902	3.10970	11	729	6.6	966.5
NH	PS CO N.HAMP	SCHILLE	0	24786	132	84755	1.690	419	566172	1.59417	0.00193	3.11162	11	738	1.4	968.0
PA		EDDYSTONE	0	24786	1640	86395	0.425	5156	571328	1.59638	0.00589	3.11752	11	744	4.4	972.3
MA	HOLYOKE WTRP	MT TOM	192	24977	0	86395	1.760	2515	573843	1.60122	0.01195	3.12946	11	744	8.9	981.2
AL	TENN VALLEY	WIDOWS	869	25846	0	86395	1.429	10103	583946	1.64468	0.03851	3.16798	12	750	28.9	1010.1
KY	TENN VALLEY	PARADIS	1992	27838	0	86395	3.390	21615	605561	1.79244	0.19218	3.36016	12	763	146.5	1156.7
OH	OHIO EDISON	BURGER	416	28254	0	86395	3.743	5092	610653	1.81781	0.04924	3.40940	12	774	38.1	1194.8
OH	CLEVE ELILCO	EAST LA	1219	29473	0	86395	3.345	14941	625593	1.88426	0.12899	3.53839	13	775	100.0	1294.7
IN	N. IND PS	BAILLY	394	29866	0	86395	2.310	4284	629878	1.90518	0.02537	3.56375	13	780	19.8	1314.5
TN	TENN VALLEY	CUMBERL	2236	32102	0	86395	1.966	25872	655750	2.02147	0.13018	3.69394	13	781	101.7	1416.3
MD	BALT G&E	CRANE	270	32372	0	86395	2.792	3591	659340	2.03163	0.02557	3.71950	14	784	20.1	1436.3
MA	NEW ENG POW	BRAYTON	904	33276	0	86395	1.634	11890	671231	2.05114	0.04825	3.76775	14	805	38.9	1475.2
PA	PHIL ELEC	RICHMON	0	33276	222	86617	0.421	698	671929	2.05142	0.00073	3.76848	14	806	0.6	1475.8
IN	N. IND PS	MICHIGA	441	33716	0	86617	2.190	4679	676608	2.07196	0.02491	3.79339	14	826	20.6	1496.3
OH	COLUM&SO OH	POSTON	150	33866	0	86617	4.027	1715	678323	2.08049	0.01656	3.80996	14	834	13.8	1510.1
OH	OHIO EDISON	TORONTO	159	34025	0	86617	4.073	1900	680223	2.08997	0.01841	3.82836	14	840	15.5	1525.6
MO	KANS CTY P&L	MONTROS	537	34562	0	86617	2.500	5673	685896	2.14008	0.03488	3.86324	14	842	29.4	1555.0
FL	GULF POWER	SMITH	416	34978	0	86617	0.206	5015	690910	2.14533	0.00340	3.86664	14	844	2.9	1557.8
PA	MET. EDISON	PORTLAN	324	35302	0	86617	3.320	4147	695058	2.15750	0.03263	3.89927	14	846	27.6	1585.4
KY	LOUISVLL G&E	MILL CR	1218	36520	0	86617	3.207	13350	708407	2.23473	0.10034	3.99962	15	853	85.6	1671.1
PA	PENN. ELEC	CONEMAU	1782	38302	0	86617	3.021	21813	730220	2.30722	0.19301	4.19262	15	864	166.7	1837.8
IN	IND & MICH	TANNERS	807	39109	0	86617	2.556	9366	739586	2.35204	0.05532	4.24794	15	866	47.9	1885.6

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
NY	NY ST E&GAS	HICKLIN	166	39275	0	86617	2.462	1877	741463	2.35609	0.01067	4.25861	15	866	9.2	1894.9
KY	BIG RIV REC	RD GREE	867	40142	0	86617	3.389	9090	750553	2.41037	0.07060	4.32921	16	873	61.6	1956.5
KY	LOUISVLL G&E	CANE RU	288	40430	0	86617	3.211	3179	753733	2.42020	0.02330	4.35251	16	876	20.4	1976.9
PA	WEST PENN PW	HATFIEL	1711	42141	0	86617	3.546	22253	775986	2.49572	0.17956	4.53207	16	879	157.8	2134.7
MD	POTOMAC E PO	MORGANT	1028	43169	0	86617	2.749	12063	788049	2.52755	0.08011	4.61217	17	883	70.7	2205.5
MD	POTOMAC E PO	CHALK	714	43882	0	86617	2.732	8949	797799	2.54951	0.05528	4.66745	17	885	48.9	2254.4
PA	PENN P&LT	MARTINS	379	44261	0	86617	3.206	4765	802563	2.56233	0.03415	4.70159	17	894	30.5	2284.9
PA	DUQUESNE LT	PHILLIP	102	44363	0	86617	3.511	1222	803785	2.56591	0.00953	4.71113	17	900	8.6	2293.5
IN	SO.IND.G&EL	WARRICK	168	44532	0	86617	2.972	1830	805616	2.57505	0.01205	4.72318	17	903	10.9	2304.4
NH	PS CO N.HAMP	MERRIMA	508	45040	0	86617	4.062	6881	812496	2.59009	0.06183	4.78501	17	904	55.9	2360.3
OH	CLEVE ELILCO	AVON LA	856	45896	0	86617	3.374	10611	823107	2.63941	0.07865	4.86366	18	910	71.6	2431.9
PA	PENN. ELEC	HOMER C	2461	48356	0	86617	3.804	28106	851213	2.72710	0.23348	5.09714	19	916	213.8	2645.7
TN	TENN VALLEY	GALLATI	1200	49556	0	86617	2.158	14978	866191	2.78997	0.07037	5.16752	19	919	64.6	2710.3
NY	NY ST E&GAS	JENNISO	142	49698	0	86617	2.264	1598	867789	2.79237	0.00786	5.17538	19	920	7.2	2717.6
PA	DUQUESNE LT	ELRAMA	360	50058	0	86617	3.413	4298	872086	2.80420	0.03170	5.20708	19	925	29.3	2746.9
KY	OWENSBORO MU	SMITH	440	50498	0	86617	2.942	4741	876827	2.82732	0.02998	5.23706	19	931	27.9	2774.8
MI	CONSUMERS PO	COBB-SA	331	50829	0	86617	2.649	3988	880815	2.84109	0.02267	5.25973	19	932	21.1	2795.9
MS	MISS. POW	JCKSN C	780	51609	0	86617	0.271	9240	890055	2.84923	0.00536	5.26509	19	934	5.0	2800.9
KY	CINCIN G&E C	EAST BE	834	52443	0	86617	3.071	9444	899499	2.89600	0.06187	5.32697	19	937	58.0	2858.9
PA	PENN. ELEC	SHAWVIL	766	53209	0	86617	3.716	9454	908952	2.92493	0.07489	5.40185	20	938	70.3	2929.2
PA	PENN P&LT	BRUNNER	1921	55129	0	86617	3.372	23906	932859	2.98923	0.17119	5.57305	20	942	161.2	3090.4
AL	AL POWER CO	GASTON	2197	57327	0	86617	1.112	26177	959036	3.05803	0.06168	5.63473	20	944	58.2	3148.6
MO	EMPIRE DISEL	ASBURY	313	57639	0	86617	3.043	3316	962351	3.08927	0.02119	5.65592	21	952	20.2	3168.8
IA	IA EL LT&POW	SUTHERL	117	57756	0	86617	1.530	1231	963582	3.09561	0.00396	5.65986	21	955	3.8	3172.6
OH	OHIO EDISON	NILES	321	58077	0	86617	4.043	3804	967386	3.11201	0.03185	5.69171	21	966	30.8	3203.3
IN	IND-KY EL CO	CLIFTY	1970	60047	0	86617	2.955	22579	989965	3.22504	0.13804	5.82975	21	967	133.4	3336.8
MD	POTOMAC E PO	DICKERS	633	60679	0	86617	2.015	7981	997946	3.24420	0.04642	5.87617	21	968	44.9	3381.7
IA	IA EL LT&POW	PRAIRIE	199	60878	0	86617	0.851	2119	1000065	3.25017	0.00367	5.87984	21	982	3.6	3385.3
NJ	PS E&G-NJ	MERCER	0	60878	0	86617	1.916	8229	1008294	3.26150	0.03196	5.91181	21	987	31.5	3416.9
IN	PS CO INDIAN	GALLAGH	594	61472	0	86617	3.047	6492	1014786	3.29454	0.04007	5.95187	22	987	39.6	3456.4
PA	PENN P&LT	HOLTWOO	130	61601	0	86617	4.056	1261	1016047	3.29841	0.01030	5.96218	22	993	10.2	3466.7
IN	SO.IND.G&EL	CULLEY	508	62109	0	86617	2.955	5576	1021623	3.32565	0.03304	5.99522	22	997	33.0	3499.6
MO	AS ELEC COOP	HILL	1550	63659	0	86617	2.594	15779	1037402	3.44341	0.08198	6.07719	22	999	81.9	3581.5
PA	PENN. ELEC	FRONT S	132	63791	0	86617	3.701	1643	1039045	3.44797	0.01214	6.08933	22	1001	12.2	3593.6

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
IL	CENT IL LT	DUCK CR	294	64085	0	86617	3.072	3100	1042145	3.46577	0.01097	6.10830	22	1004	19.0	3612.7
PA	PENN. ELEC	WARREN	120	64205	0	86617	3.039	1465	1043610	3.46996	0.01115	6.11946	22	1009	11.2	3623.9
MI	DETROIT EDCO	MONROE	3720	67925	0	86617	2.713	45396	1089006	3.61794	0.24373	6.36318	23	1011	246.3	3870.2
PA	PENN P&LT	SUNBURY	657	68581	0	86617	3.706	7350	1096355	3.63050	0.05474	6.41793	23	1017	55.7	3925.9
IN	HOOSIER ENER	MEROM	579	69160	0	86617	2.753	6425	1102780	3.66705	0.03463	6.45255	23	1022	35.4	3961.3
MO	COLUMBIA W&L	COLUMBI	34	69194	0	86617	2.520	357	1103137	3.66955	0.00174	6.45429	23	1036	1.8	3963.1
WI	WISC PWR&LT	BLACKHA	8	69202	0	86617	2.501	89	1103226	3.67002	0.00043	6.45472	23	1037	0.4	3963.5
WV	MONONGAHELA	FT MART	1055	70257	0	86617	2.939	13243	1116469	3.70630	0.07461	6.52933	24	1043	77.8	4041.4
IL	CENT IL PUBS	COFTEEN	945	71202	0	86617	3.762	9722	1126191	3.77198	0.06999	6.59932	24	1045	73.1	4114.5
IN	HOOSIER ENER	FRANK E	308	71510	0	86617	3.001	3303	1129494	3.78782	0.01922	6.61853	24	1059	20.4	4134.9
IN	RICHMND P&LT	WHITEWA	81	71591	0	86617	2.170	906	1130400	3.79008	0.00370	6.62224	24	1063	3.9	4138.8
DE	DELMARVA P&L	INDIAN	1060	72652	0	86617	2.200	13445	1143845	3.81339	0.05526	6.67749	24	1071	59.2	4197.9
WI	WISC PWR&LT	ROCK RI	147	72798	0	86617	2.507	1600	1145525	3.82220	0.00007	6.68556	24	1077	8.7	4206.6
OH	PAINESVLLE E	PAINESS	41	72839	0	86617	3.749	502	1146027	3.82400	0.00348	6.68904	24	1081	3.8	4210.4
WI	DAIRYL PBCO	STONEMA	24	72863	0	86617	2.727	268	1146295	3.82547	0.00135	6.69039	24	1083	1.5	4211.9
NJ	PS E&G-NJ	HUDSON	418	73281	0	86617	2.122	5512	1151807	3.83307	0.02144	6.71183	24	1091	23.4	4235.3
OH	CARDINAL OC	CARDINA	2064	75345	0	86617	3.494	24024	1175831	3.91220	0.15361	6.86544	25	1093	167.9	4403.1
AL	AL POWER CO	GREENE	181	75526	0	86617	1.004	2200	1178111	3.91731	0.00452	6.86996	25	1094	4.9	4408.1
GA	GA POWER	WANSLEY	2024	77550	0	86617	2.423	22007	1200918	4.01351	0.10012	6.97007	25	1104	110.5	4518.6
PA	WEST PENN PW	ARMSTRO	443	77994	0	86617	3.700	5506	1206504	4.02755	0.03740	7.00748	25	1105	41.3	4559.9
PA	PHIL ELEC	EDDYSTO	287	78281	0	86617	3.400	3721	1210225	4.03628	0.02324	7.03072	26	1114	25.9	4585.8
MS	MISS. POW	WATSON	532	78813	0	86617	1.364	6503	1216808	4.06062	0.01602	7.04675	26	1121	18.0	4603.8
WV	VIRGINIA E&P	MOUNT S	1756	80568	0	86617	3.061	21149	1237957	4.11655	0.11502	7.16177	26	1126	129.5	4733.3
WV	OHIO POW	MITCHEL	1200	81768	0	86617	2.604	14004	1252040	4.14009	0.06406	7.22662	26	1131	73.3	4806.6
GA	GA POWER	YATES	1203	82972	0	86617	2.282	13569	1265609	4.20050	0.05454	7.28116	26	1135	61.9	4868.5
WI	WISC PWR&LT	EDGEWAT	478	83450	0	86617	2.546	5142	1270751	4.22553	0.02293	7.30409	27	1142	26.2	4894.7
IN	PS CO INDIAN	CAYUGA	1229	84678	0	86617	2.915	12769	1283520	4.27927	0.06517	7.36926	27	1142	74.4	4969.2
PA	DUQUESNE LT	CHESWIC	624	85302	0	86617	3.375	7733	1291253	4.29633	0.04542	7.41468	27	1149	52.2	5021.4
MO	KANS CTY P&L	GRAND A	20	85322	0	86617	2.375	251	1291505	4.29782	0.00104	7.41572	27	1150	1.2	5022.6
OH	CINCIN G&E C	BECKJOR	854	86176	0	86617	3.424	9463	1300967	4.32673	0.05611	7.47183	27	1155	64.8	5087.4
CT	CT L&P CO	NORWALK	0	86176	1475	88092	1.475	4610	1305577	4.33090	0.01172	7.48355	27	1160	13.6	5101.0
IN	INDNPLIS P&L	PRITCHA	247	86423	0	88092	2.779	2760	1308337	4.34177	0.01318	7.49673	27	1164	15.3	5116.3
MO	ST JOE LT&PW	LAKEROA	50	86473	0	88092	2.714	634	1308971	4.34602	0.00296	7.49969	27	1164	3.4	5119.7
TN	TENN VALLEY	ALLEN	640	87121	0	88092	2.203	7731	1316702	4.37204	0.02913	7.52882	27	1169	34.1	5153.8

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
AL	AL ELEC COOP	TOMBIGB	417	87538	0	88092	1.313	4973	1321675	4.30463	0.01116	7.53998	27	1170	13.1	5166.9
PA	PENN P&LT	MONTOUR	1879	89417	0	88092	3.433	23350	1345025	4.43604	0.13608	7.67605	28	1171	160.3	5327.2
IL	COMMONWTH ED	KINCAID	1614	91031	0	88092	3.781	16482	1361507	4.53569	0.10619	7.78304	28	1174	124.6	5451.8
KY	HENDERSON MP	HENDERS	76	91107	0	88092	3.114	836	1362343	4.53910	0.00443	7.78747	28	1176	5.2	5457.0
CT	UNITED ILLUM	NEW HAV	0	91107	1971	90063	1.416	6187	1368530	4.54438	0.01485	7.80231	28	1180	17.5	5474.5
MO	SPRNGFLD UTI	SOOUTHW	75	91182	0	90063	2.394	900	1369430	4.54966	0.00367	7.80598	28	1184	4.3	5478.9
OH	CINCIN G&E C	MIAMI F	1387	92569	0	90063	3.446	15944	1385382	4.59733	0.09254	7.89852	29	1187	109.9	5588.8
CT	UNITED ILLUM	BRIDGEP	0	92569	2517	92580	1.426	7944	1393326	4.60409	0.01896	7.91749	29	1195	22.7	5611.4
GA	GA POWER	ATKINSO	684	93252	0	92580	2.400	7964	1401290	4.63460	0.03175	7.94924	29	1204	30.2	5649.7
PA	PHIL ELEC	CROMBY	161	93413	0	92580	3.493	2140	1403430	4.63920	0.01227	7.96150	29	1219	14.9	5664.6
CT	CT L&P CO	DEVON	0	93413	1187	93767	1.492	3732	1407162	4.64246	0.00914	7.97064	29	1219	11.1	5675.7
IN	PS CO INDIAN	GIBSON	3002	96415	0	93767	2.826	32252	1439414	4.76457	0.14810	8.11874	30	1231	102.3	5858.0
PA	MET. EDISON	TITUS	242	96657	0	93767	3.313	3146	1442560	4.77089	0.01682	8.13556	30	1240	20.8	5878.9
WV	MONONGAHELA	ALBRIGH	398	97055	0	93767	3.327	4858	1447418	4.78355	0.02605	8.16160	30	1241	32.3	5911.2
IA	MUSCATINE P&	MUSCATI	243	97298	0	93767	1.947	2815	1450233	4.79770	0.00001	8.17042	30	1244	11.0	5922.2
OH	OHIO EDISON	GORGE S	73	97372	0	93767	3.794	885	1451118	4.80045	0.00534	8.17575	30	1259	6.7	5928.9
MO	MISSOURI PS	SIBLEY	378	97749	0	93767	2.365	4113	1455231	4.82240	0.01533	8.19109	30	1269	19.5	5948.3
IN	PS CO INDIAN	WABASH	462	98211	0	93767	2.797	5057	1460288	4.84084	0.02226	8.21335	30	1271	28.3	5976.6
IN	PS CO INDIAN	EDWARDS	69	98280	0	93767	3.159	757	1461045	4.84305	0.00366	8.21701	30	1306	4.8	5981.4
AL	AL POWER CO	JAMES M	831	99111	0	93767	0.500	10400	1471445	4.85282	0.00795	8.22496	30	1308	10.4	5991.8
WI	WISC EL PWR	OAK CRE	1536	100646	0	93767	2.610	18187	1489632	4.93160	0.07215	8.29711	30	1316	94.9	6086.7
PA	PENN. ELEC	SEWARD	242	100888	0	93767	3.900	2933	1492565	4.93821	0.01759	8.31470	30	1327	23.3	6110.1
MO	SPRNGFLD UTI	JAMES R	189	101077	0	93767	2.669	2315	1494879	4.96158	0.00930	8.32401	30	1328	12.4	6122.4
IN	INDNPLIS P&L	STOUT	721	101798	0	93767	2.760	7992	1502872	4.97055	0.03271	8.35672	30	1349	44.1	6166.6
WI	DAIRYL POCO	GENOA N	401	102199	0	93767	2.620	3941	1506813	4.99524	0.01528	8.37200	30	1355	20.7	6187.3
CT	CT L&P CO	MONTVIL	0	102199	983	94750	1.536	3096	1509908	4.99773	0.00699	8.37899	30	1360	9.5	6196.8
IL	SPRNGFLD W,L	DALLMAN	348	102547	0	94750	3.468	3639	1513548	5.01512	0.01853	8.39752	31	1362	25.2	6222.0
IL	SPRNGFLD W,L	LAKESID	42	102589	0	94750	3.466	463	1514011	5.01732	0.00235	8.39987	31	1369	3.2	6225.2
MI	CONSUMERS PO	CAMPBEL	1367	103956	0	94750	2.306	16538	1530549	5.05225	0.05753	8.45740	31	1372	78.9	6304.2
IA	IA-IL GAS&EL	RIVERSI	120	104075	0	94750	2.010	1262	1531811	5.05819	0.00370	8.46110	31	1378	5.1	6309.3
OH	OHIO EDISON	EDGEWAT	126	104201	0	94750	3.542	1532	1533343	5.06225	0.00780	8.46890	31	1378	10.9	6320.1
WI	WISC PWR&LT	NELSON	287	104488	0	94750	2.900	3042	1536385	5.07621	0.01279	8.48176	31	1384	17.7	6337.8
PA	PENN POW	NEW CAS	346	104834	0	94750	3.770	4223	1540608	5.08474	0.02272	8.50448	31	1402	31.8	6369.6
PA	PENN. ELEC	KEYSTON	2058	106892	0	94750	3.955	25523	1566131	5.13003	0.14400	8.64848	31	1402	201.9	6571.5

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
IN	N. IND PS	MITCHEL	213	107105	0	94750	0.700	2352	1568483	5.14101	0.00264	8.65112	31	1402	3.7	6575.2
MO	CENT ELPWCO	CHAMOIS	4	107109	0	94750	3.002	41	1568524	5.14126	0.00018	8.65130	31	1404	0.2	6575.5
IN	INDNPLIS P&L	PETERSB	1671	108779	0	94750	2.985	18398	1586922	5.20561	0.07804	8.72933	32	1408	109.8	6685.3
VA	VIRGINIA E&P	POSSUM	316	109095	0	94750	2.546	4008	1590931	5.21243	0.01447	8.74380	32	1411	20.4	6705.7
OH	OHIO EDISON	SAMMIS	2075	111170	0	94750	3.704	25272	1616203	5.28227	0.13556	8.87935	32	1411	191.3	6897.0
IN	N. IND PS	ROLLIN	972	112142	0	94750	1.458	10822	1627025	5.30064	0.02228	8.90164	32	1416	31.6	6928.6
NJ	DEEPWTR BPCO	DEEPWAT	85	112227	0	94750	2.142	1112	1628137	5.30183	0.00336	8.90500	32	1417	4.8	6933.3
KY	BIG RIV REC	REID-HE	438	112666	0	94750	3.206	5107	1633244	5.31974	0.02329	8.92829	32	1441	33.6	6966.9
MO	INDEPNDNCE P	BLUE VA	89	112754	0	94750	2.646	1060	1634304	5.32531	0.00388	8.93217	32	1446	5.6	6972.5
MA	MONTAUP ELEC	SOMERSE	201	112955	0	94750	1.810	2824	1637128	5.32817	0.00707	8.93923	33	1447	10.2	6982.7
MO	AS ELEC COOP	MADRID	1166	114121	0	94750	2.670	12551	1649680	5.39469	0.04630	8.98554	33	1452	67.2	7049.9
KY	BIG RIV REC	COLEMAN	739	114860	0	94750	2.985	8394	1658074	5.42117	0.03444	9.01998	33	1455	50.1	7100.0
IL	CENT IL PUBS	MEREDOS	259	115120	0	94750	3.507	2923	1660997	5.43437	0.01407	9.03405	33	1457	20.5	7120.6
WI	WISC EL PWR	PT WASH	216	115335	0	94750	2.500	2730	1663727	5.44406	0.00960	9.04365	33	1467	14.1	7134.6
SC	SO.CAR.E&GAS	MCMEEKI	268	115603	0	94750	2.335	3402	1667128	5.45359	0.01076	9.05442	33	1476	15.9	7150.5
SC	S.C.PUB SERV	GRAINGE	128	115732	0	94750	2.413	1549	1668678	5.45768	0.00504	9.05946	33	1483	7.5	7158.0
TN	TENN VALLEY	SEVIER	788	116519	0	94750	2.166	9605	1678282	5.48234	0.02761	9.08707	33	1507	41.6	7199.6
WV	MONONGAHELA	WILLOW	171	116691	0	94750	2.000	2115	1680397	5.48626	0.00805	9.09512	33	1514	12.2	7211.8
IL	IL POWER	BALDWIN	2443	119134	0	94750	3.933	26140	1706537	5.61291	0.13496	9.23008	34	1524	205.6	7417.4
IL	IL POWER	HENNEPI	473	119607	0	94750	3.000	5168	1711705	5.63709	0.02577	9.25584	34	1527	39.4	7456.8
IA	IA SO UTILS	BURLING	165	119772	0	94750	2.132	1861	1713565	5.64539	0.00517	9.26101	34	1535	7.9	7464.7
KY	KENTUCKY UTI	GREEN R	183	119955	0	94750	3.222	2097	1715662	5.65209	0.00872	9.26973	34	1549	13.5	7478.2
SC	S.C.PUB SERV	JEFFERI	228	120182	0	94750	2.422	2778	1718440	5.65906	0.00859	9.27832	34	1566	13.5	7491.7
KY	KENTUCKY UTI	GHENT	1235	121418	0	94750	2.591	14900	1733340	5.69606	0.04916	9.32749	34	1570	77.2	7568.9
IL	CENT IL PUBS	GRAND T	204	121621	0	94750	3.050	2317	1735656	5.70752	0.01136	9.33885	34	1571	17.8	7586.7
IA	INTERSTATE P	DUBUQUE	80	121701	0	94750	2.091	844	1736500	5.71112	0.00224	9.34109	34	1573	3.5	7590.2
TN	TENN VALLEY	JOHNSON	1045	122746	0	94750	2.502	11673	1748173	5.74404	0.03685	9.37794	34	1585	50.4	7640.6
IA	EASTRN IA L&P	FAIR	54	122800	0	94750	2.300	600	1748772	5.74682	0.00173	9.37967	34	1599	2.8	7651.4
GA	GA POWER	BOWEN	3763	126563	0	94750	2.362	45608	1794381	5.87618	0.13463	9.51430	35	1600	215.5	7866.9
WI	WISC PUB SER	PULLIAM	264	126827	0	94750	2.347	3167	1797548	5.88626	0.00923	9.52353	35	1610	14.9	7881.7
IA	INTERSTATE P	KAPP	218	127044	0	94750	2.035	2289	1799837	5.89549	0.00575	9.52928	35	1619	9.3	7891.1
MO	SIKESTON MUN	SIKESTO	334	127378	0	94750	2.330	3791	1803628	5.91110	0.01086	9.54014	35	1632	17.7	7908.8
IL	SO.ILL PWR.C	MARION	262	127639	0	94750	4.253	2704	1806332	5.92428	0.01404	9.55419	35	1638	23.0	7931.8
DE	DELMARVA P&L	EDGEMOO	322	127962	0	94750	2.152	4245	1810578	5.92800	0.01111	9.56530	35	1645	18.3	7950.1

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
IL	CENT IL PUBS	HUTSONV	211	128173	0	94750	3.873	2370	1812947	5.93914	0.01102	9.57631	35	1666	18.4	7968.4
SC	SO.CAR.E&GAS	CANADYS	397	128570	0	94750	2.191	5113	1818060	5.95000	0.01339	9.58970	35	1673	22.4	7990.8
MD	BALT G&E	WAGNER	300	128870	0	94750	2.468	3916	1821976	5.95459	0.01155	9.60126	35	1673	19.3	8010.1
VA	VIRGINIA E&P	PORTSMO	410	129280	0	94750	2.452	5151	1827127	5.96168	0.01502	9.61627	35	1682	25.3	8035.4
MD	POTOMAC ED C	SMITH	96	129376	0	94750	2.747	1218	1828345	5.96325	0.00396	9.62023	35	1691	6.7	8042.1
WV	CENT OPER CO	SPORN	872	130248	0	94750	2.461	10540	1838885	5.97816	0.03067	9.65089	35	1692	51.9	8094.0
MO	UNION ELEC	SIOUX	1002	131250	0	94750	2.690	10924	1849809	6.02794	0.03465	9.68555	35	1696	58.8	8152.7
KY	KENTUCKY UTI	BROWN	565	131815	0	94750	3.190	6759	1856568	6.04746	0.02540	9.71094	35	1702	43.2	8196.0
VA	VIRGINIA E&P	CHESTER	1106	132921	0	94750	2.626	13994	1870562	6.06776	0.04302	9.75396	35	1709	73.5	8269.5
CT	HARTFORD ELC	MIDDLET	0	132921	1662	96412	1.069	5190	1875752	6.07005	0.00644	9.76040	35	1724	11.1	8280.6
FL	GAIN-ALACNTY	DEERHAV	324	133244	0	96412	0.535	4161	1879913	6.07395	0.00253	9.76292	36	1761	4.5	8285.0
OH	DAYTON P&LCO	STUART	2413	135657	0	96412	3.300	27993	1907906	6.12782	0.10455	9.86747	36	1767	184.8	8469.8
VA	APPAL POWER	GLEN LY	172	135830	0	96412	2.241	2099	1910004	6.13033	0.00532	9.87279	36	1768	9.4	8479.2
AL	AL POWER CO	GORGAS	2816	138646	0	96412	1.166	34081	1944085	6.18102	0.04492	9.91771	36	1769	79.5	8558.7
OH	TOLEDO EDISO	BAY SHO	566	139212	0	96412	2.946	7467	1951552	6.19344	0.02412	9.94183	36	1824	44.0	8602.7
GA	GA POWER	ARKWRIG	110	139322	0	96412	2.269	1371	1952923	6.19671	0.00340	9.94523	36	1828	6.2	8608.9
IL	CENT IL PUBS	NEWTON	761	140083	0	96412	3.308	8817	1961740	6.22711	0.03239	9.97762	36	1844	59.7	8668.6
MI	HOLLAND BD	JAMES D	67	140150	0	96412	2.542	855	1962595	6.22853	0.00233	9.97996	36	1863	4.3	8673.0
VA	VIRGINIA E&P	BREMO B	266	140415	0	96412	2.358	3317	1965913	6.23240	0.00820	9.98816	36	1907	15.6	8688.6
WV	MONONGAHELA	RIVESVI	118	140533	0	96412	2.976	1463	1967375	6.23453	0.00439	9.99255	36	1902	8.7	8697.3
KY	TENN VALLEY	SHAWNEE	1299	141832	0	96412	2.309	16154	1983529	6.26446	0.03892	10.03147	36	1983	77.2	8774.5
VA	POTOMAC E PO	POTOMAC	461	142293	0	96412	2.411	6017	1989546	6.27118	0.01424	10.04571	37	2037	29.0	8803.5
GA	GA POWER	HAMMOND	647	142940	0	96412	2.327	8162	1997709	6.28900	0.01856	10.06427	37	2047	38.0	8841.5
MO	UNION ELEC	LABADIE	2655	145595	0	96412	2.733	30051	2027759	6.40116	0.08016	10.14443	37	2049	164.3	9005.8
MI	DETROIT EDCO	CONNERS	66	145661	0	96412	2.150	814	2028573	6.40519	0.00170	10.14613	37	2060	3.5	9009.3
MI	DETROIT EDCO	MARYSVI	91	145751	0	96412	2.100	1138	2029712	6.40659	0.00232	10.14845	37	2065	4.8	9014.0
SC	SO.CAR.E&GAS	URGUHAR	223	145974	0	96412	2.250	2895	2032606	6.41169	0.00629	10.15473	37	2073	13.0	9027.1
MI	DETROIT EDCO	HARBOR	19	145993	0	96412	2.004	229	2032835	6.41197	0.00046	10.15519	37	2081	1.0	9028.0
SC	SO.CAR.E&GAS	WATEREE	817	146810	0	96412	2.192	10506	2043341	6.42990	0.02212	10.17731	37	2082	46.1	9074.1
NC	CAROLINA P&L	CAPE FE	198	147008	0	96412	3.090	2439	2045779	6.43404	0.00695	10.18426	37	2170	15.1	9089.1
IL	IL POWER	VERMILI	305	147313	0	96412	4.140	3235	2049014	6.44555	0.01227	10.19653	37	2182	26.8	9115.9
KY	EAST KY REC	COOPER	252	147565	0	96412	3.343	3087	2052101	6.45281	0.00944	10.20597	37	2186	20.6	9136.6
SC	CAROLINA P&L	ROBINSO	109	147674	0	96412	2.599	1346	2053447	6.45539	0.00318	10.20915	37	2202	7.0	9143.6
WV	APPAL POWER	KANAWHA	274	147948	0	96412	2.753	3165	2056612	6.45919	0.00782	10.21697	37	2229	17.4	9161.0

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
NC	CAROLINA P&L	WEATHER	81	140029	0	96412	3.098	999	2057610	6.46082	0.00274	10.21970	37	2262	6.2	9167.2
WV	APPAL POWER	AMOS	2333	150362	0	96412	2.558	28639	2086249	6.49232	0.06478	10.28448	37	2262	146.5	9313.7
NC	CAROLINA P&L	LEE	283	150645	0	96412	3.066	3514	2089763	6.49798	0.00950	10.29398	37	2268	21.5	9335.2
MI	LANSING W&LT	OTTAWA	12	150657	0	96412	2.252	161	2089924	6.49817	0.00032	10.29430	37	2278	0.7	9336.0
GA	GA POWER	HARLLEE	1352	152009	0	96412	2.211	17069	2106993	6.52979	0.03291	10.32721	38	2294	75.5	9411.4
TN	TENN VALLEY	KINGSTO	1284	153293	0	96412	2.140	15249	2122242	6.55522	0.02847	10.35568	38	2301	65.5	9477.0
VA	APPAL POWER	CLINCH	658	153952	0	96412	2.495	8308	2130550	6.56364	0.01783	10.37351	38	2325	41.5	9518.4
GA	GA POWER	MITCHEL	200	154152	0	96412	2.237	2574	2133124	6.56839	0.00495	10.37846	38	2327	11.5	9529.9
MI	DETROIT EDCO	TRENTON	500	154651	0	96412	2.096	6505	2139629	6.57550	0.01170	10.39016	38	2330	27.3	9557.2
IL	ELEC ENERGY	JOPPA	1085	155737	0	96412	3.643	12772	2152401	6.61261	0.03955	10.42970	38	2353	93.1	9650.2
MS	S MISS EL PO	R D MOR	485	156222	0	96412	1.121	5989	2158390	6.62125	0.00569	10.43540	38	2360	13.4	9663.7
MI	CONSUMERS PO	KARN-WE	955	157177	0	96412	2.342	11783	2170173	6.63535	0.02322	10.45861	38	2377	55.2	9718.9
SC	S.C.PUB SERV	CROSS	117	157294	0	96412	2.432	1418	2171591	6.63765	0.00284	10.46145	38	2433	6.9	9725.8
SC	S.C.PUB SERV	WINYAH	1102	158396	0	96412	2.408	13420	2185011	6.65987	0.02642	10.48787	38	2446	64.6	9790.4
MO	KANS CTY P&L	HAWTHOR	279	158675	0	96412	2.389	2977	2187988	6.66740	0.00579	10.49366	38	2455	14.2	9804.6
NC	DUKE POWER	MARSHAL	1758	160433	0	96412	2.821	21811	2209799	6.69682	0.04943	10.54310	38	2489	123.1	9927.7
MI	DETROIT EDCO	RIVER R	512	160945	0	96412	2.339	6152	2215952	6.70383	0.01154	10.55464	38	2494	28.8	9956.5
MI	LANSING W&LT	ECKERT	218	161163	0	96412	2.002	2821	2218773	6.70665	0.00464	10.55928	38	2529	11.7	9968.2
GA	GA POWER	SCHERER	548	161710	0	96412	1.211	7193	2225966	6.71325	0.00687	10.56616	38	2535	17.4	9985.6
NC	DUKE POWER	RIVERBE	70	161780	0	96412	3.060	885	2226851	6.71453	0.00214	10.56829	38	2541	5.4	9991.1
MI	UPPER PEN GE	PRESQUE	543	162323	0	96412	2.236	5172	2232022	6.72000	0.00901	10.57730	38	2567	23.1	10014.2
KY	EAST KY REC	SPURLOC	512	162835	0	96412	2.761	6143	2238165	6.73013	0.01319	10.59049	39	2573	33.9	10048.1
MI	LANSING W&LT	ERICKSO	190	163025	0	96412	2.120	2463	2240628	6.73259	0.00405	10.59454	39	2578	10.4	10058.5
NC	DUKE POWER	ALLEN	605	163630	0	96412	2.084	7535	2248163	6.74261	0.01683	10.61136	39	2583	43.5	10102.0
NC	DUKE POWER	CLIFFSI	456	164086	0	96412	3.247	5733	2253896	6.75114	0.01434	10.62570	39	2597	37.2	10139.2
NC	DUKE POWER	BELEWS	2417	166503	0	96412	3.011	30095	2283990	6.79247	0.06944	10.69514	39	2610	181.2	10320.5
MI	MARQUETTE L&	SHIRAS	79	166582	0	96412	2.323	773	2284763	6.79330	0.00135	10.69649	39	2655	3.6	10324.1
MI	DETROIT EDCO	ST CLAI	2099	168681	0	96412	2.490	20771	2305535	6.81672	0.03858	10.73507	39	2690	103.8	10427.8
MI	CONSUMERS PO	WHITING	378	169059	0	96412	2.701	4658	2310193	6.82223	0.00908	10.74415	39	2772	25.2	10453.0
WV	APPAL POWER	MOUNTAI	1180	170239	0	96412	2.481	14691	2324883	6.83497	0.02620	10.77035	39	2782	72.9	10525.9
SC	DUKE POWER	LEE	96	170334	0	96412	2.519	1231	2326114	6.83677	0.00223	10.77257	39	2785	6.2	10532.1
NC	CAROLINA P&L	SUTTON	352	170686	0	96412	2.933	4293	2330407	6.84209	0.00893	10.78151	39	2819	25.2	10557.3
KY	KENTUCKY POW	BIG SAN	1168	171854	0	96412	2.976	14124	2344530	6.86501	0.02981	10.81131	39	2820	84.1	10641.3
WI	MADISON G&E	BLOUNT	38	171891	0	96412	2.451	426	2344956	6.86581	0.00074	10.81205	39	2830	2.1	10643.4

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
WI	WISC EL PWR	VALLEY	11	171902	0	96412	2.399	137	2345093	6.86606	0.00023	10.81228	39	2844	0.7	10644.1
NC	CAROLINA P&L	ASHEVIL	470	172372	0	96412	3.238	6109	2351202	6.87428	0.01380	10.82608	39	2867	39.6	10683.6
TN	TENN VALLEY	BULL RU	1005	173377	0	96412	2.152	11543	2362744	6.88965	0.01721	10.84328	39	2887	49.7	10733.3
OH	COLUM DIV EL	REFUSE&	29	173406	0	96412	3.459	370	2363114	6.89009	0.00087	10.84415	39	2941	2.6	10735.9
NC	CAROLINA P&L	ROXBORO	2666	176072	0	96412	2.954	33121	2396235	6.92097	0.06531	10.90946	40	2996	195.7	10931.6
NC	DUKE POWER	DAN RIV	11	176084	0	96412	3.397	140	2396378	6.92916	0.00032	10.90978	40	3024	1.0	10932.5
NC	DUKE POWER	BUCK	44	176127	0	96412	3.290	532	2396987	6.92984	0.00115	10.91093	40	3055	3.5	10936.0
WI	DAIRYL POCO	ALMA-MA	609	176736	0	96412	2.400	5348	2402255	6.93904	0.00843	10.91936	40	3147	26.5	10962.5
MN	ROCH DPT PU	SILVER	101	176837	0	96412	1.784	1240	2403496	6.94242	0.00140	10.92076	40	3159	4.4	10967.0
OH	CLEVE ELILCO	LAKE SH	143	176980	0	96412	2.803	1885	2405381	6.94412	0.00330	10.92405	40	3205	10.6	10977.5
OH	DAYTON P&LCO	HUTCHIN	109	177089	0	96412	2.744	1373	2406753	6.94533	0.00235	10.92640	40	3207	7.5	10985.1
KY	KENTUCKY UTI	TYRONE	8	177097	0	96412	2.944	101	2406854	6.94547	0.00018	10.92659	40	3242	0.6	10985.7
WI	WISC PUB SER	WESTON	491	177587	0	96412	2.175	4440	2411295	6.95183	0.00583	10.93241	40	3315	19.3	11005.0
GA	SAVANNAH E&P	PT WENT	210	177797	0	96412	2.393	2755	2414050	6.95560	0.00392	10.93634	40	3360	13.2	11018.2
LA	CAJUN EPC	BIG CAJ	904	178701	0	96412	0.751	7384	2421433	6.96259	0.00327	10.93961	40	3391	11.1	11029.2
IL	COMMONWTH ED	JOLIET	830	179531	0	96412	1.973	7935	2429368	6.97096	0.00891	10.94852	40	3513	31.3	11060.6
MO	UNION ELEC	MERAMEC	406	179936	0	96412	2.339	4785	2434153	6.98000	0.00635	10.95487	40	3524	22.4	11082.9
OH	HAMILTON,CTY	HAMILTO	57	179993	0	96412	3.649	705	2434858	6.98082	0.00145	10.95632	40	3559	5.1	11088.1
IN	COMMON ED-IN	STATE L	532	180524	0	96412	1.683	5061	2439919	6.98455	0.00452	10.96084	40	3586	16.2	11104.3
NC	CAROLINA P&L	MAYO	844	181368	0	96412	2.090	10412	2450330	6.99443	0.01659	10.97743	40	3628	60.2	11164.5
GA	SAVANNAH E&P	MCINTOS	187	181556	0	96412	2.353	2452	2452782	6.99746	0.00316	10.98059	40	3652	11.5	11176.0
IL	COMMONWTH ED	WILL CO	984	182540	0	96412	2.096	9333	2462115	7.00738	0.01057	10.99115	40	3703	39.1	11215.1
IL	COMMONWTH ED	FISK	206	182746	0	96412	2.041	1960	2464075	7.00938	0.00213	10.99328	40	3752	8.0	11223.2
WI	MANITOWAC PU	MANITOW	46	182792	0	96412	2.240	566	2464641	7.01012	0.00068	10.99396	40	3767	2.5	11225.7
OH	DAYTON P&LCO	KILLEN	208	183000	0	96412	3.242	2596	2467237	7.01241	0.00444	10.99840	40	3794	16.8	11242.5
IL	COMMONWTH ED	WAUKEGA	761	183761	0	96412	2.154	7262	2474499	7.02000	0.00817	11.00657	40	3828	31.3	11273.8
ME	CENT ME POW	WYMAN	0	183761	1653	98065	2.990	5194	2479694	7.02526	0.00809	11.01466	40	3839	31.1	11304.9
IL	COMMONWTH ED	CRAWFOR	474	184235	0	98065	2.100	4497	2484191	7.02986	0.00490	11.01956	40	3868	19.0	11323.8
MN	NORTH STS PO	BLACK D	102	184336	0	98065	2.100	934	2485125	7.03231	0.00102	11.02058	40	3872	3.9	11327.8
OH	TOLEDO EDISO	ACME	65	184401	0	98065	3.555	843	2485968	7.03310	0.00153	11.02211	40	3909	6.0	11333.8
KY	EAST KY REC	DALE	76	184477	0	98065	3.361	915	2486883	7.03428	0.00154	11.02365	40	4006	6.2	11339.9
LA	CENT LA ELEC	RODEMAC	308	184785	0	98065	0.970	2740	2489623	7.03677	0.00117	11.02481	40	4555	5.3	11345.2
MN	OTTER TAIL P	HOOT LA	111	184896	0	98065	2.172	765	2490388	7.03848	0.00071	11.02553	40	4673	3.3	11348.6
WI	WISC PWR&LT	COLUMBI	1643	186539	0	98065	2.581	14068	2504456	7.05534	0.01544	11.04096	40	4784	72.6	11421.2

1	2 COMPANY	3 PLANT	4 COAL	5 CUM COAL	6 OIL	7 CUM OIL	8 PRICE DIFF.	9 TOTAL BBTU	10 GAS USED	11 CUM EMISSION	12 DEP SUMMER	13 CUM DEP	14 % CHANGE DEP	15 $/kg SO4 REMOVED	16 COST	17 CUM COST
LA	GULF STS UTI	NELSON	602	187140	0	90065	0.985	5340	2509795	7.06010	0.00223	11.04319	40	4719	10.5	11431.7
MN	NORTH STS PO	RIVERSI	251	187392	0	90065	2.359	2392	2512187	7.06585	0.00239	11.04558	40	4725	11.3	11443.0
MO	UNION ELEC	RUSH IS	1332	188723	0	90065	2.779	14166	2526353	7.08958	0.01652	11.06210	40	4767	78.7	11521.7
IL	CENT IL LT	EDWARDS	593	189316	0	90065	3.267	7324	2533677	7.09896	0.01000	11.07209	40	4786	47.9	11569.6
IA	IOWA POW&LT	DES MOI	15	189330	0	90065	2.200	123	2533800	7.09915	0.00012	11.07221	40	4793	0.6	11570.1
IA	INTERSTATE P	LANSING	395	189725	0	90065	1.815	3395	2537195	7.10320	0.00252	11.07473	40	4804	12.3	11582.5
IL	COMMONWTH ED	POWERTO	2090	191815	0	90065	2.659	19526	2556721	7.12201	0.02004	11.09478	40	5181	103.8	11686.3
MN	INTERSTATE P	FOX LAK	22	191838	0	90065	1.500	194	2556915	7.12228	0.00011	11.09489	40	5281	0.6	11686.9
IL	IL POWER	WOOD RI	179	192017	0	90065	2.776	1927	2558842	7.12406	0.00189	11.09678	40	5660	10.7	11697.6
AR	AR POWER&LT	WHITEBL	2003	194020	0	90065	1.384	17807	2576649	7.13992	0.00863	11.10541	40	5711	49.3	11746.9
MN	NORTH STS PO	KING	606	194626	0	90065	2.227	5536	2582185	7.15028	0.00431	11.10971	40	5728	24.7	11771.5
IL	IL POWER	HAVANA	145	194771	0	90065	2.611	1562	2583746	7.15156	0.00136	11.11107	40	6001	8.2	11779.7
IL	CENT IL LT	WALLACE	58	194828	0	90065	3.210	765	2584511	7.15226	0.00075	11.11182	40	6591	4.9	11784.6
IA	IOWA PUB SER	GEO. NE	1446	196274	0	90065	2.153	13236	2597747	7.16553	0.00827	11.12009	40	6896	57.0	11841.6
AR	AR POWER&LT	INDEPEN	1550	197824	0	90065	1.477	13536	2611283	7.17585	0.00562	11.12570	40	7120	40.0	11881.6
MN	MINN. P&LT	BOSWELL	1273	199097	0	90065	2.589	11001	2622284	7.19418	0.00762	11.13332	40	7476	57.0	11938.5
WI	WISC EL PWR	PLEASAN	869	199966	0	90065	2.684	7103	2629387	7.19934	0.00473	11.13805	41	8069	38.1	11976.7
MN	NORTH STS PO	SHERBUR	2299	202265	0	90065	2.475	20216	2649603	7.22789	0.01187	11.14992	41	8430	100.1	12076.7
AR	SO.WEST.E PW	FLINT C	843	203108	0	90065	1.792	7040	2656643	7.23335	0.00297	11.15289	41	8495	25.2	12102.0
IA	IA-IL GAS&EL	LOUISA	306	203413	0	90065	2.057	2579	2659222	7.23511	0.00110	11.15398	41	9608	10.6	12112.6
IA	IOWA POW&LT	COUNCIL	1242	204655	0	90065	2.510	10383	2669604	7.24293	0.00407	11.15805	41	10698	52.1	12164.7
IA	IA SO UTILS	OTTUMWA	906	205561	0	90065	2.327	7644	2677248	7.24815	0.00326	11.16210	41	10950	35.6	12200.3
MO	KANS CTY P&L	IATAN	1173	206733	0	90065	2.878	10355	2687603	7.25511	0.00485	11.16695	41	12294	59.6	12259.9
			206733		90065			2687603			11.16695				12260	