NERA
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A White Paper for TXU

TXU Activities Regarding Actual and Potential US Air Emissions and Climate Change Policies

Prepared by NERA Economic Consulting, in collaboration with Marc Goldsmith & Associates, LLC

September 2004

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How Markets Work℠

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Acknowledgements

This White Paper was requested and funded by TXU in order to provide an independent assessment of TXU's activities related to air emissions and climate change. The study does not address the public policy desirability of potential climate change or other air emissions regulations, but rather whether TXU's activities are in its shareholders' financial interests. Moreover, the study relates to TXU and its current participation in the deregulated Texas electricity markets; the analyses are not necessarily transferable to other companies, other markets, or to the electricity sector as a whole.

NERA Economic Consulting (NERA) conducted the study in collaboration with Marc Goldsmith of Marc Goldsmith & Associates LLC (MGA). NERA is an international firm of approximately 500 staff members with nine offices in the US, four offices in Europe as well as offices in Australia, Japan and Brazil that has extensive experience in energy and environmental policy issues, including those related to climate change. Dr. David Harrison of NERA directed the project and is the principal author of the White Paper. The other authors of the study are Marc Goldsmith (primary responsibility for Section 2 as well as contributions to other parts of the report) of MGA, as well as Daniel Radov (primary responsibility for Section 6, with contributions to other parts of the report) and Jonathan Falk (who contributed to various methodological assessments in the report) of NERA. Other individuals who contributed to the White Paper include James Patchett, Matthew Evans, Alex Lenkoski, David Biegel, Jesse David, and Mike King of NERA and Karen Hamilton of MGA.

The study benefited from the assistance of numerous individuals at TXU, most notably Dr. Ed Powell, who provided us with numerous internal TXU documents and arranged our meetings with TXU officials. We would also like to acknowledge the substantial help of Kenneth Price, particularly in assisting with our illustrative analyses of the costs to TXU of reducing its carbon dioxide emissions. Appendix A provides a full list of the TXU officials with whom we met. (Note that during the preparation of the White Paper, TXU was undergoing numerous organizational changes; although descriptions of TXU in the White Paper may not reflect the current company structure as it relates to names, organizations and reporting relationships, the findings of the White Paper are not affected by these differences.) NERA is grateful to these individuals for their assistance. Responsibility for the report, however, and for any errors or omissions it may contain, rests solely with NERA.

About the Authors

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Dr. Harrison is co-chair of NERA's energy practice and directs NERA's environmental economics practice. At NERA, Dr. Harrison has directed numerous studies related to energy and environmental issues. These studies include analyses of individual environmental and energy policies, climate change policy, and the use of emissions trading and other innovative policy approaches. He has served as a consultant in these and other areas to numerous public and private organizations including the US Environmental Protection Agency, the Organization for Economic Cooperation and Development, the European Commission, and various federal, state and local governments. Dr. Harrison has participated in the development or evaluation of the major emissions trading programs in the US and abroad, including most recently the European Union Emissions Trading Scheme for greenhouse gases. He has served as a consultant to the European Commission as well as the U.K. government with regard to the design and implementation of the European Union program. In addition, he has directed numerous studies for individual companies in the US, Europe and Asia on the impacts of climate change policies. Before joining NERA, Dr. Harrison was an Associate Professor at the John F. Kennedy School of Government at Harvard University, where he taught microeconomics, energy and environmental policy, benefit-cost analysis, economic impact assessment, and other subjects for more than a decade. He earlier served as Senior Staff Economist on the President's Council of Economic Advisors, where his areas of responsibility included energy and environmental regulation. Dr. Harrison is the author or co-author of five books and monographs, as well as many articles in professional journals, and he is a frequent speaker at international conferences on energy and environmental policy. He received a Ph.D. in Economics from Harvard University, a M.Sc. in Economics from the London School of Economics, and a B.A. in Economics from Harvard College.

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Mr. Goldsmith is a founder and directs operations of MGA. Mr. Goldsmith has provided technical, environmental and management consulting services to electric and gas utilities, independent power companies and large energy users for over thirty years. He has directed, managed, and conducted over a dozen studies on environmental externalities including managing a multi-disciplinary, year-long study on Hawaiian island externalities of power generation. He has served as a consultant to a number of the ten largest as well as the ten smallest utilities in the US. Most recently, he has facilitated business planning programs for a number of electric utilities entering the renewable energy business area. Prior to founding MGA Mr. Goldsmith was a Vice President in Strategic Energy Business at Stone & Webster Management Consultants Inc. (SWMCI), where he led a survey of electric utility implementation of the Sarbanes-Oxley law on corporate governance. Before joining SWMCI, Mr. Goldsmith was a Director in Arthur D. Little's Technology and Innovation Management Group, where he consulted on new technology introduction and business models. He is one of the founders of Energy Research Group, Inc. where he served as President for over twenty years. Mr. Goldsmith has testified before numerous legislatures and regulatory bodies and has authored several hundred technical and policy reports. He is the in-coming Vice President for Public Information, for the American Society of Mechanical Engineers International and is a Fellow of the Society. He earned the Degree of Nuclear Engineer and a Masters of Nuclear Engineering from Massachusetts Institute of Technology and a B.S. in Marine Nuclear Science from the State University of New York Maritime College at Fort Schuyler.

Daniel Radov, Senior Consultant at NERA

Mr. Radov works in NERA's energy and environment practices. His work concentrates on environmental and energy economics, with a focus on emissions trading, climate change, and economic issues associated with environmental regulations. Mr. Radov's work has spanned a range of industries, including electric power, automobile and engine manufacturing, forest and paper products, cement, agrochemicals, and refining. Mr. Radov has assisted the UK government in developing its National Allocation Plan and evaluating its current emissions trading program for greenhouse gases. In addition, he recently prepared a study for the European Commission evaluating the initial allocation of allowances in their proposed greenhouse gas emissions trading program. Mr. Radov has studied and evaluated the design, implementation, and effects on different industries of other emissions trading programs, including existing and proposed greenhouse gas trading programs in the US and Europe. He also directed a study for the European Commission assessing the prospects for developing an emissions trading program for emissions from marine sources. Mr. Radov holds a BA in Chemistry and Philosophy from Williams College and an M.Phil. from the University of Cambridge.

Jonathan Falk, Vice President at NERA

Mr. Falk has worked in the energy practice on a variety of issues involving the modeling of investment and industry structure. He has recently been involved in the creation of novel insurance products to transfer price risk in electric markets. He is the current developer of the NERA Electric Market Model, which estimates market-clearing prices in heretofore regulated markets. He has studied market power questions in emerging electricity markets and has estimated the social benefits of real-time pricing options for electricity as well as questions of valuation and the financial risks associated with restructured electric markets. He has advised on the structure of market rules. Finally, he has created a number of models to value flexibility in electric company planning. Mr. Falk holds a BA and a MA in Economics, both from Yale University, where he completed the Ph.D. examination requirements.

Executive Summary

TXU and other electricity companies have long histories of addressing air emissions issues. The path-breaking 1970 amendments to the 1963 Clean Air Act established a national framework for addressing air quality. In 1990, Congress passed further major amendments to the Clean Air Act that added a variety of new requirements, including an innovative national emissions trading program for emissions of sulfur dioxide from electricity generators and other requirements that have resulted in additional state controls on emissions of nitrogen oxides. Recent attention has focused on the possibility of requirements to control other emissions, notably mercury and particularly carbon dioxide and other greenhouse gas emissions.

We emphasize that although we conclude that costly actions to reduce carbon dioxide emissions are likely to be premature right now, we believe that TXU shareholders are well served by specific TXU actions related to potential future air emissions and climate change regulations that build upon the foundation of TXU's experience as outlined here.

TXU (along with other companies) has received two shareholder resolutions—one for 2003 and one for 2004—that question the extent to which TXU's activities with regard to air emissions and climate change are in shareholders' interests. The resolutions raise the question of whether TXU is taking prudent steps to deal with the possibility of future air emissions regulations, particularly those related to carbon dioxide emissions. TXU asked NERA Economic Consulting in collaboration with Marc Goldsmith and Associates to develop an independent White Paper to consider the issues raised by the shareholder resolutions. The first task was to identify the issues and concerns that lay behind the resolutions. We conclude that the shareholder resolutions can be usefully characterized as raising three general sets of concerns.

1. *Concern that TXU does not have the institutions and related procedures in place to evaluate properly the financial consequences of air emissions and climate change regulations.*
2. *Concern that TXU does not take appropriate actions to maximize shareholder value in light of current environmental regulations.*
3. *Concern that TXU is not taking appropriate actions to reduce carbon dioxide emissions in anticipation of potential future regulatory requirements.*

This White Paper considers these issues in some detail. The paper evaluates the internal institutions and the methodologies that TXU has in place to track and to evaluate air emissions and climate change policies. We consider in some detail TXU's past and current responses to two major air emissions issues, the federal acid rain trading program for sulfur dioxide emissions and the detailed Texas state requirements for nitrogen oxide emissions. We identify the actions that TXU currently is taking with respect to mercury and carbon dioxide emissions and then consider the desirability of TXU taking substantial unilateral actions now to reduce its carbon dioxide emissions in anticipation of potential mandatory regulations in the US, an issue explicitly raised in the shareholder resolutions.

It is important to emphasize that this paper does ***not*** *address the public policy desirability of mandatory regulation of carbon dioxide emissions. Rather, we consider only the private actions that TXU has undertaken and whether* ***unilateral actions*** *by TXU right now to reduce its carbon dioxide emissions would be in its shareholders' financial interests.*

The following are the principal conclusions of the White Paper.

1. *TXU has appropriate institutions in place—including analytical processes, internal task forces, and external relationships—to track legislative and regulatory initiatives related to air emissions and climate change and to consider the potential financial risks and opportunities to TXU.*
2. *TXU uses appropriate economic methodologies to evaluate the financial consequences of alternative air emissions and climate change policies and scenarios. These methodologies take into account the large number of complexities involved (such as the complexity of the regulations, uncertainties regarding potential emissions control technologies, and the complicated interactions among various actual and potential regulatory requirements). Moreover, the level of detail of the TXU analysis changes appropriately as policies move from general proposals to specific requirements.*
3. *TXU has put in place appropriate internal policies to develop cost-effective compliance plans and has implemented these plans in responding to current air emissions requirements. These cost-effective policies include appropriate use of allowance markets and other compliance flexibility provided by existing regulations.*
4. *TXU has consistently met the air emissions requirements of its generating facilities. This compliance record is reported regularly to the public.*
5. *Unless certain specific conditions are met (as outlined below), TXU's shareholders generally would not be well served if TXU devoted major financial resources now to reduce its carbon dioxide emissions in advance of the development of potential mandatory requirements on carbon dioxide. The reasons for this conclusion—which is based in part on estimates we develop of the potential costs to TXU from reducing carbon dioxide emissions—include: the time value of money and the likelihood that there would be sufficient time to adopt cost-effective carbon-reducing measures when any requirements are imposed; the likelihood that costs incurred by TXU in advance of mandatory controls would be absorbed by TXU shareholders rather than passed on to customers (at least in part) in the form of higher electricity prices as would be the case under a mandatory regime; the possibility that later advances in technology will reduce the costs to TXU of reducing carbon emissions; the many uncertainties regarding future legislation or regulation and thus the current inability of TXU to target its activities to reflect the specific requirements that would actually be set; the current inability to use the flexibility of the cap-and-trade program that would likely be put in place under a mandatory program; and the danger that early actions would decrease the number of initial allowances TXU received, effectively penalizing the company and its shareholders for taking early action to reduce its carbon dioxide emissions.*

We emphasize that although we conclude that costly actions to reduce carbon dioxide emissions are likely to be premature right now, we believe that TXU shareholders are well served by specific TXU actions related to potential future air emissions and climate change regulations that build upon the foundation of TXU's experience as outlined here.

The specific recommended actions related to future air emissions and climate policies include the following:

1. *Take prudent steps to reduce the carbon dioxide emissions from its generation if one or more of the following conditions holds:*

   (a)

   The cost per ton of CO_2 reduced is less than the risk-adjusted expected future CO_2 allowance price estimate (appropriately accounting for the time value of money), and the time to implement the investment would be longer than the likely time period before the mandatory program takes effect.

   (b)

   The investment would provide learning benefits, reduce cost uncertainties, expand the range of cost-effective CO_2 reduction alternatives, or otherwise allow better direction of future resources toward the most cost-effective approaches (assuming also that such advances would not be made without TXU investments).

   (c)

   The investment would yield other benefits (e.g., reductions in other emissions, improvements in facility efficiency) that make the alternative "pay for itself."
2. *Keep abreast of research and development activities that might provide such early options to reduce costs or improve environmental effectiveness.*
3. *Evaluate the financial implications to TXU of potential carbon dioxide policies and other air emissions policies, refining the analyses as the nature of the potential requirements becomes more precise.*
4. *Encourage the use of effective and efficient regulatory structures for future air emissions and climate change policies, including emissions trading regimes that provide environmental and economic advantages.*
5. *Communicate the potential risks and opportunities regarding these issues within the TXU organization.*
6. *Be prepared to take additional actions to respond effectively and efficiently to any future requirements.*
7. *To the extent that competitive conditions permit, communicate the results of these various assessments to shareholders and other interested parties.*

1. Introduction

This White Paper addresses issues related to TXU's responses to current and potential future air emissions and climate change policies in the United States. This White Paper is motivated by TXU's interest in an independent evaluation of its activities in these areas in the context of recent shareholder resolutions.

With regard to air emissions, any future policies would build upon a set of policies that has been developed over more than three decades, since the path-breaking 1970 Amendments to the Clean Air Act were passed. The key regulations currently affecting TXU include the Title IV acid rain program primarily to control national sulfur dioxide (SO_2) emissions from electricity generators and the regulations developed in Texas to control nitrogen oxide (NO_x) emissions as one means to achieve ambient ozone standards in Texas air quality regions. Recent regulatory proposals would increase the stringency of SO_2 and NO_x requirements as well as add requirements for mercury (Hg) emissions. In addition to these specific regulatory proposals, several proposed bills in Congress would add mandatory controls on carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions as a means of dealing with potential climate change.

1.1. TXU Charge and Study Objectives

The charge to us was to develop a White Paper that evaluates TXU's activities with regard to air emissions and climate change from the perspective of the recent shareholder resolutions. The initial tasks thus were to identify the concerns and issues that lay behind the shareholder resolutions and to develop a research effort to evaluate the concerns.

1.1.1. Shareholder Resolutions

An initial shareholder resolution dealing with air emissions and climate change, sponsored by the Benedictine Sisters of San Antonio, Texas, was filed with TXU in late 2002 for consideration in 2003 (2003 resolution). In late 2003, shareholder groups filed a resolution for consideration in 2004 (2004 resolution). The 2004 resolution was withdrawn.

Both shareholder resolutions consider the extent to which TXU's activities with regard to air emissions and climate change are in shareholder interests. The 2003 resolution recommended that TXU provide a report to shareholders on:

a) the economic risks associated with the Company's past, present, and future emissions of carbon dioxide, sulfur dioxide, nitrogen oxide and mercury emissions;
b) the public stance of the company regarding efforts to reduce these emissions; and
c) the economic benefits of committing to a substantial reduction of these emissions related to its current business activities (i.e., potential improvement in competitiveness and profitability).

The 2004 shareholder resolution entitled, "Shareholder Proposal Related to an Environmental Report" was stated as follows:

> *RESOLVED: The shareholders request that a committee of independent directors of the Board assess how the company is responding to rising regulatory, competitive and public pressure to significantly reduce carbon dioxide and other emissions and report to shareholders (at reasonable cost and omitting proprietary information) by September 1, 2004.*

The resolution was followed by the following supporting statement.

> *We believe management and the Board have a fiduciary duty to carefully assess and disclose to shareholders all pertinent information on its climate change responses. We believe taking early action to reduce emissions and prepare for standards will provide competitive advantages, and inaction and opposition to emission control efforts could expose companies to regulatory risk and reputation damage.*

1.1.2. Identification of Concerns Raised by Resolutions

Our review of the shareholder resolutions and discussions with TXU officials provided the basis for an assessment of the issues and concerns that lay behind the resolutions. We conclude that the concerns and general issues can usefully be put into three main categories.

One type of concern relates to TXU's analytical capabilities and institutional capacities. Shareholders would be well served by TXU (or any company) having the capacity to evaluate the financial effects of alternative courses of action with regard to air emissions and climate change. This capacity would include internal institutions to monitor potential regulatory or legislative initiatives as they proceed through the policy development process. The capacity also would include sound methodologies for determining optimal actions in response to potential or actual regulatory requirements. Since many of the current air emissions and climate change initiatives involve the use of emissions trading—which provides the opportunity to buy and sell emissions allowances in order to reduce the cost of compliance—it also would be important to have institutions in place to evaluate optimum trading actions and to implement these actions. Indeed, both these trading functions and the general analytical functions could be seen as examples of appropriate risk management activities.

A second type of concern relates to the previous actions that TXU has taken with regard to air emissions requirements. Shareholders would be well served by TXU taking appropriate actions to deal with major air emissions requirements. The evaluation of TXU's previous actions serves two purposes: (1) this evaluation indicates whether TXU's shareholders currently are well served in terms of minimizing the costs of meeting regulatory requirements; and (2) the evaluation of historical activities sheds light on the appropriate actions with regard to future requirements, notably potential CO_2 regulations. Indeed, as discussed below, TXU's long experience with SO_2 requirements—including assessments before the 1990 amendments were passed of what TXU actions would be appropriate in light of the potential future requirements—provides a useful precedent for how to deal with potential CO_2 regulations, which are bound to involve a substantial gestation period.

A third and final type of concern relates to TXU actions with regard to prospective future requirements, particularly with respect to CO_2 emissions. The shareholder resolutions indicate a concern that TXU is not taking appropriate actions in anticipation of possible mandatory CO_2 regulations. Thus, we consider both the actions TXU currently is taking with regard to CO_2 emissions and whether additional actions would be in shareholder interests. We also consider TXU actions with respect to mercury, in light of recent regulatory proposals.

In summary, we conclude that the shareholder resolutions can usefully be characterized as raising three general sets of concerns.

1. Concern that TXU does not have the institutions and related procedures in place to evaluate properly the financial consequences of air emissions and climate change regulations.
2. Concern that TXU does not take appropriate actions to maximize shareholder value in light of current environmental regulations.
3. Concern that TXU is not taking appropriate actions to reduce carbon dioxide emissions and other emissions in anticipation of *potential* future regulatory requirements, particularly related to CO_2 emissions.

As noted, these concerns relate to the institutional capabilities of TXU to evaluate the financial consequences of alternative policies as well as to the specific actions that TXU has taken to deal with environmental matters.

1.1.3. TXU Charge and Objectives of this White Paper

The charge from TXU was to evaluate these three sets of concerns and produce a White Paper that summarizes the results and conclusions of our evaluations. This White Paper thus has three major objectives corresponding to the three concerns noted above:

1. *TXU institutional capabilities.* Review and evaluate the institutions that TXU has in place to evaluate air emissions and climate change policies, including assessments of the methods that TXU uses to evaluate the financial impacts and risks to TXU from potential environmental policies.
2. *TXU previous actions regarding air emissions.* Review and evaluate the actions that TXU has taken in the past to respond to previous air emissions requirements, including both public statements and emission control and other market responses.

3. *TXU actions regarding CO_2 emissions.* Review and evaluate the actions that TXU has taken with regard to potential future CO_2 requirements and assess the economic and risk-management consequences of reducing emissions now in anticipation of future requirements.

It is important to stress that this White Paper relates to TXU's specific circumstances, including the detailed Texas air emissions requirements and the specific deregulatory environment in Texas. Thus, observations and conclusions from this review would not necessarily apply to companies in different circumstances.

Note also that our charge is limited to evaluations of TXU's activities and their relationship to shareholder value, rather than to broader issues of public policy. Thus, the White Paper does *not* consider the *public policy desirability* of the US establishing additional controls on conventional air emissions or initiating mandatory requirements for greenhouse gases. Nor does the study consider the potential "image" or public relations effects of TXU undertaking additional efforts to reduce its air emissions or its greenhouse gas emissions in advance of mandatory requirements. Finally, the White Paper does not provide specific quantitative estimates of the financial impacts to TXU of specific actions it could take regarding future air emissions and climate change requirements. We do, however, provide cost estimates to illustrate the key issues, particularly the implications of uncertainties regarding the potential timing and nature of greenhouse gas controls.

1.2. Methodology for the White Paper

The issues we consider require that we develop detailed information on analytical capabilities and actions taken by TXU. To that end, we have been given access to a wide set of TXU documents and other materials, as well as interviews with various TXU officials. Appendix A provides a list of the individuals at TXU we have interviewed, mostly in person but sometimes on the phone.

With regard to TXU's institutional arrangements and methods of analysis, we have been provided with various public pronouncements and relevant background information that provide information on the procedures in place to monitor and to evaluate potential air emissions policies. With regard to TXU's actions regarding current air emissions programs, we have been given the public statements as well as information on the environmental programs at TXU and TXU participation in relevant air emissions markets.

With regard to potential regulations, we rely upon information provided by TXU on their activities with regard to CO_2 and mercury as well as on various climate change and multi-pollutant legislative initiatives. As noted, although we do not provide quantitative estimates of the full financial effects on TXU, we do use cost estimates to illustrate the issues at stake with regard to potential TXU actions to reduce CO_2 emissions.

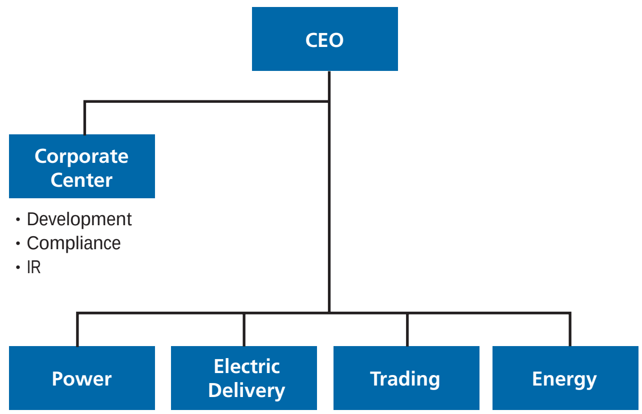
1.3. Organization of the White Paper

Given our focus on TXU's situation, Section 2 provides a brief overview of TXU and the status of electricity regulation in Texas. The remainder of the White Paper is organized according to the three major study objectives outlined above. Section 3 deals with the institutions and methodologies that TXU has in place to address air emissions and climate change issues. Section 4 considers the specific actions that TXU has taken in response to previous and current air emissions regulatory requirements. Sections 5 and 6 relate to future regulatory requirements. Section 5 considers the actions TXU has undertaken with regard to the pollutants that might be regulated in the future—mercury and CO_2. Section 6 considers the possible consequences of TXU undertaking additional actions with respect to CO_2 emissions, using illustrative cost analyses. Section 7 provides brief concluding remarks. Appendices provide background and supplementary information regarding the individuals at TXU we interviewed, information on TXU's generating facilities, and specifics of potential air emissions and climate change legislation.

2. TXU and Texas Electric Sector Overview

This section provides brief overviews of TXU and of the regulatory and legislative environment for Texas electricity companies. The principal purpose of this section is to provide a context for the subsequent discussions of environmental regulatory issues and TXU decision-making. Perhaps the most salient fact for the purposes of the White Paper is that deregulation in Texas means that the costs of environmental compliance are not recaptured "automatically" in electricity prices through regulatory rate determination but rather are passed on to customers only to the extent that they may be incorporated in competitively determined prices. As a consequence, and as discussed further in Section 6, environmental control costs that are not responses to regulatory requirements (for example, costs incurred now to reduce CO_2 emissions) would be absorbed entirely by shareholders and would not be shared by TXU customers.

Figure 1. TXU Corporation Organization



Source: TXU.

2.1. TXU Corporate Overview

TXU Corporation traces its origins to the original Dallas Electric Lighting Company founded in the 1880s. Most recently TXU Corporation was re-organized in 1997 as the successor to TXU Energy Industries Company. TXU Corporation engages in electricity generation, sales of retail and wholesale electricity and natural gas*, transmission and distribution of electricity and natural gas*, and hedging and risk management activities. TXU traditionally has served north, central, and west Texas including the Dallas-Fort Worth Metroplex. It services 643 cities and 122 counties with over 13,000 miles of transmission lines, and 91,000 miles of distribution lines, supplying over 80 Terawatt-hours of energy. Capital is provided by over 31,000 shareholders; the Company's operating revenues in 2003 were 11 billion dollars on assets of 31 billion dollars.

When Texas' electric utility industry was restructured (as discussed below), TXU's integrated vertical electric utility business was disaggregated, and its operations were transferred to TXU Energy and TXU Power (two competitive companies) and TXU Electric Delivery (the regulated transmission and distribution company.) Figure 1 details TXU's current organizational structure, which also includes a fourth company, TXU Trading. The following sections describe these four components of TXU.

2.1.1. TXU Power

TXU Power currently operates 22 generating stations with a total of 51 units in Texas. Figure 2 shows the location of the stations, including identification of their fuel type (gas, lignite, or nuclear). Appendix B lists TXU's current generating units and their capacity by fuel type. These units comprise around 19,000 MW of the approximately 70,000 MW within Electric Reliability Council of Texas (ERCOT).

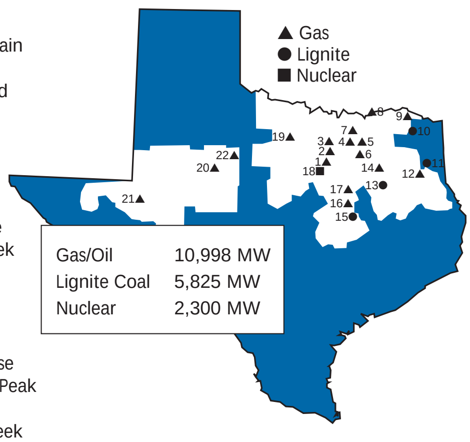
Figure 3 shows the fuel mix for TXU's generation. Gas and oil units account for about 58 percent of TXU's generating capacity, with coal/lignite accounting for about 30 percent and nuclear 12 percent. Since the nuclear and coal/lignite units are run much more often, and since TXU purchases generation, the fuel mix of its *generation* is considerably different. As Figure 4 shows, coal/lignite account for 43 percent of TXU's retail electricity sales, followed by gas/oil (22 percent) and nuclear (19 percent).

Lignite and coal make up a significant percentage of the TXU fuel supply. Lignite is mined and burned in a series of mine-mouth plants throughout eastern and central Texas. Low sulfur

*TXU has recently sold the natural gas portion of the company.

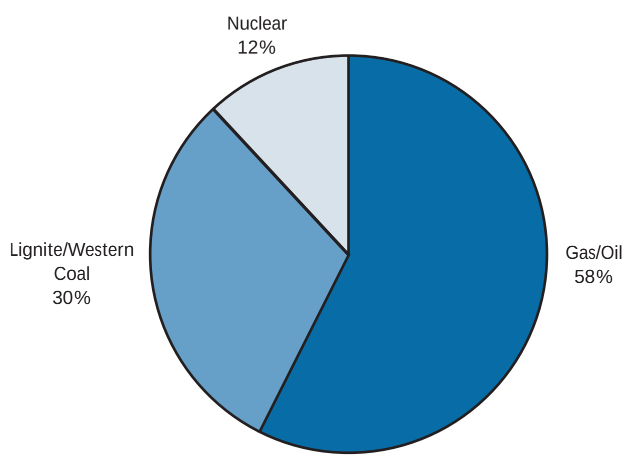
Figure 2. TXU Generating Plants

1. Decordova
2. North Main
3. Eagle Mountain
4. North Lake
5. Lake Hubbard
6. Parkdale
7. Collin
8. Valley
9. River Crest
10. Monticello
11. Martin Lake
12. Stryker Creek
13. Big Brown
14. Trinidad
15. Sandow
16. Lake Creek
17. Tradinghouse
18. Comanche Peak
19. Graham
20. Morgan Creek
21. Permian Basin
22. Sweetwater



Source: TXU.

Figure 3. Capacity Mix of TXU-Owned Units



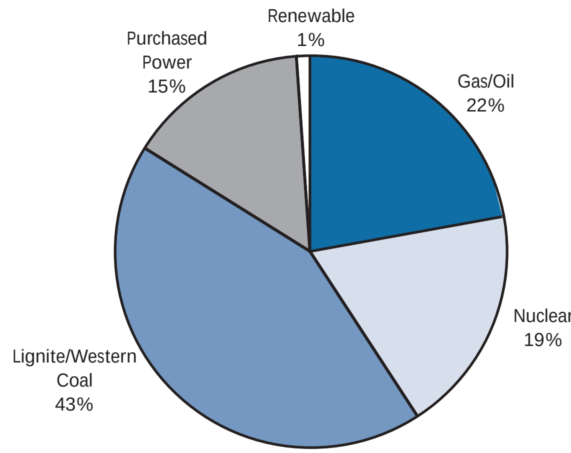
Source: TXU.

coal from the Powder River Basin supplements the lignite mined in Texas in some of the plants.

2.1.2. TXU Electric Delivery

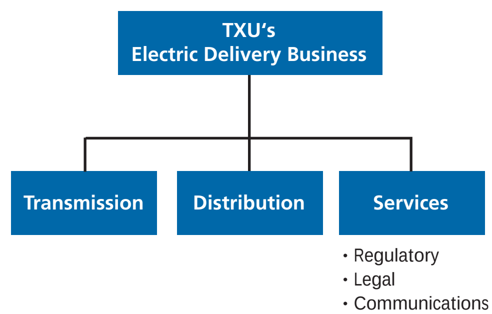
TXU Electric Delivery delivers electricity from generating units to the end-use customer. This business contains the transmission and distribution functions regulated by the PUCT. Figure 5 describes TXU Electric Delivery's broad organizational structure.

Figure 4. TXU Retail Fuel Mix



Source: TXU.

Figure 5. TXU Electric Delivery

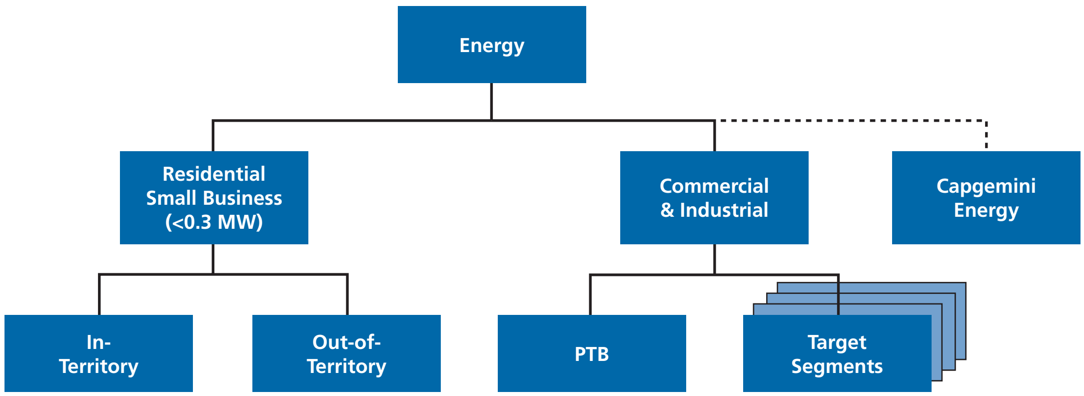


Source: TXU.

2.1.3. TXU Energy

TXU Energy is the largest provider of retail energy in Texas, with 2.6 million customers. It sells electricity and natural gas to retail customers and also provides other energy-related services. This business is the result of Texas deregulation legislation separating retail functions from those of the distribution or "wires" company. This separation is one of the distinct features of the Texas system. Figure 6 shows the organization chart of TXU Energy. Overall company functions are divided into three major areas. Two of those areas are based upon the type of customer served. The third area, Capgemini Energy, represents TXU's outsourcing of various corporate center functions, including information technology and human resources.

Figure 6. TXU Energy Organization Chart



Source: TXU.

2.1.4. TXU Trading

TXU Trading buys electricity and natural gas in the wholesale markets and sells to retail electric providers or commercial customers. It offers portfolio, asset, and risk management services to wholesale market participants such as municipalities, electric cooperatives, retail electric providers, and generators.

2.2. Key Features of the Texas Electricity Regulatory Environment

This section describes various important features of TXU's market environment in Texas and highlights implications for environmental decision making. We begin with a brief overview of the deregulation in Texas introduced by Senate Bill 7 (SB 7).

2.2.1. Deregulation in Texas

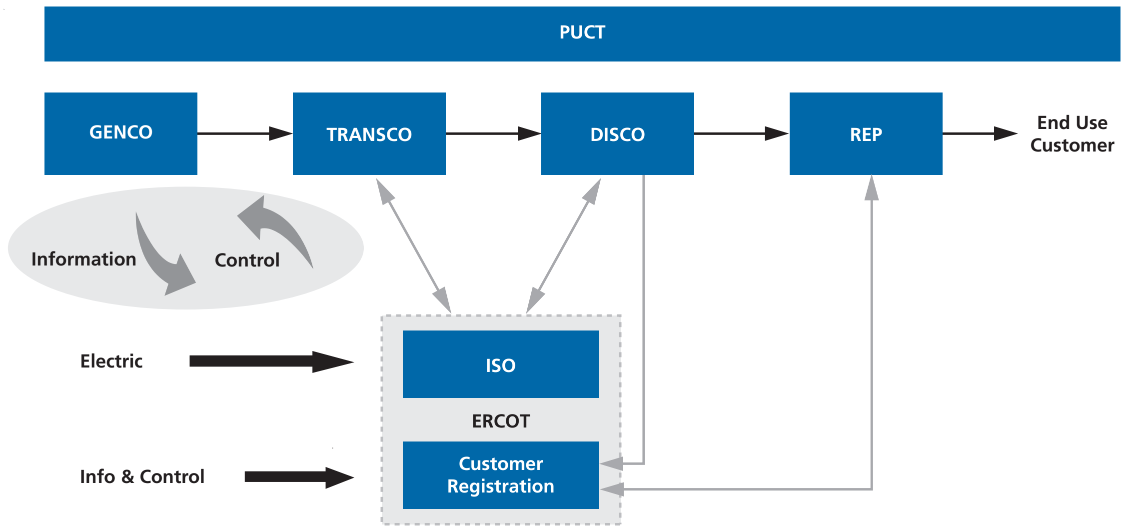
Texas started a new era of electricity supply with the enactment of SB 7 in 1999 to become effective in 2001, which was overwhelmingly supported by the Texas Legislature. SB 7 was intended to reduce electricity prices in Texas, create better services related to electricity, and support greater consumer choice. The overall judgment of most commentators is that the legislation has been largely successful. Because of deregulation the state now has many more producers and sellers of electricity, as well as customers in good positions to make informed choices about their electric service.

To carry out SB 7, the PUCT was given responsibility for creating a set of rules changing the structure of Texas utilities. Utilities were required to separate their regulated activities from their competitive energy services. These competitive services included power generation, retail electric service, and other items such as energy efficiency, load management, and maintenance of transformers and substations. In compliance with the law, TXU and other Texas utilities created separate companies engaged in power generation (Genco), retail electric service (REP), transmission (Transco), and distribution (Disco). Figure 7 summarizes the basic structure of the current Texas electricity regulatory structure, showing the regulated and deregulated entities. The Electric Reliability Council of Texas (ERCOT), under the supervision of the PUCT, was given the responsibility for running both the markets and the transmission system (the Grid).

2.2.2. Competitive Business Structure

Under the competitive environment, each Texas generator must secure customers for their plant output. Most generators contract with a retail energy provider; approximately 85 percent of the energy used in Texas is sold by contract and about 15 percent is sold on the balancing energy or spot market. If a plant's output is not contracted it is dispatched by ERCOT according to the bid price. Units are dispatched each hour on the basis of price. If there is overcapacity or a plant's bid price is too high, the plant does not run and it does not receive revenues.

Figure 7. Texas Competitive Marketplace



There are several other noteworthy features of the Texas competitive structure.

- Texas has restructured the electric utility industry for competition by separating the generation and retail functions into competitive businesses while keeping transmission and distribution regulated. Indeed, Texas is the only state that has made the retail function separate.
- Incumbent utilities (including TXU) are allowed to participate as retail providers anywhere in ERCOT.
- Incumbent utilities were not required to divest their generation. However, the incumbent generators were required to auction off a minimum of 15% of their installed capacity.
- Retail functions are separated from distribution. Retail is competitive and distribution is not. Retailers can buy from any generator. Incumbent retailers are required to offer a fixed "price to beat" to residential and small commercial customers in their "home" markets until they have lost 40 percent of their customers in a segment or until five years have passed
- Retail competition has been substantial, even for relatively small customers.
- Additional environmental requirements for NO_x and SO_2 are placed on the incumbent generators by SB 7, but not on the new generators. New generators are subject to all air quality rules in effect at the time they are permitted for construction.
- The incumbent retailer is not required to be a "provider of last resort."

2.2.3. Overview of Key Implications of Deregulation in Texas

Regulated companies have different financial and planning drivers than unregulated companies. Their impact on how companies invest in new technology and plant upgrades is summarized in the table below.

2.2.4. Rate and Price Structure

As noted above, perhaps the key difference under deregulation is that both wholesale and retail electricity prices are set on the basis of market activity rather than regulatory decision. The wholesale power price is set in a competitive environment through the interplay of generators and wholesale purchasers. The retail price is set between the end-use customer and the retail energy provider. In contrast, regulated electricity rates had been set by the State PUC in a regulated environment. Under SB 7 law and the ERCOT protocols, as approved by the PUCT,

Table 1. General Attributes of Regulated and Deregulated Generation Companies

Attribute	Regulated Generation Company	Competitive Generation Company
Return on Capital	10 -12%	15 -20%
Borrowing Structure	Approximately 50% debt	Approximately 80% debt
New Plant Timing	Based on regulatory process	When market conditions are considered right
Rate Base Treatment	Used, useful, and prudent in the rate base for cost recovery	None
Central Planning	Determined by regulatory process	When the generator expects to make a profit by building and operating

wholesale market prices are set by buyers and sellers within ERCOT, but the Texas PUC can, and does, intervene to prevent perceived market power abuse in the wholesale power market. Retail prices are set competitively.

2.2.5. Generation Investment Strategy

Generation investments in Texas, as in many other states, are now driven by market considerations. Investments are based upon expectations of profits, i.e., the projection that costs—including an adequate return on investment—can be recovered in prices that a buyer will be willing to pay, as there is no regulated return on investment.

New power generation investment has been primarily by Independent Power Producers (IPPs), because there are specific limits in Texas that prohibit incumbent utilities like TXU from adding any new net capacity until market concentration is diluted. There are a variety of related factors that make it easier for IPPs to construct new units than for incumbents, and that affect incentives to invest in new units in general. Some of these factors are outlined below.

2.2.5.1. Transmission "Competing" with Generation

One consequence of deregulation was that the separate generation and transmission companies were able to compete with each other to serve local areas. New transmission capacity allows more remote—and potentially lower cost—generation to serve the load in a given region. The competing alternative is to build new *generation* closer to the load in those areas where there is weak or constrained transmission. Since transmission is regulated and the return is relatively guaranteed, transmission can be a more financially attractive option. In contrast, investment in generation carries greater risks, because of uncertainties about future prices, fuel costs, and emissions requirements.

2.2.5.2. Transmission Constraints

For the most part, power generated in ERCOT by either new or incumbent units can reach most ERCOT consumers. However, in some places, this may not be true, because of transmission constraints. These constraints mean that only power from certain units can serve load in these areas. As it happens, the units that are able to serve these areas may be older units that have higher emissions and lower efficiency. When they run, they may therefore need to purchase emissions allowances or be retrofitted with pollution control equipment.

If there were no transmission constraints, generation from these older units probably would be supplanted by generation from newer, more efficient units—the older units would not be profitable to operate at the prevailing market prices. But because there is no other source of generation, these units must run if the constrained regions are to receive sufficient power. These units are not paid or run on a competitive basis; instead, they are effectively controlled by the system operator and paid under a scheme that does not currently reward their importance in resolving reliability problems. The older units may be paid a supplement to the market price for electricity, but this supplement may not always be enough to cover all of the costs at such units—particularly the costs associated with emissions abatement and emissions allowances. Typically the system will call on these plants, which in many cases are owned by incumbent generators like TXU, to generate even when the net price being paid to the generator is insufficient to cover their total costs.

The lack of sufficient compensation means that there are insufficient incentives to displace the older units with more efficient ones with lower emission levels. Potential future plans in ERCOT for locational marginal pricing (LMP) are designed to compensate generators for operating in a constrained area, but these systems are not yet in place. Currently, there is no economic incentive to locate generation to fix transmission constraints. If LMP is enacted, generators will recognize the incentive to build in transmission-constrained areas along with other economic considerations. Thus, in areas with transmission constraints—many of which are served by incumbents—there may be insufficient incentives for new investment in generating facilities.

2.3. Texas Market Summary and Implications

In sum, deregulation in Texas has substantial implications for TXU's activities and its environmental decision making. TXU and other Texas electricity companies have been operating in an unbundled and deregulated marketplace since January 2002. Although still evolving, the wholesale and retail power markets in Texas are operating well, with generators competing for customers and retail customers of all sizes picking retail suppliers. Many new plants have been built and some existing plants have been retired or mothballed. Power plants are operating without the traditional regulatory "safety net," with all of the opportunities and risks that implies.

These changes have had and will continue to have important implications for TXU's activities in general and its responses to environmental initiatives in particular. The combination of the increasingly competitive market, transmission constrained areas, additional environmental requirements, and regulations to control market power means that oftentimes incumbents face greater barriers to new investment than do new entrants. Incumbents may be burdened with uneconomic units that they nevertheless have little choice but to keep open.

As emphasized throughout this review, the major change due to Texas deregulation is that environmental costs would not be passed on to customers through regulation-induced rate increases. This market discipline puts added pressure on TXU and some other companies in Texas to develop sound means of developing cost-effective compliance plans and to manage their environmental risks effectively. The following section provides our assessments of TXU's analytical and risk management activities related to environmental compliance.

3. TXU Institutions and Methodologies to Evaluate Air Emissions and Climate Change

We consider the TXU activities that focus specifically on air emissions and climate change and well as how the nature of the analyses change as potential requirements become more specific.

3.1. TXU Institutions to Deal with Air Emissions and Climate Change

This section focuses on the institutions TXU has in place to deal with initiatives in air emissions and climate change, including outreach activities that take advantage of activities of other groups. We begin with an overview of the review.

3.1.1. Overview of Our Review

Our review consists of obtaining information from TXU documents and individuals regarding the activities and institutions at TXU for considering air emissions and climate change issues. The objective of the review is to evaluate whether TXU has institutions in place to identify and evaluate these environmental issues, to ensure that management considers key decisions, and to disseminate relevant results to shareholders and others. The following are the major TXU institutions identified in our review.

- TXU processes for tracking state and federal environmental regulations.
- TXU development of internal issue papers.
- TXU development of an Air Strategy Team with representatives from various TXU departments.
- TXU inclusion of air emissions issues in its ongoing high-level updates of key issues through the TXU Energy Leadership Team meetings.
- TXU membership in industry organizations that provide analyses of air emissions and climate change issues.
- TXU dissemination to the public of an annual Environmental Report and an annual report to the Securities and Exchange Commission.

These activities allow TXU to develop different types of information depending upon the stage of potential or actual regulations. This section is organized according to these institutions, with the final subsection providing an overview of the way that TXU's evaluations change over time as regulatory requirements become more explicit.

3.1.2. TXU Basic Process for Tracking State and Federal Environmental Regulations

TXU has developed a detailed process for tracking state and federal environmental regulations and commenting on regulatory proposals. The stated objective is to ensure that adopted rules and regulations are operationally flexible and cost effective. TXU has developed detailed procedures for monitoring, reviewing and commenting on proposed rules and regulations from the point at which a state or federal agency identifies a need for a new rule or regulation to the point at which a final rule, if any, is adopted.

3.1.3. TXU Internal Issue Papers

One means of keeping abreast of issues and informing management is to develop issue papers that summarize key areas of activity and interest. The following is a list of recent TXU issue papers regarding air emissions issues:

- Mercury;
- Global Climate Change;
- Renewable Energy;
- Coal Combustion Products;
- New Source Review; and
- Multi-Pollutant Strategy.

These papers, which vary in length from 10 to 25 pages, highlight the general situation regarding each issue, their potential effects on TXU and TXU's position.

3.1.4. TXU Air Strategy Team

In mid-2002, TXU established an Air Strategy Team to ensure that critical air issues are considered by all relevant parts of TXU. The Air Strategy Team is chaired by an individual within the Environmental group and meets as often as required, roughly every three months. The Team includes members of Environment, TXU Energy—Generation, Governmental Affairs, Legal, TXU Energy—Trading (i.e., Portfolio Management) and Media Relations.

This team draws on the expertise of the individual members, informed by their experience in dealing with air emissions issues at TXU as well as with the various groups noted above. The processes of the Air Strategy Team are designed to make sure that future strategic issues are brought into focus, evaluations undertaken, and actions taken where appropriate. Communication within the entire TXU organization is maintained by distributing final minutes (after editing a draft version) to more than 20 individuals—including the eight members of the Team—that encompass senior officials in all relevant parts of TXU.

The meetings of the Air Strategy Team indicate the wide range of issues that are followed by TXU and the long gestation periods for major legislation or regulations. Indeed, the minutes of the Air Strategy Team show how air emissions initiatives can change substantially over time, both in terms of their prospects for passage/promulgation as well as in terms of their provisions. As discussed below, these considerations provide one reason to question any corporate policy that would commit TXU to expensive actions in advance of the resolution of specific legislation or regulatory initiatives. But they also underscore the importance of continual analyses to consider potential impacts.

3.1.5. TXU Leadership Team Meeting

TXU has a senior group that meets regularly to discuss standing agenda topics as well as other agenda topics that affect TXU. The standing topics include updates for the major TXU activities (e.g., production, retail, portfolio management) each of which is generally scheduled to be discussed once a month.

The LT meeting includes many agenda items related to environmental issues. The 2004 list includes the following specific topics.

- Air emissions issues/impacts and position.
- SO_2 and NO_x position update.
- Mercury management program.

These briefings provide an opportunity for senior management to be briefed on the status of major air emissions and regulatory issues, including interactions with other issues facing TXU. The briefings also provide the opportunity to discuss key decisions related to air emissions issues, including testing programs, compliance programs, and efforts to clarify key future regulatory initiatives. In the case of mercury, for example, a recent briefing explained plans for testing and research related to the potential mercury regulations.

3.1.6. TXU Involvement in Outside Organizations with Air Emissions and Climate Change Expertise

TXU maintains an active involvement in various organizations that constitute key resources for the company. The following sections provide a list of these organizations, broken down into three categories:

1. Industry groups;
2. Governmental groups; and
3. Environmental organizations.

3.1.6.1. Industry Groups

The following is a list of the industry groups related to air emissions and climate change issues with which TXU is involved. TXU's membership in these groups includes participation in and funding of studies, research, and analyses of proposed legislation and regulations related to environmental issues.

- Edison Electric Institute, including five committees and task forces (Clean Air Strategy Group, Environment Executive Advisory Committee, Mercury Task Force, Global Climate Change Subcommittee, Electric Power Industry Climate Initiative and PowerPartners).
- Utility Air Regulatory Group, including eleven committees (Policy Committee, Steering/Audit Committee, Planning Committee, Ambient Standards Committee, Atmospheric Modeling Committee, Control Technologies Committee, Hazardous Air Pollutants Committee, Measurement Techniques Committee, Nonattainment Committee, Plant Repair, Enforcement and Permitting Committee, and Regional Air Quality Effects Committee).
- Association of Electric Utilities of Texas, including its Environmental Committee.

- National Mining Association.
- Electric Power Research Institute, including four committees (Environment Council, Air Quality, PISCES, and Integrated Environmental Controls).
- North Texas Clean Air Coalition.
- North East Texas Air Care.
- Clean Air Act Advisory Committee (CAAAC) Utility maximum achievable control technology (MACT) Working Group.
- Texas Renewable Energy Industries Association.

TXU maintains connections with these groups and committees by assigning TXU officials to each of the organizations.

3.1.6.2. Governmental Groups

TXU interfaces with numerous governmental agencies on air emissions and climate topics, including the US Environmental Protection Agency (EPA), US Department of Energy, and Texas Commission on Environmental Quality.

3.1.6.3. Environmental and Educational Organizations

Since 1971, TXU has had in place a unique research program that sponsors studies of power plant and mining activities by university graduate students. Several past and current research topics relate to air emissions, emissions controls, and carbon sequestration. In addition, TXU supports research at colleges and universities on emissions control technologies.

3.1.7. TXU External Environmental Reports and Securities and Exchange Commission Filings

TXU communicates with shareholders and other external groups in several ways, the most significant of which are its annual Environmental Report and its annual filing to the Securities and Exchange Commission.

3.1.7.1. TXU Environmental Reports

In 1991 TXU began to produce an Environmental Report that is disseminated to the public.[1] In addition to its role in informing the public of TXU activities and accomplishments related to the environment, the preparation of this document provides a means for management to consider, at a broad level, TXU's environmental performance. The most recent report for 2003 provides an overview of the company's environment-related activities as well as emissions data and compliance records. Detailed records are provided on TXU's emission rates and the company's efforts made to reduce emissions. The report also provides details about TXU's compliance history and air, land, and water compliance rates as well as efforts taken to reduce CO_2 emissions. The air compliance rates are discussed in section 4.3.2. Here we provide a brief summary of the key issues and statistics in the 2003 report.

In 2002, TXU's emission rates were below the national average by 34 percent for NO_x, by 2.3 percent for SO_2, and by 3.2 percent for CO_2. In 2002, the company's fossil power plants emitted 59.4 million tons of CO_2. TXU has been involved in the Department of Energy's voluntary program to track CO_2 reductions. Based on its reports to the DOE, TXU has avoided, reduced or sequestered 224 million tons of CO_2 since 1991. The company reported 22.8 million tons of voluntary CO_2 reduction in 2002. TXU has also spent the last five years researching new technologies for reducing mercury emissions and has received two mercury research grants from the US Department of Energy.

TXU has been involved in a number of other activities aimed at improving the environment. The company has added more than 2,850 megawatts of electricity capacity with zero air-emissions since 1990. In 2003, TXU provided its customers with one million megawatt hours of renewable energy. The generating capacity of these renewable energy purchases accounts for 580 megawatts of Texas' current renewable energy capacity. At the end of 2003 TXU had over five times the renewable energy capacity mandated by the state. The company has also recycled 2.4 billion pounds of used material in 2003, an increase of 2.9 percent from the previous year.

The 2003 Environmental Report also contains a section addressing environmental regulatory risks and TXU's fuel mix, issues not directly addressed in past environmental reports. Indeed, this

[1] TXU's recent environmental reports are available at www.txucorp.com/envcom/reports/default.asp.

section of the report describes the purpose of the current White Paper, namely:

- Review of company's procedures and methodologies to evaluate air emissions and climate change policies and to communicate the results;
- Review the company's actions regarding previous major air emissions policies and compliance; and
- Consider the financial consequences and related risk to the company of prospective air emissions and climate change policies, including an assessment of the financial effects of reducing emissions now in anticipation of future requirements.

Finally, the 2003 Environmental Report also presents TXU's fuel mix for electric generation, illustrating how the fuel mix has become increasingly diversified over time.

3.1.7.2. TXU Securities and Exchange Commission Filings

In addition to its Environmental Reports, TXU annually submits information on relevant aspects of its operations to the Securities and Exchange Commission as part of its 10-K filing.[2] TXU's 2003 10-K filing provides a section addressing environmental issues. The section provides an overview of current and future potential environmental regulations that TXU is, or may be, subject to and discusses relevant regulatory agencies and their jurisdictions. Specifically, the report discusses the implications to TXU of the Texas Clean Air Act, the proposed national Clear Skies Initiative, and potential standards proposed by the EPA on mercury emissions. The 10-K form also describes specific provisions of the 1999 Texas Restructuring Legislation and details the manner in which TXU complied with these provisions. Environmental issues related to water and hazardous waste are also addressed.

Potential costs of regulations are discussed in Appendix A of the 10-K form (page A-53). The section acknowledges that complying with environmental regulation may cause TXU to "incur significant additional costs," though from which regulations these significant costs may arise is not discussed. In addition, TXU states that when the costs of complying are significant, it is possible that older facilities may need to be shut down.

[2] See: http://www.txucorp.com/investres/invarch/03txuar/financials/10k.asp.

3.1.8. Summary of TXU Institutions Related to Air Emissions and Climate Change Issues

This review suggests the following conclusions regarding TXU's institutions for tracking air emissions and climate change issues.

- TXU has a detailed set of procedures to monitor all significant environmental regulations.
- This set of procedures involves many TXU organizations.
- The set of procedures allow for TXU to work with electricity and other industry groups where there are mutual areas of interest.
- The TXU organizations and electricity/industry groups work together to identify potential regulations, evaluate the potential impacts of specific proposals, provide comments to state and local agencies as part of the rulemaking process, track changes as the rulemaking proceeds, and obtain information on the final rule.
- The set of procedures provides an indication of both the large number of steps involved in environmental regulations as well as the potential changes that might take place.

3.2. TXU Methodologies for Evaluating Regulatory Compliance Options

The prior section outlines the institutions established by TXU to track policies and regulations. Perhaps the most important element of TXU's activities is the set of procedures and methodologies that TXU uses to evaluate alternative air emissions policies. This section considers TXU's evaluation methods.

3.2.1. Overview of Our Review

Our review consisted of evaluating various TXU internal and external documents, including recent Congressional testimony by the President of Production at TXU Energy North America (subsequently, "recent Congressional testimony") regarding the methodologies that TXU uses to evaluate potential air emissions expenditures. In addition to reviewing these internal and external materials, we have undertaken interviews with key personnel within TXU with responsibility for developing these materials to provide a fuller description of TXU's analytical methods.

TXU's evaluations change in details as the potential environmental regulations take shape. This feature is important because of the different role of information at different stages of the process as well as the different availability of key data. The following sections provide an overview of TXU's basic methodologies for evaluating alternative policies and present examples of TXU's treatment of sequencing of various decisions and how the nature/detail of the analysis changes.

3.2.2. Basic TXU Methodology for Evaluating Air Emissions Compliance Decisions

TXU has developed a systematic economic approach to evaluate capital investment and other decisions related to compliance with air emissions requirements. This methodology takes into account the internal options that TXU has to reduce its emissions as well as the external options TXU has in some circumstances to purchase emissions allowances from other participants in relevant cap-and-trade programs.

The TXU methodology can be summarized in terms of the following basic steps:

1. Develop viable alternative investment options.
2. Determine the economic value of each alternative option.
3. Compare the alternative options in light of potential constraints and risks.
4. Choose the highest economic value option from the feasible set of alternatives.

The following are brief summaries of the issues that TXU addresses in each of these steps.

3.2.2.1. Develop Viable Alternative Investment Options

The first step that TXU takes is to identify all viable alternative investment options for compliance with a new emissions standard or other requirement (e.g., requirement to comply with a cap-and-trade program). At this initial step in the analysis, options may be considered from a wide range of alternatives, including:

- Capital investments in emission control technology of various types (e.g., low-NO_x burners, SO_2 scrubbers);
- Fuel switching at a power plant;
- Improving the efficiency of a power plant;
- Reducing output (and/or purchasing power externally to meet demand);
- Purchasing/selling emissions allowances (if relevant); and
- Closing down a power plant or generating units, thereby losing the generating capacity and output revenue (but avoiding new investment).

Each option would include a set of actions that would achieve the air emissions requirements. Note that in the case of a cap-and-trade program—such as the national Title IV program for SO_2 (acid rain trading program)—the full range of alternative actions would be feasible because TXU has full flexibility to reduce its emissions or purchase allowances in any proportion it chooses across its entire generation fleet. In contrast, requirements that limit emissions (or emission rates) at individual facilities restrict the range of potential alternative compliance options.

The identification of alternatives takes into account operational constraints in light of the real world in which TXU operates, including the deregulated competitive environment in Texas (as discussed above). TXU does not have full control over the operation of or investments in its transmission system, for example, and thus some options to reduce NO_x emissions by importing more power from outside may not be feasible in light of transmission constraints. (As already noted above, these circumstances sometimes affect the implementation of TXU's compliance plan when, for example, TXU is required by the system operator to run units at particular times in order to meet load requirements.)

3.2.2.2. Determine the Economic Costs and Benefits Associated with Each Alternative Option

TXU's next step is to assess the net economic cost of each option. The full economic cost of a particular option consists of various elements.

- The capital investment needed initially (and anticipated to be needed in the future).
- The additional operating expenses associated with the initial and anticipated future capital equipment.

- Other net operating costs that might be involved (e.g., in the case of a cap-and-trade program, the purchase of emissions allowances).
- In the case of alternatives that would involve operating restrictions on the plant, the value of the lost power and capacity (or equivalently, the net costs of obtaining replacement power and capacity).
- Any potential gains that might accrue from the investment scenario, such as any byproducts from installation of the emission control equipment (in the case of a cap-and-trade program, these gains could include sales of emissions allowances).
- Any improved operating efficiencies.

The objective in this step is to identify the full range of potential costs (and benefits) and to put them in an appropriate framework.

TXU's economic framework takes into account the time pattern of costs and benefits through a financial pro-forma that includes estimates of the added costs or benefits in each calendar year. This proforma includes tax-related impacts as well as the direct costs or revenues in each year. This step also involves determining the lives of the various TXU facilities involved.

The final element of this step is to calculate the present value of each of the options, i.e., the equivalent dollar amount that would be paid now (or at a given point in the future) to cover the stream of costs and revenues associated with the compliance option. This element requires the choice of a relevant discount rate, which reflects TXU's opportunity cost of capital.

3.2.2.3. Compare Alternative Options

TXU then compares alternative options in light of other financial constraints that might be operating. These constraints might include credit limits, debt covenants, and required financial ratios. This step might also involve restructuring certain options to improve their feasibility (e.g., revising the timing of capital expenditures if further reflection indicated that some capital expenditures might be postponed).

This process includes the pruning of options that lead to non-viable financial outcomes. The net result of this step is a set of potential compliance options and their associated economic values. Depending on the circumstances, it may be important to incorporate some analysis and valuation of the relative uncertainty associated with each option in these comparisons.

3.2.2.4. Choose Highest Economic Value

The final step is to choose the option that achieves the given air emissions requirement (e.g., set of emission standards or cap-and-trade regime) at the lowest cost, i.e., the scenario that produces the highest economic value to TXU. Where valuations of uncertainty and risk are relevant, these may be included here.

3.2.3. Treatment of Uncertainty and Changes Over Time in the Evaluation Methodology

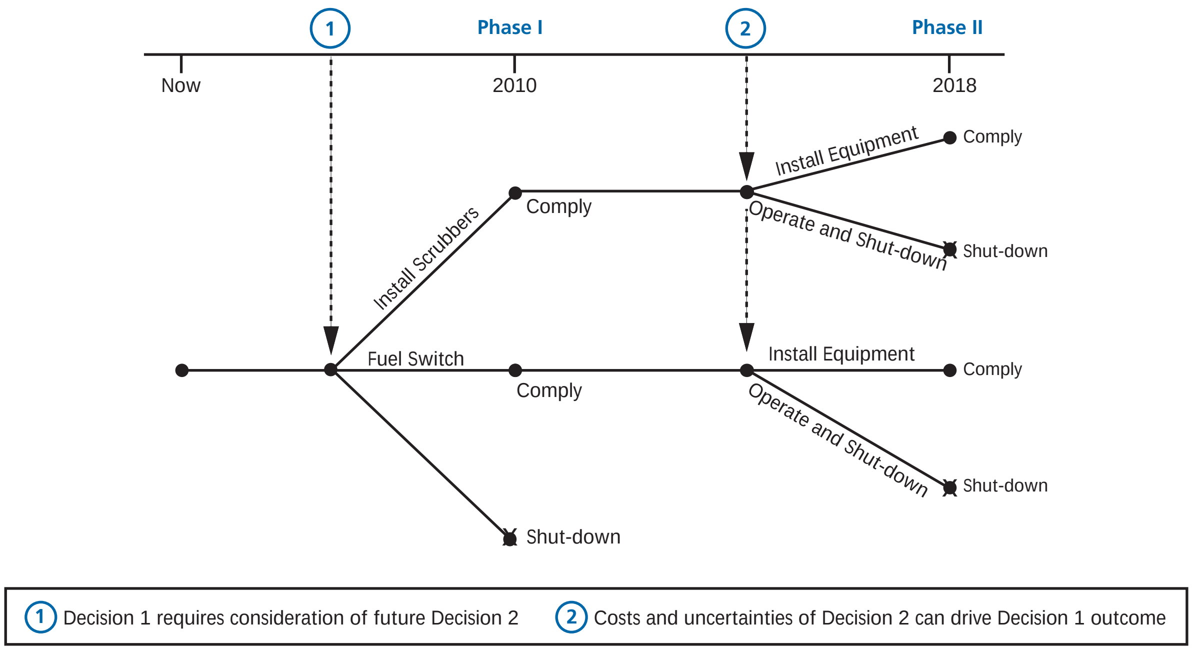
TXU is continually developing these economic assessments as part of its ongoing compliance with air emissions requirements. The specific evaluations done in the context of the Title IV SO_2 program and the Texas state NO_x requirements are discussed below.

The recent TXU Congressional testimony also notes that the usefulness of the analysis depends in part on the level of information available on the costs and effectiveness of the available options for emissions control equipment as well as on the sequence of air emissions requirements. The case of successive requirements on different types of emissions illustrates the additional complexities that are involved when information on controls is highly uncertain and when sequential interrelated decisions are involved.

3.2.3.1. Example of Analyses of Successive Air Emissions Controls

The recent TXU Congressional testimony notes the complexities introduced by uncertainties regarding controls on multiple emissions, occurring in different time periods. Figure 8 shows the decision process that TXU has used to organize the possibility of various future regulatory requirements, and their interrelationship. This "decision analysis" framework is a well-established means of organizing uncertainty and showing the interaction

Figure 8. Decision Tree For Clear Skies Act Emission Controls



Source: TXU.

among decisions. The figure shows that TXU's different compliance options for the potential Phase I requirements (for example, continued use of lignite with SO_2 scrubbers or, alternatively, fuel switching to achieve the SO_2 limits) may have different implications for meeting the potential Phase II requirements, which involve new regulations of mercury emission levels.

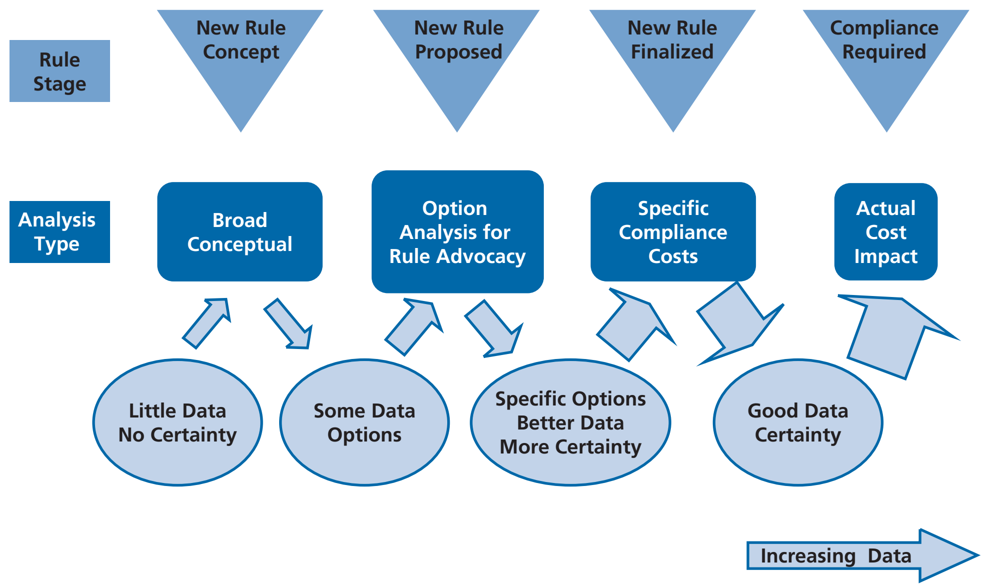
The decision analysis framework can also illustrate differences in the level of uncertainty regarding controls on different types of emissions. The lignite coal used by TXU and other electricity generators creates additional hurdles and uncertainties. The mercury content of lignite is higher than that of bituminous or subbituminous coal. In addition, the form of mercury in combination with other constituents, such as chlorine, in lignite coal makes mercury more difficult to remove using the pilot-tested activated carbon injection technology. The lack of a demonstrated technology for mercury could result in fuel switching, or possibly plant closings. This situation is in contrast to that for SO_2 or NO_x emissions, for which the cost and effectiveness of various control technologies are well established.

3.2.3.2. Changes Over Time in the Nature and Detail of Evaluations

TXU's internal procedures also indicate differences in the application of methodologies as additional information is developed, both on the nature of the likely requirements and the costs and effectiveness of potential control technologies. Figure 9 illustrates the changes that occur in TXU analyses over time.

The above figure indicates that TXU has evaluation methodologies in place that reflect the nature of the information available at different points in a possible legislative rule development. In the early stages of possible rule development, TXU develops a framework that takes into account key uncertainties as well as the timing and interactions of potential requirements. As issues are resolved—both with regard to regulatory requirements and potential control alternatives—TXU's methodology changes to take advantage of additional data or other information. After specific rules are in place, TXU develops methods of ensuring compliance and minimizing the cost of meeting regulatory targets, including taking advantage of the flexibility provided by

Figure 9. Environmental Analysis Continuum



cap-and-trade programs. (These methods are described below in the context of TXU's activities with regard to SO_2 and NO_x emission requirements.)

3.2.4. Summary of TXU Regulatory Evaluation Methodology

In summary, TXU's evaluations of regulatory options appear sound along various dimensions.

- TXU's basic evaluation methodology is consistent with sound economic principles.
- TXU appropriately takes into account interactions among various air compliance considerations.
- TXU has procedures in place for assessing different compliance approaches when policies and outcomes are uncertain.
- TXU appropriately evaluates the sequencing of environmental decisions.
- TXU appropriately changes the nature and details of its evaluations as data and need for analyses change.

3.3. Overall Evaluation of TXU Institutions and Methodologies to Evaluate Air Emissions and Climate Change Issues

In summary, TXU has the methods in place to evaluate the financial effects on TXU of alternative air emissions compliance strategies and take appropriate actions. These methods include economically sound methods of evaluating alternatives—including alternatives that include cap-and-trade programs—as well as sensible means of managing the cash flow risks that air emissions compliances poses to TXU. In all of these areas, TXU's activities appear to be consistent with sound professional practice. The following section provides information on how those procedures have been used to deal with previous major air compliance issues.

4. TXU Actions in Response to Current Air Emissions Regulations

This section considers the actions that TXU has taken in response to current air emissions regulations. Having institutions and methodologies in place is important, but of course a key test is whether those institutions and methodologies are appropriately brought to bear when specific air emissions initiatives arise.

The section focuses on the two major initiatives that dominate TXU's current air emissions compliance activities:

1. Federal Title IV requirements for SO_2 emissions (acid rain trading program); and
2. Texas requirements related to NO_x emissions in order to meet air quality requirements in various regions of Texas.

We consider three major evaluations of TXU's air emissions compliance.

1. Consideration of TXU's response to the SO_2 requirements as they were developed in the 1980's and ultimately included in Title IV of the 1990 Clean Air Act.
2. Consideration of TXU's response to the NO_x requirements that have been set by Texas state government as part of the Texas State Implemenation Plan (SIP).
3. Consideration of the overall compliance record of TXU's generation facilities.

4.1 TXU Actions Regarding the Federal Acid Rain Program

This section considers the federal acid rain program, perhaps the most significant air emissions legislation affecting the electricity sector to date. Moreover, the legislation is characterized by a path-breaking emissions trading program that is widely regarded as a general model for the type of program that might be developed for CO_2.

4.1.1. Overview of Our Review

TXU has a rich set of experiences with regard to Title IV of the Clean Air Act Amendments of 1990 that includes several periods:

- Analyses and activities as federal legislative requirements were developed in the 1980's.
- Analyses and activities after the legislation was passed to plan for compliance with the requirements, including the emissions trading provisions.
- Ongoing activities to maintain compliance with the requirements and take advantage of emissions trading provisions.

This set of experiences corresponds to the full set of general steps outlined above.

Our review is based upon our general background on the Title IV legislation as well as our interviews with key individuals at TXU responsible for the development of TXU's compliance plan and its ongoing compliance plans. Note that this long experience with SO_2 issues seems particularly relevant to consideration of potential CO_2 regulation, which seems destined to have a similar lengthy regulatory gestation period. Indeed, as we discuss at some length below, the SO_2 experience provides important insights into the appropriate responses to potential CO_2 controls. In particular, the SO_2 experience suggests the advantages of waiting until regulatory requirements are clear to make costly emission control decisions.

4.1.2. Overview of the Acid Rain Trading Program (Title IV of the 1990 Clean Air Act Amendments)

The acid rain trading program set an overall cap on SO_2 emissions from electricity generation units of about 9 million tons per year, effective in 2000 and beyond.[3] This emissions cap was to be achieved in two phases. In Phase I, from 1995-1999, the 263 highest emitting units (in 110 generation plants) were required to reduce their emissions by about 3.5 million tons per year. In Phase II, 2000 and beyond, virtually all fossil-fueled electric

[3] For a summary and evaluation of the acid rain trading program, see Ellerman, A. Denny, Paul L. Joskow, Richard Schmalensee, Juan-Pablo Montero, and Elizabeth M. Bailey. *Markets for Clean Air: The US Acid Rain Programme.* Cambridge: Cambridge University Press (2000). For a brief review, see also Ellerman, A. Denny, Paul L. Joskow, and David Harrison, Jr. 2003. *Emissions Trading: Experience, Lessons, and Considerations for Greenhouse Gases.* Prepared for the Pew Center on Global Climate Change. Arlington, VA: Pew Center on Global Climate Change.

generating units became subject to the national cap on SO_2 emissions. The Phase I and Phase II caps are enforced by the annual issuance of tradable emission allowances, each of which permits the holder to emit one ton of SO_2 in the year or any future year. Within 30 days of each year, each unit delivers valid allowances to cover its annual emissions, at which point the EPA (administrator of the program) cancels the allowances needed to cover emissions. Failure to produce the necessary allowances to cover emissions subjects an electricity generator to financial penalties and requirements for future additional emission reductions.

Allowances not needed to cover emissions in a particular year can be "banked" for future use or sale. Owners thus are free to decide what mix of emission reductions and allowance transactions they employ.

4.1.3. TXU Activities in Anticipation of Title IV of the 1990 Clean Air Act

Like other electricity companies, TXU had been subject to federal SO_2 regulations before the 1990 Amendments and, indeed, these prior actions are important in developing the appropriate context for the 1990 controls. The 1970 Clean Air Act Amendments (the first significant federal air pollution legislation) established national maximum standards for ambient concentrations of SO_2 (and other pollutants). These amendments also imposed New Source Performance Standards (NSPS) for new power plants; new plants could not exceed 1.2 lb of SO_2 per million British Thermal Units (Btus) of fuel burned. In 1977, the NSPS was tightened and a provision was added requiring that new plants meet a "percent reduction" standard. The net effect of the 1977 Amendments was to require all new coal plants to be built with flue gas desulfurization facilities (scrubbers) even if they burned low-sulfur coal.

During the 1980s, various proposals were developed to extend SO_2 controls to existing power plants, largely as a means of dealing with "acid rain," which became of increasing interest in light of the objections of Canadian officials to emissions from the US that were alleged to be damaging Canadian (and American) forests and water bodies. There also was evidence that the stringent controls on new sources had the effect of encouraging electricity companies to keep existing facilities operating longer than they otherwise would.

Many acid rain bills were proposed (largely by western and northeastern senators and representatives) during the 1980s. These bills generally called for reductions of about 6-12 million tons of SO_2 emissions from 1980 levels, achieved by extending the NSPS requirement to existing units. Although some commentators called for electricity companies to reduce SO_2 emissions from their existing plants in light of the potential regulations, TXU did not add scrubbers to its units or engage in major SO_2-reducing activities. Many of TXU's facilities burned lignite, which had substantially lower SO_2 emissions (generally under 3.0 lbs/mmbtu) than units burning bituminous coal (which had emission rates in the range of 8-12 lbs/mmbtu). TXU also participated actively in the analyses developed by EEI and UARG during this period.

Although there were calls for TXU and other electricity companies to decrease their SO_2 emissions in light of likely future requirements to reduce SO_2 from existing plants, TXU declined to reduce its SO_2 emissions beyond the existing requirements for several reasons:

- Capital and other expenditures incurred by TXU that were not required by federal or state requirements would not have been recoverable in rates and thus would have reduced stockholder returns.
- Retrofitting existing units with scrubbers would be costly and, moreover, these costs were likely to decline over time, making immediate expenditures more costly than necessary.
- Making changes before the regulatory requirements were firmly established created risks that the actions taken to reduce emissions would be suboptimal and more costly than when faced with more certain requirements.
- All proposals involved a phase-in period and thus there was little danger that TXU would not have time to implement controls at a latter date, if necessary.
- The possibility that a cap-and-trade program would be used to control emissions meant that some formula would need to be developed to allocate allowances initially; reducing emissions then would result in fewer allowances

later and thus higher compliance costs if the allocation were based upon current or recent emissions.

Acid rain legislation gathered considerable support in 1989, when George Bush, who had promised to be the "the Environmental President," took office. The political strength of the environmental movement had gained strength in the 1980s and political opposition to controls on high-sulfur coal had diminished as the number of miners producing high-sulfur coal diminished. Work on acid rain legislation also was heavily influenced by various proposals for the use of emissions trading, which appealed to President Bush's advocacy to "look to the marketplace for innovative solutions" to environmental problems. Although the concept of emissions trading had been discussed for many years—and there had been previous programs that included emissions trading—the acid rain program was the first major program to develop a cap-and-trade program. This program was in stark contrast to the dominant "command-and-control" approach that required that individual sources meet emission rate limits (e.g., lbs per million btus of fuel input) or install particular control technologies (e.g., scrubbers).

TXU participated actively in the development of Title IV, including the complex negotiations that led to the distribution of Phase II allowances. (TXU did not have any Phase I units.) The basic formula for Phase II units for setting "baseline emissions" provided Phase II allowances equal to each unit's baseline heat input (fuel use) times the lesser of its actual 1985 emission rate or 1.2 lb. of SO_2 per million Btu (divided by 2000 to express allowances in tons). However, Title IV contained more than thirty individual allocation rules that provide for deviations from this simple formula.

4.1.4. TXU Activities to Plan for Compliance with the Acid Rain Trading Program

After the acid rain trading program was put in place, TXU developed procedures to develop a least-cost compliance plan to meet the requirements of the legislation. The key analysis consisted of assessments of the potential financial advantages of installing scrubbers. The analyses followed the general procedures outlined above.

TXU has developed a compliance plan for the SO_2 requirements based upon the general methodology outlined above. The basic steps are summarized as follows:

1. For each facility, assess the costs and emissions reduction potential of adding scrubbers, taking into account plant-specific considerations including costs and removal efficiencies.
2. Develop projections of the likely future prices of SO_2 allowances based upon the available forward price curves.
3. Compare the likely cost per ton of installing scrubbers with these projections of the market price of SO_2 allowances.
4. Consider potential uncertainties regarding scrubber costs, removal efficiencies and operating costs, and the market price of SO_2 allowances.
5. Using information on the caps (allowances) provided to TXU facilities under Phase II, the costs of reducing SO_2 emissions over the entire generation fleet portfolio, and the projections of SO_2 allowance prices, choose the set of decisions with the highest economic value to TXU and its shareholders.

The eventual Title IV bill appears to have vindicated TXU's analysis and decision not to install scrubbers or otherwise reduce its SO_2 emissions in advance of the requirements of the 1990 legislation for several reasons:

- The 1990 legislation provided for a 10-year delay before TXU had to comply with the requirements of the statute, and thus expenditures made to reduce emissions in advance of the legislation would have been much more costly because of the time value of money and the cheaper technologies that became available over time.
- Since it was based upon recorded emission rates in 1985, the formula for allocating initial allowances would have penalized TXU if it had installed scrubbers or switched to more expensive low-sulfur coal substantially in advance of the legislation.
- The opportunity to buy and sell allowances meant that TXU could wait until market SO_2 prices were established to decide whether or not to install scrubbers or shift to low-sulfur coal. Indeed, the prices of SO_2 allowances after the program went into effect turned out to be lower than anticipated when the legislation was passed, leading some early decisions to install scrubbers to be uneconomic.

- Compliance costs have tended to decrease over time, both because of improvements in scrubber technology and because of the lower cost of low-sulfur Power River Basin (PRB) coal. PRB coal prices declined in part because of reductions in the cost of transportation made possible by railroad deregulation in the 1980s.

4.1.5. TXU Ongoing Compliance with Title IV SO_2 Requirements

The results of the TXU analyses of control options have been for TXU to fuel switch, to over-scrub using existing equipment and to rely upon the purchase of SO_2 allowances for the remainder of the allowances needed to cover TXU facility emissions. The assessments of the required number of allowances that might be needed are made monthly, with annual submissions to EPA that show compliance with the Title IV requirements.

Table 2 presents TXU's allocations, allowances and emissions in 2003 by plant. The table shows that, although the allowances held by TXU's individual facilities were in some cases greater and in other cases less than their actual emissions, TXU's overall allowances were sufficient to cover total fleet-wide emissions. TXU received an allocation of roughly 240,000 tons of SO_2 and purchased just over 42,000 tons worth of allowances, giving it a fleet-wide total of 282,800 tons worth of allowances in 2003, easily sufficient to cover its 273,593 tons worth of emissions.

Note that the trading activities TXU engages in with respect to SO_2 allowances are designed primarily to achieve least-cost compliance, rather than to profit from swings in SO_2 allowance prices. As with its trading related to fuel and electricity, however, TXU's traders use standard financial risk management techniques to identify financial risks and take appropriate actions to hedge the financial risks.

4.1.6. Evaluation of TXU's Approach to the Acid Rain Trading Program

TXU appears to have been successful in its various activities related to Title IV of the 1990 Clear Air Act Amendments.

- TXU was active in the industry evaluations and assessments that lead up to the 1990 legislation.
- TXU was able to provide information in the legislative process that resulted in adequate initial allowances for TXU facilities.
- TXU appropriately did not undertake costly retrofits or fuel switching in anticipation of the deadline for complying, which in the case of TXU facilities was the Phase II period (2000 and beyond).
- TXU has developed a cost-effective compliance plan that appropriately takes advantage of the flexibility provided by emissions trading.
- TXU has developed trading and risk management activities that reduce both the costs and the financial risks associated with complying with Title IV requirements.

4.2. TXU and Texas Air Emissions Standards

This section provides information on TXU's actions with respect to Texas requirements related to NO_x emissions as developed under the Texas SIP.

4.2.1. Overview of Our Review

TXU has a complex set of regulatory requirements related to its NO_x emissions, derived from federal requirements to achieve ambient air quality standards in Texas air quality regions. TXU has developed considerable internal resources to evaluate investment alternatives and to maintain an optimum compliance plan over time. Indeed, TXU is in the middle of a substantial upgrade of its program to monitor its NO_x emissions and the opportunities to reduce emissions and achieve compliance.

Our review consists of summarizing the complicated set of NO_x requirements facing individual TXU generating plants—based on federal requirements and the Texas air quality regions—and then considering TXU's activities in two dimensions.

1. Assessments of its optimal investment/compliance plan; and
2. Ongoing plans to develop optimal controls over time.

Although the NO_x requirements provide for a cap-and-trade program, the cost-saving opportunities are substantially smaller than for SO_2 emissions because of the more limited geographic

Table 2. TXU SO_2 Allocations, Allowances and Emissions in 2003

TXU Facility	SO_2 Allocation	SO_2 Allowances	SO_2 Actual Emissions
Big Brown 1	20,979	44,898	46,888
Big Brown 2	19,872	36,433	39,452
Collin 1	92	100	41
Dallas 3	27	27	0
Dallas 9	26	26	0
Decordova 1	1,018	1,039	9
Eagle Mountain 1	52	55	38
Eagle Mountain 2	140	146	101
Eagle Mountain 3	100	104	2
Graham 1	235	244	8
Graham 2	496	506	226
Lake Creek 1	39	45	0
Lake Creek 2	191	194	0
Lake Hubbard 1	170	178	22
Lake Hubbard 2	604	629	24
Martin Lake 1	33,220	1,215	24,221
Martin Lake 2	32,255	32,613	21,197
Martin Lake 3	33,425	33,792	30,554
Monticello 1	23,633	23,953	30,515
Monticello 2	22,930	23,273	29,906
Monticello 3	35,220	35,534	22,019
Morgan Creek 3	8	10	0
Morgan Creek 4	72	77	0
Morgan Creek 5	154	160	0
Morgan Creek 6	836	841	5
North Lake 1	131	138	6
North Lake 2	150	160	4
North Lake 3	294	301	3
North Main 4	42	44	0
Parkdale 1	34	35	0
Parkdale 2	62	63	0
Parkdale 3	61	63	0
Pedricktown 1	0	5	0
Permian Basin 5	103	105	0
Permian Basin 6	804	812	563
River Crest 1	61	63	0
Sandow 4	0	35,008	27,475
Stryker Creek 1	170	175	11
Stryker Creek 2	525	544	145
Sweetwater Gt01	0	1	0
Sweetwater Gt02	0	1	1
Sweetwater Gt03	0	2	1
Tradinghouse 1	593	598	2
Tradinghouse 2	995	1,002	21
Trinidad 7	6	6	0
Trinidad 8	1	4	0
Trinidad 9	135	141	97
Twin Oak 1	8,012	5,158	0
Twin Oak 2	1,540	1,540	0
Valley 1	77	86	10
Valley 2	518	526	20
Valley 3	124	127	0
Total	**240,232**	**282,800**	**273,593**

Source: TXU.

Table 3. National Ambient Air Quality Standards

Pollutant	Primary Standards	Averaging Times
Carbon Monoxide (CO)	9 ppm (10 mg/m^3) 35 ppm (40 mg/m^3)	8-hour 1-hour
Lead (Pb)	1.5 µg/ m^3	Quarterly Average
Nitrogen Oxides (NO_x)	0.053ppm (100 µg/ m^3)	Annual (Arithmetic Mean)
Particulate Matter (PM_{10})	50 µg/ m3 150 µg/ m^3	Annual (Arithmetic Mean) 24-hour
Particulate Matter ($PM_{2.5}$)	15 µg/ m^3 65 µg/ m^3	Annual (Arithmetic Mean) 24-hour
Ozone (O_3)	0.08 ppm 0.12 ppm	8-hour 1-hour
Sulfur Oxides (SO_x)	0.03 ppm 0.14 ppm	Annual (Arithmetic Mean) 24-hour

Source: http://www.epa.gov/air/criteria.html

regions for NO_x emissions. For this reason, TXU's activities related to NO_x emissions are less of a model for potential future CO_2 regulations than its activities regarding SO_2 emissions and the acid rain trading program.

4.2.2. Federal Ambient Air Quality Standards and State Implementation Plans

The federal Clean Air Act (CAA) provides the legal foundation for the national air pollution control program. As the first step towards a national air quality policy, the CAA directs the EPA Office of Air Quality Planning and Standards (OAQPS) to set National Ambient Air Quality Standards (NAAQS) for the following six criteria pollutants:

1. Carbon Monoxide (CO);
2. Lead (Pb);
3. Nitrogen Oxides (NO_x);
4. Particulate Matter (PM10 and PM2.5);
5. Ground-Level Ozone (O3); and
6. Sulfur Oxides (SOX).

The NAAQS establish nationally acceptable levels of ambient air concentrations for each of the six pollutants in order to protect public health – including the health of sensitive populations such as asthmatics, children, and the elderly – and public welfare – including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Table 3 shows the NAAQS for each of the six criteria pollutants.

After developing NAAQS for the six criteria pollutants, the CAA requires that each state produce and regularly update a SIP in order to satisfy the air quality standards. Each SIP includes a description of the state's particular plan and control strategies intended to comply with the NAAQS. After developing a SIP, each state submits it to the EPA for approval.

4.2.3. Texas Air Quality Regions

The Texas SIP was initially approved in May 1972 and has gone through numerous revisions since then. Texas currently meets federal air quality standards in all of its regions with the following exceptions:

1. Carbon monoxide and particulate matter standards in El Paso; and
2. Ozone standards (1-hour) in Dallas/Fort Worth, Houston/Galveston, Beaumont/Port Arthur, and El Paso.

In addition to these four non-attainment areas, there are five areas that meet ozone air quality standards by a slim margin. These near non-attainment areas are Corpus Christi, Victoria, Austin, San Antonio, and Northeast Texas.

In April of 2004, EPA classified the following four areas in Texas as non-attainment areas for the 8-hour standard: Dallas/Fort Worth, Houston/Galveston, Beaumont/Port Arthur, and San Antonio. All of these areas except San Antonio were already designated as non-attainment areas for the 1-hour standard. In addition, the EPA proposed 8-hour ozone non-attainment designation included several counties in the Dallas/Fort Worth area that were not previously included in the 1-hour ozone non-attainment designation. Furthermore, the EPA's selection of counties in the Dallas/Fort Worth and San Antonio areas include more counties than Texas had included in its July 2003 recommendations.

4.2.4. TXU Requirements Under the Texas State Implementation Plan

TXU operates 22 generating plants in Texas. Of these 22 plants, six are located within the Dallas/Fort Worth region and are required to comply with the Dallas/Fort Worth SIP NO_x emissions cap. Eleven additional plants are required to comply with the East and Central Texas SIP NO_x emissions cap. Furthermore, two of these eleven plants in the East and Central Texas SIP face additional requirements due to their location in the Northeast Texas near non-attainment area. These two lignite plants, Martin Lake and Monticello, are required to comply with NO_x emission rate limits of 0.20 lb/mmBtu.

In addition to these SIP requirements, the Texas State Legislature created additional NO_x emissions regulations when it initiated the restructuring of the electric industry in 1999 through the adoption of Senate Bill SB 7. SB 7 directed the Texas Natural Resources Conservation Commission (now the Texas Commission on Environmental Quality or TCEQ) to develop NO_x and SO_2 cap-and-trade programs for certain electric generating facilities. The trading programs established two separate trading regions, one for eastern Texas and one for western Texas. Electricity companies may trade emissions permits within their region, but trades between regions are not permitted. The SB 7 air emissions requirements resulted in a 50 percent reduction in NO_x and a 25 percent reduction in SO_2 (from 1997 levels) by May of 2003 from units that had been designated as "grandfathered" units. The new more stringent SIP requirements will soon supplant SB 7 requirements.

Table 4 summarizes the relevant NO_x regulatory requirements for each TXU generating plant.

4.2.5. TXU Analyses of NO_x Compliance Investments

TXU periodically reviews its NO_x compliance program in order to meet the complex NO_x requirements in the most cost-effective way. In April 2002, for example, TXU analyzed the future capital requirements to maintain NO_x compliance, concluding that an additional $101.4 million of equipment should be installed to reduce NO_x emissions. The review stressed that without the NO_x reducing investments, TXU would not be able to operate some of its units. That is, NO_x investments were evaluated in terms of their impact on the value of TXU's generation fleet, weighed in the context of their cost. In addition, this analysis included the following components and complexities.

- Each project was evaluated independently relative to a "hurdle rate" of 13 percent (after tax), in order to avoid approving individual expenditures that would not be justified.
- Reliability limits in ERCOT were included, to ensure that the NO_x compliance and reliability requirements of the Dallas Fort Worth area are met.
- The advisability of some investments were uncertain because of inadequate testing data; TXU committed to developing the additional data before making decisions on those investments.
- The potential availability of emissions credits (discrete emissions reduction credits, or DERCs) also was unclear; TXU decided to get greater clarity before proceeding with some controls.
- The April 2002 analysis is part of an ongoing evaluation; the April 2002 analysis noted the additional features that would be forthcoming in a summer 2002 analysis.

Table 4. Relevant NO_X Regulatory Requirements for TXU Plants

TXU Plant	Dallas/Fort Worth SIP	East/Central Texas SIP	Northeast Texas Near Non-Attainment Area	SB 7 East	SB 7 West
DeCordova		X		X	
North Main	X			X	
Eagle Mountain	X			X	
North Lake	X			X	
Lake Hubbard	X			X	
Parkdale	X			X	
Collin	X			X	
Valley				X	
River Crest				X	
Monticello		X	X	X	
Martin Lake		X	X	X	
Stryker Creek		X		X	
Big Brown		X		X	
Trinidad		X		X	
Sandow		X		X	
Lake Creek		X		X	
Tradinghouse		X		X	
Comanche Peak					
Graham					X
Morgan Creek					X
Permian Basin					X
Sweetwater					X

Source: TXU.

Note that analyzing the optimum response to state NO_x controls involved a more complex process than determining the optimum response to the federal acid rain program for SO_2 emissions. Two primary factors accounted for the added complexity of TXU's NO_x capital investment analysis:

- Many NO_x control technologies can be developed at each power facility, in contrast to the case of SO_2 in which scrubbers are the major technological option for reducing emissions.
- TXU was required to comply with no less than five different localized or regional NO_x limits for its power plants, rather than the fleet-wide emission limit in the case of the SO_2 program.

In addition to the more complex analysis, the highly localized and multiple regional NO_x limits hinder the development of markets for NO_x emission allowances, reducing the ability of TXU to use NO_x emission allowance markets to reduce overall compliance costs. Texas deregulation also complicates the development of cost-effective compliance options. Current ERCOT rules, for example, impose operational constraints on plants that in some cases require them to run even if TXU would not choose to operate the plants. Moreover, constraints on transmission upgrades further limit choices.

Although more complicated than the SO_2 acid rain program investment analysis, TXU's April 2002 analysis appears to have appropriately incorporated the complexities of alternative NO_x investment scenarios. While the NO_x compliance program involves hundreds of millions of dollars for capital investment in control technologies, TXU has only made these capital commitments after extensive economic analysis.

4.2.6. TXU Methods to Optimize Ongoing Compliance

Ongoing compliance with the NO_x requirements in Texas is a complicated enterprise because of the large number of regions and requirements. TXU has long had in place the ability to monitor its emissions and keep track of ongoing emission requirements. This ability is substantially improved by the development of the computer-based Emissions Management System. This software program allows TXU to develop alternative NO_x scenarios and to determine the optimum means of achieving the NO_x emissions requirements at individual facilities. This software allows TXU managers to determine whether changes in operations or other means would be more effective means of achieving the NO_x targets.

4.3. TXU Compliance with Air Emissions Requirements

Another important criterion for judging TXU's actions with regard to current air emissions requirements is whether the company has been in compliance with air emissions requirements. Although this test does not relate to whether or not the choices minimize costs, it does reflect on the Company's commitment to compliance and relates to the success of its planning procedures.

4.3.1. Overview of Our Review

Our review of TXU's compliance performance consists of considering four related issues:

- TXU's overall record of compliance.
- TXU's Compliance Assistance Visits (CAV) program.
- TXU's emissions monitoring and compliance systems (both current and future).
- TXU's Continuous Emissions Monitoring (CEMs) data.

4.3.2. TXU Overall Air Emissions Compliance Record

TXU reports its overall air emissions compliance record, expressed as the percentage of its generation (kilowatt-hours), in its annual Environmental Report. Table 5 summarizes the history of compliance over the last decade. The record shows that; TXU has been in compliance with air emissions requirements for more than 98 percent of its generating hours in each of these years, and in most years the percentage is above 99 percent.

Table 6 shows TXU projected compliance with Texas NO_x and SO_2 emissions requirements in 2003-2004.[4] The table shows the NO_x and SO_2 caps faced by TXU plants for both east and west SIP and SB 7 regions, adjusted to account for trades in emissions

[4] The annual caps began on May 1, 2003 and ended on April 30, 2004.

Table 5. TXU Historical Air Emission Compliance

Year	Air Compliance Ratio
1993	98.2%
1994	98.4%
1995	98.9%
1996	99.0%
1997	99.3%
1998	99.4%
1999	99.3%
2000	99.2%
2001	99.3%
2002	98.8%
2003	99.4%

Source: TXU.

allowances. The table also shows actual emissions from May 1, 2003 through August 31, 2003 and projects the additional emissions that will occur from September 1, 2003 until April 30, 2004. The final columns demonstrate that the TXU plants are projected to comply with all of the NO_x and SO_2 requirements.

4.3.3. TXU Compliance Assistance Visits (CAV) Program

Many companies do internal environmental audits of environmental performance. Some accomplish this with a team of dedicated auditors housed either in the environmental department or in the internal audit department. Some years ago, TXU decided on a cooperative approach that avoided the "policeman" approach and even the term "audit." Thus the cooperative, "Compliance Assistance Visit" or CAV was developed. The CAV program is TXU's environmental audit program and an important part of its overall air quality program.

The CAV program is one of the controls the Company has in place to ensure compliance with existing environmental regulations. In addition to the CAV program, TXU does solid waste vendor audits, real estate, merger and acquisition environmental site assessments and audits, and special evaluations and audits, such as the one done for the CEMs by Hunton and Williams and described below.

The CAV program is a formal self-monitoring program that is carried out at each TXU facility. In the program, a site inspection is performed by TXU environmental discipline specialists in air, water, solid waste, and mining/reclamation much as the State and Federal compliance inspections done by personnel from these regulatory agencies. The purposes of the CAV program are to help ensure that TXU facilities adhere to environmentally acceptable production and operating procedures, and to help ensure that these facilities achieve and maintain a high degree of compliance with environmental laws and regulations.

Table 6. TXU Projected Compliance With 2003-2004 NO_X and SO_2 Caps

Emission Zone / Pollutant	Adjusted Legal Limit *	Actual Emissions	Projected Future Emissions	Total Emissions	Difference of Limit and Total Emissions
SB 7 East / NOx	54,999	18,613	30,705	49,318	5,681
SIP East / NOx	54,667	17,669	30,233	47,902	6,765
SB 7 West / NOx	7,838	1,515	1,607	3,122	4,716
SB 7 East / SO2	273,954	98,347	186,784	265,131	8,823

Note: * Adjusted Legal Limit = Original Legal Limit +/- Allowance Trades.

Source: TXU.

CAVs are done on a periodic schedule and are done by discipline specialists in the area of air quality, continuous emissions monitoring, water, wastewater, potable water, solid waste, hazardous waste, and mining and reclamation (which includes wetlands). Written checklists or other written procedures documents are used during the CAVs, which are performed by environmental personnel who are independent of the facility being visited. Facilities include power plants, surface mines, electric and gas service centers, gas compressor stations, the solid waste management facility, and the linear "projects" such as new transmission line and new pipeline construction projects. The results of the CAVs are provided to facility environmental and management personnel who are responsible for addressing CAV findings. CAV findings are tracked and trended and summary reports are presented to company management.

In 2003, TXU did 12 air quality CAVs and 18 CAVs for the CEMs program. The results of the CAVs for CEMs data are described below.

4.3.4. TXU's Current and 2005 Emissions Monitoring and Compliance Systems

An important aspect of compliance records is the systems TXU has in place to track and monitor emissions. This section reviews TXU's current emissions monitoring and compliance systems and outlines the features of an updated system to be installed in 2005.

4.3.4.1. TXU's Current Emissions Management System

To facilitate the monitoring of emissions at TXU's generating facilities, the EMS program outlined above provides users with a broad scope of information related to TXU's emissions. The system has the following key features:

- Obtains hourly emissions data from the existing CEM System Central Repository.
- Sums hourly unit emissions into zones, complying with 2003 rules for 24 hour, 30 day rolling averages and annual limits.
- Forecasts and displays emissions by zone based on historical and expected future generation unit output.
- Calculates and displays hourly allowance trade adjusted emission targets and limits by zone.
- Utilizes the ability to manually enter remaining current day unit generation output for analyzing the effects on emissions limits.
- Takes advantage of the existing trading systems.

4.3.4.2. TXU's 2005 Emissions Project

Motivated in part by the more restrictive NO_x limits beginning in May 2005, TXU has developed a 2005 Emission Project to update their current emissions monitoring and compliance system. The key new objectives/features of this project are:

- Maintain the 2003 system functionality plus data feed as the 2005 system is designed.
- Integrate real-time dispatch corrections to avoid 2005 limit violations.
- Include an explicit add-on module that incorporates the existing trading system, which allows optimization within the NO_x constraints.
- Incorporate 2003 operational experience into 2005 emission system design.

This project thus should allow help TXU to minimize the costs of meeting the NO_x requirements and ensure compliance.

4.3.5. Continuous Emissions Monitoring (CEMs) Data

The accuracy of CEMs data is an important component of the emissions monitoring process. TXU contracted the services of Hunton & Williams to provide an audit on TXU's Clean Air Act compliance program, which included a review of TXU's CEMs data. Overall, Hunton & Williams give a favorable rating to the TXU's Clean Air Act compliance program. The audit describes the program as "sufficiently robust to accurately monitor and report emissions data."[5] Specifically, the audits comments on the maintenance of CEMs hardware were positive, noting that TXU has achieved an uptime record of greater than 99 percent and has devoted significant resources to maintaining CEMS hardware reliability. However, concerns were expressed about TXU's CEMs compliance software, and recommendations were provided.

[5] Hunton and Williams, 2003. "TXU Electric Clean Air Act Compliance Review: Executive Summary and Report."

In response to the Hunton & Williams audit and their recommendations, TXU has implemented various action plans to improve its Clean Air Act compliance program. These action plans include a number of tasks that specifically address the software issues pointed to in the Hunton & Williams audit. Thus, TXU appears to have used outside reviews to improve its air emissions data collection system.

4.4. Overall Evaluation of TXU Actions with Regard to Current Air Emissions Requirements

TXU appears to have responded to current regulatory requirements in an environmentally and economically sound manner.

- TXU has developed appropriate analyses at different points in the rulemaking process.
- TXU has developed cost-effective and effective compliance plans to meet national SO_2 emissions requirements and Texas NO_x emissions requirements.
- TXU has used the flexibility provided by emissions trading under Title IV of the Clean Air Act Amendments of 1990.
- TXU has an excellent compliance record with respect to air emissions.
- TXU has developed internal and external audits to ensure that its environmental reporting is accurate.
- TXU has taken actions to audit/evaluate its methods and to improve features based upon the reviews.

5. TXU Activities Related to Potential Future Air Emissions and Climate Change Requirements

This section and the next relate to potential air emissions and climate change regulatory requirements. Potential federal requirements for various emissions are contained in various "multi-pollutant" bills in Congress; one of the bills only deals with CO_2 emissions. In addition, the US EPA has proposed additional regulations on SO_2, NO_x and mercury. All of the federal CO_2 proposals call for the development of a cap-and-trade program for CO_2, following the pattern begun by the European Union to develop a program that will begin operation January 1, 2005.

This section provides an overview of the federal legislative and regulatory initiatives and, emphasizing the large differences among the various legislative and regulatory proposals. Indeed, although many commentators believe that mandatory CO_2 controls on electric generators in the US are inevitable at some point, there is little agreement on the timing and nature of these controls (beyond the preference for a cap-and-trade program for CO_2 emissions). In this section we then discuss the actions that TXU has taken thus far with regard to future air emissions, focusing on those related to mercury emissions and greenhouse gas emissions. The following section addresses the key issue of which actions might be in TXU's financial interest to take now with respect to CO_2 emissions in light of the possibility of a future federal cap-and-trade program for CO_2.

5.1. Overview of Potential Federal Legislation and Regulation

Various bills have been introduced in the last several sessions of Congress, including a bill introduced by Senators John McCain and Joseph Lieberman to regulate CO_2 emissions as well as the various "multi-pollutant" bills. All of the multi-pollutant bills would require additional reductions in NO_x and SO_2 emissions and add limits on mercury emissions. Some of the bills also call for mandatory limits on CO_2 emissions. The legislative alternatives in some cases provide relief from other air emissions requirements. In addition, the Bush administration in December 2003 released two regulatory proposals, one to reduce NO_x and SO_2 emissions and one to impose limits on mercury emissions. Note that our aim here is not to provide detailed analyses of these initiatives, but rather to provide a context for TXU decision making. The key point here is that uncertainties regarding the timing and nature of mandatory CO_2 controls are much greater than those for the other emissions (although mercury controls also have substantial uncertainties).

5.1.1. McCain-Lieberman Bill

On October 30, 2003, the Senate voted on the Climate Stewardship Act (McCain-Lieberman Bill), which was defeated by a vote of 43-55. The bill would have established a cap-and-trade program for CO_2 that would cover about 70 percent of US CO_2 and GHG (greenhouse gas) emissions. The cap-and-trade program would have covered CO_2 emissions from all non-residential and non-agricultural sources of greenhouse gases that emit at least 10,000 metric tons of CO_2 per year.

The McCain-Lieberman Bill would establish two phases of CO_2 caps for covered sources:

- 2010 – total emissions cap equal to 2000 levels (approximately 4.63 billion tons)
- 2016 – total emissions cap equal to 1990 levels (approximately 4.04 billion tons).

The sponsors of the bill, Senators McCain and Lieberman, have attempted to reintroduce the bill in the current congressional session.

5.1.2. Multi-pollutant Bills

Several multi-pollutant bills have been introduced that would establish caps for emissions from electricity generation units. The three major multi-pollutant proposals are the Bush administration's Clear Skies Initiative (Clear Skies), Senator Carper's Clean Air Planning Act (Carper Bill), and Senator Jeffords Clean Power Act (Jeffords Bill). All three bills would establish cap-and-trade programs for emissions, i.e., programs that set overall caps for covered facilities and allow the facilities to buy and sell allowances among themselves, as in the acid rain trading program. The three initiatives, however, differ substantially on many dimensions.

Appendix C provides a summary comparison of the major features of the three multi-pollutant bills as of January 2004 as reported on the website of Resources for the Future. The proposals differ on many key features.

- *Pollutants included.* Clear Skies does not include CO_2 emissions, while the other two impose caps on CO_2.
- *Stringency of caps.* Both the timetables and the caps differ substantially in the three bills.
- *Additional allowance availability, including "safety valve."* The three bills differ substantially in the availability of allowances from other programs—such as carryover from the existing Title IV and NO_x SIP Call programs as well as the possibility of project-specific credits for CO_2. One of the bills (Clear Skies) provides for safety valves, i.e., prices per ton that participants could pay in lieu of reducing emissions.
- *Constraints due to local concerns.* The bills also differ in the extent to which emissions in non-attainment areas would constrain a unit's ability to purchase allowances to cover emissions, and at what exchange rate.
- *Future changes in caps.* Some bills specifically provide for a "re-opener" that would change the nature of the cap in some future year.
- *Allowance banking and trading restrictions.* The bills also differ in the regions within which allowances could be traded and the linkages with other trading programs (e.g., NO_x SIP Call, Western Regional Air Partnership).
- *Allowance allocation method.* The bills differ substantially in the critical issue of how initial allocations are determined, including the extent to which allocations would be auctioned rather than distributed for free and the precise formulas that would be used for free allocations.
- *Penalties for excess emissions.* The bills differ on whether any excess emissions must be offset in a following year and what the penalty would be based upon (e.g., Jeffords has a penalty equal to three times the average allowance price, Clean Skies has a penalty equal to the average allowance price, and Carper sets particular penalty rates for each of the pollutants).
- *Monitoring and record keeping.* The bills differ in terms of whether continuous emissions monitors (CEMs) are required and how often reporting is required.
- *Regulatory relief.* The bills differ substantially in the changes that would be implemented in the Clean Air Act that would reduce other regulatory requirements. The potential changes include how the New Source Review program would operate and whether other air provisions would be eliminated (e.g., Section 126 related to petitions by downwind states, Section 112 dealing with hazardous emission requirements, and Section 169 dealing with visibility and regional haze).

The large differences among these three bills on many dimensions indicate the enormous uncertainties regarding potential additional constraints on air emissions and GHG emissions. It is simply difficult to assess whether one of these (or another) bills will pass, when it might pass, and what specific requirements it might involve, particularly with regard to CO_2 requirements.

5.1.3. Bush Administration Regulatory Proposals

The Bush administration has developed two proposals to address the further restriction of electricity generator emissions from a regulatory rather than a legislative perspective. The two Bush administration regulatory proposals further complicate projections of the nature of future air and climate change requirements.

In December 2003, the Administrator of EPA proposed both an "Interstate Air Quality Rule" (covering NO_x and SO_2 emissions—subsequently renamed the "Clean Air Interstate Rule" (CAIR)—and a mercury rule that together are intended to achieve emission reductions roughly comparable to those in the Clear Skies legislation. (Appendix C contains summaries of these two proposals on the Resources for the Future website.)

The CAIR sets up programs to reduce SO_2 and NO_x emissions from electric generators. The proposed rule would cover a total of 28 states (including Texas) and the District of Columbia. States could meet the proposed emissions reductions either by requiring electric generators to participate in a cap-and-trade program or by using other measures the state chooses. The proposed cap-and-trade program would reduce power plant SO_2 emissions by about 3.6 million tons in 2010, with ultimate reductions of about 4.7 million tons. The reductions for NO_x emissions would be about 1.5 million tons in 2010 and 1.8 million tons in 2015.

EPA's mercury proposal includes two alternatives to reduce electricity generator mercury emissions. The first would implement the mercury MACT requirement at individual power plants. The second, and EPA's preferred approach, would allow electricity companies to trade mercury allowances.

Although the combination of these two proposals might lead to reductions roughly equivalent to those that would be achieved by the Clear Skies initiative, many other elements would be different under this regulatory approach. The regulatory approach, for example, does not provide for any relief or modification of existing regulatory requirements (e.g., visibility requirements) and, indeed, some commentators have pointed out potential inconsistencies between the NO_x and SO_2 proposals—which focus on cap-and-trade programs—and the existing visibility requirements that might provide less trading flexibility.[6]

5.1.4. State and Private Initiatives

In addition to these federal legislative and regulatory initiatives, there are a host of other developments related to efforts by States, regional entities, and private entities with regard to CO_2 and climate change. The following are some of the efforts in recent years by states and private institutions.[7]

- Ten states in the Northeast are developing a plan for a cap-and-trade program for CO_2 emissions from electric power plants—the Regional Greenhouse Gas Initiative—with the intention of having a final agreement in place by April 2005. These ten states account for about 13.4 percent of US CO_2 emissions. (Note that Massachusetts already has a plan in place to cap CO_2 emissions from power plants.)
- Several states—including Massachusetts, Connecticut, and Maine—have sued the US EPA over its decision that it lacks the legal authority to regulate GHG emissions under the Clean Air Act.
- Various institutions within the US are developing mechanisms to allow trading in CO_2 allowances. The Chicago Climate Exchange, for example, has announced that it will broker CO_2 trades. These US developments complement the institutions developing in Europe to broker CO_2 trades for the current UK carbon trading program and the European Union emissions trading scheme for CO_2, set to begin in January 2005.

5.1.5. Comparisons of Uncertainties Regarding CO_2 Controls and Controls on Air Emissions

Clearly there are substantial uncertainties about the nature of future requirements for air emissions and greenhouse gas emissions. These uncertainties, however, differ substantially for the different emissions.

- *SO_2 emissions.* It seems highly likely that the national cap on electricity generator SO_2 allowances will be lowered in the foreseeable future, either through regulatory or legislative action. The level and the precise timing of the likely cap reduction remain uncertain.
- *NO_x emissions.* It seems likely that the same regulatory or legislative action that lowers the SO_2 cap will establish a NO_x cap-and-trade program for several states, including Texas. This national cap will further complicate TXU's compliance plans with respect to NO_x.
- *Mercury emissions.* Electricity generator mercury emissions seem destined to be regulated, although the nature, timing, and extent of regulation are highly uncertain. The

[6] See Greenwire, December 18, 2003, "Leavitt signs proposal to cut interstate NOX, SO2 emissions."

[7] For a more extensive list of state initiatives related to climate change as of 2002, see Rabe, Barry G. 2002. *Greenhouse and Statehouse: The Evolving State Government Role in Climate Change.* Pew Center for Global Climate Change. November. Additional information related to efforts taken by states and private institutions to address climate change can be found on the Pew Center's website (www.pewclimate.org).

implications for TXU would vary greatly depending upon how these regulatory decisions are made.

- *CO_2 and other greenhouse gas emissions.* Although many expect that TXU and other electricity companies eventually will face mandatory programs to constrain CO_2 and other greenhouse gas emissions, virtually all aspects of the potential regulations are highly uncertain.

In sum, although many commentators suggest the inevitability at some point of binding requirements in the US on CO_2 emissions, there is no agreement about when such legislation might pass, when any requirements would apply, the specific emission sources that would be regulated, and what would be the specific elements of the requirements. The current legislative proposals differ dramatically in their provisions.

5.2. TXU Actions Relevant to Future Air Emissions Requirements

This section provides information on the actions that TXU is taking with regard to future potential regulatory requirements for mercury and CO_2 emissions. We focus on mercury and CO_2—since actions with respect to NO_x and SO_2 emissions have been described in the previous section—although we do review TXU analysis that considers the interactions of various future requirements.

5.2.1. Overview of Our Review

We obtained information on the actions TXU has undertaken (or is undertaking) with respect to mercury and CO_2 emissions based upon various internal documents and interviews. The following is a list of the major categories.

- Purchases of wind power.
- Monitoring of potential future legislative and regulatory requirements.
- Testing and research regarding lignite and mercury emissions as well as potential mercury and CO_2 reduction technologies.
- Evaluation of implications to TXU of potential regulatory requirements, including interactions with future strategic fuel choices.

Table 7. Texas Renewable Energy Requirements

Date	MW of New Renewable Energy
2002	400
2003	400
2004	850
2005	850
2006	1,400
2007	1,400
2008	2,000
2009-2019	2,000

Source: http://www.dsireusa.org

5.2.2. TXU Purchases of Wind Power

The Public Utility Commission of Texas enacted the Renewable Energy Mandate Rule in December of 1999. This rule established a renewable portfolio standard (RPS), requiring 2,000 MW of new renewable energy sources to be installed in Texas by 2009. The renewable energy MW requirements in the interim years are detailed in Table 7. Technologies that qualify as renewable energy under this rule are: solar thermal electric, wind, photovoltaics, landfill gas, biomass, fuel cells, tidal energy, wave energy, and ocean thermal.

The rule allows for the trading of renewable energy credits, defined as one MWh supplied by renewable energy that is metered and generated in Texas. Retail electricity suppliers are each allocated a share of the total renewable energy requirements based on their share of total Texas energy sales. Market participants may sell, transfer and bank these credits.

TXU has been an active participant in the renewable energy program through its purchase of wind power. Indeed, the company has surpassed current state requirements, with more than five times the renewable energy mandated by the state under contract by the end of 2003. With more than 580 MW of renewable energy purchased in 2003, TXU is currently the largest purchaser of renewable energy in Texas. In addition, 75 percent of the wind energy in Texas is distributed through TXU's electric delivery system. In 2003 they purchased wind energy from 702 of the 1,000 wind turbines in Texas.

5.2.3. TXU Monitoring of Legislative and Regulatory Proposals

TXU has been active in industry efforts to monitor the status of the various legislative and regulatory proposals related to mercury emissions and climate change. The basic mechanisms are those outlined in Section 3, including participation in various industry groups that monitor progress of these proposals.

Given the success with the SO_2 program and the potential for cost savings from emissions trading, electric companies have tended to support the development of cap-and-trade programs rather than less flexible regulatory requirements. Thus, for example, the industry has developed information on the potential advantages of the cap-and-trade mercury proposal relative to the MACT approach. TXU has supported the various industry efforts—through its participation in industry groups—to encourage the development of emissions trading and other means of improving the cost-effectiveness of any regulatory requirements that are set for air emissions.

Because of the importance of lignite in TXU's fuel mix and the relatively high mercury emission rates from lignite—as explained below—TXU has been particularly active with respect to mercury controls. TXU has participated in EPA's Working Group on Mercury Emissions and provided information on the relative costs of reducing emissions from lignite versus other coal sources.

5.2.4. TXU Monitoring and Research on Mercury Emissions

The various regulatory proposals on mercury have focused the attention of TXU and other electric companies on their mercury emissions. TXU has responded to these concerns by developing an extensive research program to assess its emissions and control options.

Table 8. Average Mercury Content of CoalFs

Coal Type	Content	Percent of Overall Coal Use for US Electricity Generation
Anthracite	6.3 lb/t btu	Less than 1%
Lignite	7.9 lb/t btu	8.7%
Bituminous	7.1 lb/t btu	48.8%
Subbituminous	5.0 lb/t btu	42.4%

Source: TXU.

5.2.4.1. Background on TXU Mercury Emissions

About 43.1 percent of TXU's generation is from lignite and western coal facilities. The lignite generation is significant because Texas lignite contains higher concentrations of mercury than the most widely used coals and, moreover, there is currently no existing proven technology to further reduce mercury emissions from lignite power plants. Table 8 summarizes the average mercury content of the major coal types.

Currently installed air emission control technologies at TXU to control other emissions—notably electrostatic precipitators, baghouses, and flue gas desulfurization systems—already capture a significant amount of mercury. TXU also has recently reduced its mercury emissions through use of lower-cost subbituminous (Western) coal, which as noted above has lower mercury concentrations than lignite fuel.

5.2.4.2. TXU Research Activities with Respect to Mercury

TXU's major activities with respect to mercury involve research and development to determine more effective and cost-effective means of reducing mercury emissions from Texas lignite. TXU has formed an internal committee (Advanced Air Emission Control Committee) to study which control technologies are appropriate and cost effective to reduce mercury emissions. The following is a summary of TXU's current research efforts on mercury controls.

- Mercury testing to assess the extent of "co-benefit" controls, i.e., reductions in mercury emissions due to other control measures (notably SO_2 scrubbers).

- TXU collaboration with the Energy and Environmental Research Center at the University of North Dakota to test the mercury content of various lignite sources and to evaluate mercury mass balance at key TXU lignite plants.
- TXU collaboration with the University of Texas to evaluate the costs and effectiveness of various methods to reduce mercury, including mercury stratification, oxidation catalyst, chemical injection for improved oxidation, and coal cleaning.
- TXU participation in research by the Electric Power Research Institute (EPRI) that includes controls on mercury as well as other types of air emissions.

These efforts are part of a broad Mercury Management Program at TXU to provide information about sources of mercury emissions and promising technologies for reducing emissions. These activities will allow TXU to develop cost-effective compliance strategies to respond to any mercury emission control requirements.

5.2.5. TXU Evaluation of Alternative Future Regulatory Scenarios

TXU has developed various analyses of the implications to TXU of possible controls on mercury and CO_2 emissions, including important linkages between environmental requirements and fuel choices. These analyses follow the general TXU methodology for evaluating compliance alternatives, as outlined in Section 3. Because the specifics of the potential controls are not clear, however, these analyses are necessarily less precise than those that have been done for SO_2 and NO_x under the existing Title IV SO_2 controls and Texas state NO_x regulations.

5.2.5.1. TXU Long-Term Strategic Fuel Plan

Because different fuel types often have significantly different emissions rates, an electric company's fuel plan is a critical component of its strategy for dealing with environmental regulations. Moreover, environmental costs can affect desirable fuel choices. Thus, it is important for electric companies such as TXU to consider current and potential future emissions regulations when determining their future fuel plans and, indeed to factor potential future air emissions regulations in their fuel planning.

TXU has recently completed a long-term (2004-2017) strategic fuel plan for its lignite fleet that integrates key fuel use and environmental considerations. This long-term fuel plan indicates that TXU officials are properly taking into account potential future emissions regulations—including those related to NO_x, SO_2 and mercury emissions as reflected in recent regulatory proposals—in their planning. The TXU study considers a variety of reasonable emissions regulation scenarios in developing their fuel plan for the 2004-2017 period. The study is consistent with TXU's general approach to evaluating regulatory compliance options, as outlined previously in this report.

This TXU study focused on the possible impacts of potential future SO_2, NO_x and mercury regulations on TXU's long-term fuel plan for their major coal facilities. The key methodological elements of the study are the following:

- Plant-by-plant analysis of various blends of lignite and PRB coal over a 15-year study period.
- Plant scenarios for coal options combined with and overlaid with environmental controls.
- Economic assessments based upon fuel and other plant costs.
- Identification of the most cost-effective options for each plant, including the use of emissions trading to meet the air emissions requirements (where feasible).
- Uncertainties analyzed with sensitivity analyses.

Table 9 shows the base case and sensitivity ranges for the estimated allowance prices for the relevant pollutants.

TXU's analysis of alternative fuel plans took the assumptions presented in the table above and integrated them into a broader framework that accounted for other important financial considerations, including the price of different fuels (e.g. lignite vs. Powder River Basin coal), the cost of transporting fuels, capital and O&M costs, and potential derate effects. Using these assumptions and information about the emissions rates of TXU

Table 9. Permit Price Assumptions in TXU Long-Term Strategic Fuel Plan

Pollutant	Units	Base Case Price	Sensitivity Range
SO_2	$/ton	250	150 – 500
NO_x	$/ton	4,000	2,000 – 6,000
Mercury (Hg)	$/lb	35,000	15,000 – 60,000

Source: TXU.

facilities using different fuels, TXU estimated the total net present value cost of operating under various fuel scenarios over the 2004-2017 period. These results provided the bases for various decisions.

5.2.5.2. TXU Multi-Pollutant Evaluation

As discussed above, various multi-pollutant legislative and regulatory proposals have been developed in recent years. Particularly for CO_2, these proposals differ widely and their prospects for enactment remain uncertain. TXU conducted a study to estimate the financial consequences of potential multi-pollutant requirements. In this study, TXU considered a number of different scenarios, each with different restrictions on NO_x, SO_2, CO_2 and mercury emissions. TXU then identified the most likely consequences to TXU under each scenario.

This multi-pollutant analysis provides an example of TXU using the basic analytic framework described above to keep current with its analyses of potential future air emissions and climate change requirements. TXU takes specific care to address interactions between different regulations, noting where "co-benefits" of control technologies will allow TXU to meet regulations for different pollutants. As emphasized above, studies at an early stage of regulatory/legislative development are necessarily less precise than the studies that can be done as details are developed in the context of specific regulatory proposals.

5.3. Summary

TXU has taken various actions with respect to mercury and CO_2 emissions. These activities include purchase of wind power as well as efforts to monitor legislative/regulatory initiatives and encourage the development of cost-effective regulatory approaches. Although both mercury and CO_2 emissions currently are unregulated, mercury controls are further along in the regulatory process. TXU has a substantial research program underway to develop more effective and cost-effective mercury controls. The next section considers whether it would be in TXU's financial interest to take additional actions to reduce its CO_2 emissions, one of the major issues raised in the shareholder resolutions.

6. Impacts on TXU Shareholders of TXU Taking Actions Now to Reduce Carbon Dioxide Emissions

This section considers the desirability to TXU shareholders of TXU taking costly actions now to reduce its CO_2 emissions in advance of any mandatory climate change policies. As discussed in the previous section, TXU is taking various actions with regard to climate change. But the shareholder resolutions raise the issue of whether TXU (and other companies) should invest substantial company resources now to reduce CO_2 emissions in anticipation of possible future mandatory climate change policies. Put another way, the resolutions raise the question—would TXU shareholders be better off if TXU devoted substantial resources now to reduce its CO_2 emissions and thus reduce the potential costs it would incur with mandatory requirements?

As emphasized in the previous section, the specific elements of any future mandatory requirements to reduce CO_2 emissions in the US are highly uncertain at this point, but it seems virtually certain that any mandatory program would impose requirements on power stations owned by electricity generators, including TXU. It also seems likely that a mandatory program would involve a cap-and-trade program for large "downstream" emitters—such as the one that has been developed by the European Commission for stationary sources within the European Union and similar to the US acid rain trading program for SO_2 emissions—although other types of regulations are also possible.

We have developed some information on the costs to TXU of actions to reduce CO_2 emissions from its generation facilities and the implications of taking these actions now on TXU shareholders. Developing full empirical estimates of how TXU would fare under alternative scenarios would be a major research project that is beyond the scope of our assignment. Nevertheless, it is possible to identify key issues regarding the desirability of TXU incurring costs now to reduce its CO_2 emissions.

The key observations of this section can be summarized in several points. If TXU were to act unilaterally right now to reduce CO_2 emissions from its generating units, it would incur costs without the prospect of any corresponding increase in revenues from the sale of its electricity. The net result would be a loss to TXU and to its shareholders. Although there are some advantages of action now under some circumstances—including the possibility of insufficient time to put cost-effective controls in place when a mandatory program were put in place, the presence of co-benefits from reducing non-CO_2 emissions, and information gains from prototypes—these considerations seem unlikely to change the conclusion that unilateral action now would not be in TXU shareholders' best interests. In contrast, if TXU waited until a mandatory program were in place, its electricity revenues could increase to cover (at least) some of its added costs. Moreover, under a cap-and-trade program, TXU would stand to gain from its initial allocation of allowances and from potential trading opportunities in the CO_2 allowance market. Indeed, as noted below, efforts to reduce CO_2 emissions now may have the perverse effect of reducing TXU's allocation of CO_2 allowances under a mandatory cap-and-trade program.

Our review of possible actions by TXU to reduce CO_2 emissions consists of the following three steps:

1. *Potential CO_2 reduction options.* Identification of the potential alternatives TXU may have currently to reduce its CO_2 emissions, including illustrative information on costs and CO_2 reduction potentials of selected options.
2. *Financial effects of acting now.* Illustrations of the financial effects of taking actions to reduce CO_2 emissions now in advance of any mandatory program.
3. *Conclusions.* Conclusions regarding the types of actions that TXU could take now that would be in the interest of its shareholders, as well as the actions that would be desirable to delay until mandatory programs are developed.

We emphasize that the quantitative results in this section are speculative. Nevertheless, we believe the general conclusions we derive from the empirical estimates are robust.

6.1. Potential TXU CO_2 Reduction Options

This section considers information on options TXU would have to reduce CO_2 emissions from its generating units, including each option's costs and emission reduction potentials. We begin with discussions of the general factors that influence CO_2 emissions from electricity generation as well as the specific options generators such as TXU would have to reduce CO_2 emissions, followed by a general characterization of any emitter's marginal cost curve, i.e., the incremental costs of reducing CO_2 emissions to lower and lower levels. We then consider TXU's baseline CO_2 emissions, i.e., CO_2 emissions from TXU generating units in the absence of any restrictions, and some options that TXU has to reduce its future CO_2 emissions. The final subsection provides an illustrative marginal cost curve for TXU.

It is important to note that the information in this section relates to the CO_2 emissions from TXU generating units, rather than to the CO_2 emissions from all units supplying power for TXU's retail customers. We focus on CO_2 from TXU generating units because a cap-and-trade program for CO_2 would regulate generators rather than retail providers.[8]

6.1.1. General Options to Affect CO_2 Emissions from Electricity Generation

The general factors that affect CO_2 emissions from electricity generation—and thus the options to reduce CO_2 emissions—can be put into four major categories, with several subcategories:

1. *Generation efficiency.* Improvements in the efficiency of operating facilities and generating electricity lead to lower levels of fuel use, and thus lower CO_2 emissions. Other internal efficiency improvements (e.g., vehicle usage) could generate small additional reductions.
2. *Mix of fuel sources.* The widest range of options relate to fuel switching. In the near term, the units used to provide power at various demand periods could be shifted to those with lower CO_2 rates. Over a longer term, carbon intensity could be reduced further by changing carbon intensity of the fuel mix used at existing facilities (e.g., via biomass co-firing), and retiring high-carbon plants and replacing them with lower-carbon or zero-carbon facilities (e.g., natural gas, wind farms, nuclear power plants).
3. *Electricity demand.* Decreases in electricity use also result in reductions in CO_2 emissions, with the extent of reduction depending upon the carbon intensity of units supplying power. Thus, if higher electricity prices reduce demand for electricity—or if consumers are otherwise encouraged to increase energy efficiency in their use of electricity, and thereby reduce demand— CO_2 emissions will decline (relative to what they would have been in the absence of the price increases or other efficiency measures).
4. *Capture/storage of carbon.* Electricity companies could capture and dispose of carbon from their fossil plants, although the present opportunities are limited and costly.

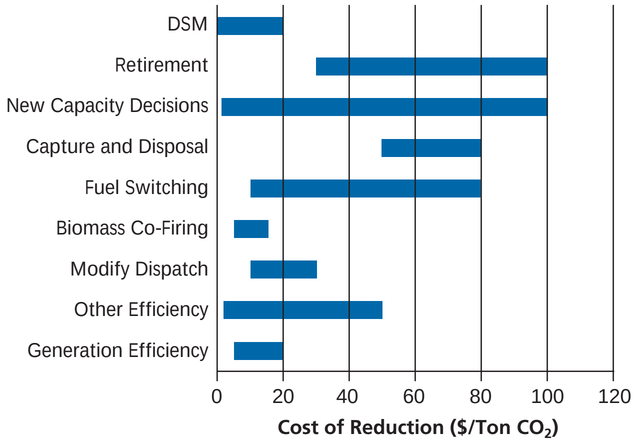
6.1.2. Specific Options a Generating Company Might Have to Reduce CO_2 Emissions from Its Facilities

The four general options noted above provide a structure for considering the specific options a generating company has to reduce its CO_2 emissions, although a given company may not be able to take advantage of all the options implicit in this list. In particular, an individual generating company generally would not be able to influence the demand for electricity, although there are exceptions; vertically integrated companies in regulated electricity environments could introduce demand-side management (DSM) programs to reduce electricity use to some extent. Demand side management would not be an option for a generator in a deregulated market such as ERCOT.

The various CO_2 control options differ substantially along various dimensions, including the scale of potential CO_2 reductions, cost effectiveness (i.e., dollar per ton of CO_2 removed), and the lead times that would be necessary to implement them. Figure 10, developed from a recent report by EPRI, provides an

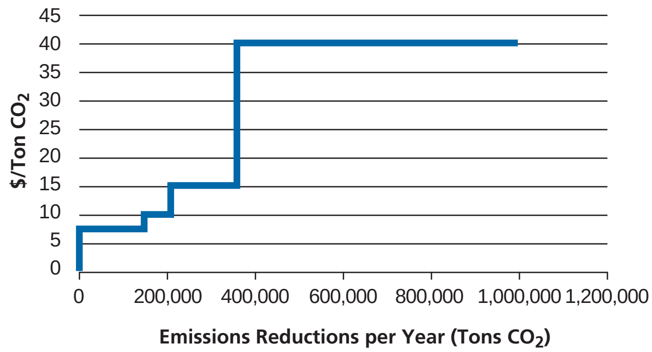
[8] Note that the RPS program in Texas differs, in that requirements are placed on retail providers rather than on generators.

Figure 10. Cost Effectiveness Ranges for CO_2 Reduction Options



Source: A Climate Contingency Roadmap: The U.S. Electric Sector and Climate Change, EPRI, Palo Alto, CA. 2003. 1009311.

Figure 11. A Typical Marginal Cost of CO_2 Reductions Curve



Source: Illustrative calculations as explained in text.

overview of the range of cost effectiveness for various CO_2 reduction options that fall within these four categories.

As noted by EPRI, the wide range for the cost-effectiveness for a given reduction option reflects the highly site-specific nature of the costs (and the emission reductions). The cost per ton depends upon the age and location of the power plant, its conversion efficiency, the prices of natural gas and other fuels, and the control requirements for other emissions (notably SO_2, NO_x, and mercury).

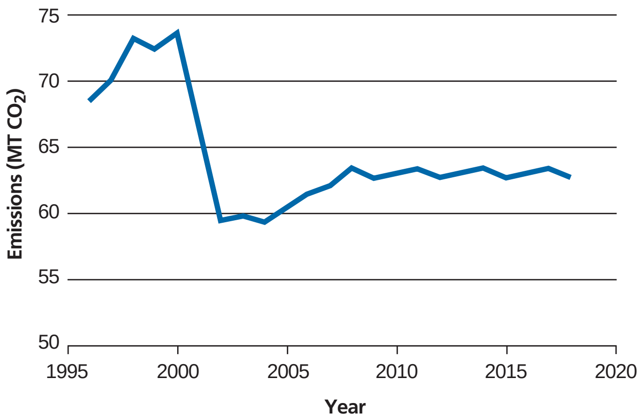
6.1.3. Illustrative Electric Generator Marginal Cost Curve

Information on the costs and emission reduction potentials of the various alternatives can be used to construct a "supply curve" of reduction opportunities for a given generator. As noted, this supply curve typically is referred to as a "marginal abatement cost curve," or simply a "marginal cost curve," since the options are arranged in order of increasing incremental or "marginal" costs of reducing CO_2 emissions.

Figure 11 illustrates a typical marginal cost curve for CO_2 reductions, representing the options a generator would have to reduce its CO_2 emissions from its baseline or projected emissions level at a given level of total generation. The curve shows the increasing *additional* (or marginal) costs as the number of tons of CO_2 reduced increases, and reflects the limited CO_2 reduction potential of the least expensive options (e.g., efficiency improvements) as well as the substantial costs involved in large shifts in the fuel mix or in major sequestration technologies.

It is important to note that this CO_2 marginal cost curve will differ substantially by company and by year. These differences reflect both a company's specific circumstances (e.g., current fuel mix, plant efficiencies, fuel costs, capital costs, etc.) as well as the possibilities for technological progress that could lower costs and expand the range of possible future CO_2 reductions. Note also that there can be interactions between reductions in CO_2 and reductions in other emissions; options such as shifts in fuel mix can lower emissions of NO_x and SO_2, for example, which effectively lowers the incremental cost of achieving the CO_2 reductions (because the company saves the costs that otherwise would be incurred to reduce NO_x and SO_2). Moreover, the cumulative effects of many electric company' actions to reduce their CO_2 emissions by shifting to low-carbon fuels could affect the prices of those fuels, in turn affecting the marginal costs and the wholesale price of electricity. These "general equilibrium" effects would be included in economy-wide modelling of the effects of mandatory CO_2 controls.

Figure 12. TXU CO_2 Emissions, 1996-2018



Source: TXU.

6.1.4. TXU Baseline CO_2 Emissions

Figure 12 presents TXU's current estimates of its historical and projected future CO_2 emissions. As shown in the table, TXU's CO_2 emissions have fallen significantly since 2000, when they were at roughly 73 million tons (Mt) CO_2. Since that time, TXU's emissions have fallen to roughly 59 Mt CO_2. This significant fall is due to a combination of factors, including the sale of two gas plants, less generation from the Company's remaining gas plants, and reduced retail load between 2000 and 2001. TXU's projections suggest that these emissions will grow slightly through 2009 and then remain roughly constant through the year 2018 at around 62 Mt CO_2.

The TXU baseline CO_2 emissions provide the beginning point for developing estimates of a TXU marginal abatement cost curve. The following section provides information on the assumptions we use to develop an illustrative TXU marginal cost curve.

6.1.5. Illustrative TXU Marginal Cost Curve

We have used the general background on CO_2 reduction options as well as specific information on TXU generating facilities to develop illustrative estimates of some possible CO_2 reduction options for TXU. Our estimates are based upon certain generic assumptions, however, and thus are not necessarily applicable to TXU specifically. Nevertheless, these estimates help to illustrate the nature of CO_2 reduction options and the implications to TXU shareholders of TXU taking actions now.

The illustrative marginal cost curve we develop for TXU is based upon the following four options for reducing CO_2 emissions at TXU facilities.

- *Modify generation mix.* TXU currently has a number of open-cycle gas units that run infrequently. These open-cycle gas units emit about one-half the CO_2 emissions per kilowatt-hour (kWh) of TXU's existing coal units.[9] TXU could reduce its CO_2 emissions by generating more from these facilities and less from its coal facilities.
- *Co-fire with biomass.* TXU could run existing coal units using a mixture of both coal and biomass fuel. Supplementing coal with sufficient biomass could reduce the CO_2 emission rate of the coal units by about 15 percent.
- *Build a new closed-cycle gas turbine (CCGT) facility.* TXU could build a new CCGT facility and use the CCGT unit to generate some of the electricity it currently supplies from its coal facilities. A new CCGT unit has a CO_2 emission rate that is about one-third of that of TXU's existing coal units.
- *Build or buy a new wind facility.* TXU might build or buy new wind facilities and use the electricity generated to replace some of the power supplied by its coal facilities. Wind turbines have no CO_2 emissions.

Although clearly not complete, this list is representative of the types of options TXU would have now to reduce CO_2 emissions from its facilities.

All of these CO_2 reduction alternatives would involve the replacement of some existing TXU coal generation with a non-coal source (or in the case of biomass, co-firing with an existing coal unit). Thus, the relevant costs are the added costs relative to the "business-as-usual" (BAU) costs of operating an existing TXU coal unit. Table 10 shows our estimates of the costs

[9] TXU's lignite and coal units are referred to as "coal" units for simplicity.

Table 10. Cost of Reducing CO_2 at TXU Generation Under Four Illustrative Options (in Thousands of 2003 Dollars per MW coal displaced)

	Abatement Options			
	Biomass	New Wind	New CCGT	Modify Mix
Cost (Thousands of Dollars per MW)	70	1,768	1,257	1,170

Source: Illustrative calculations as explained in text.

(relative to BAU) that TXU would incur if it undertook each of these four options, standardized in dollars per megawatt of generating capacity to facilitate comparison of the range of costs.[10] These costs include construction cost (where relevant) as well as fuel costs and operating and maintenance costs. Note that the cost comparisons between coal and other generation include differences in the costs of purchasing/using emissions allowances to cover NO_x and SO_2 emissions.

[10] These estimates are based on the cost of replacing the energy (in MWhs) that would be generated by one MW of coal. Note that, because of differences in capacity factors, certain alternatives would require the installation of more than one MW of capacity in order to replace the generation produced by one MW of existing coal capacity. Moreover, each alternative would abate a different amount of CO_2, as discussed below.

Developing an illustrative marginal cost curve for TXU requires projecting the emission reduction potentials of these four options relative to TXU baseline emissions. (Note that the overall level of CO_2 reductions TXU could achieve by "shifting away from coal" is limited by TXU's BAU levels of coal generation.) Table 11 summarizes our assumptions regarding CO_2 emission reduction potential and the resulting calculated marginal cost per ton of CO_2 reduced for each of the four options. Because we later consider the lead-time requirements for undertaking CO_2 reducing options, we include rough estimates of the construction time involved for each option. Note that these estimates ignore complexities in the process of constructing new generation that may affect potential CO_2 reductions, e.g., siting considerations for a wind plant.

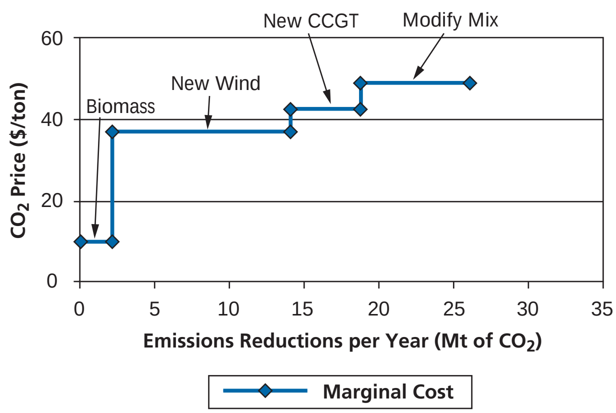
Figure 13 presents an illustrative TXU marginal cost curve based upon these cost and emissions reduction potential estimates. This illustrative curve shows four "tiers" of potential reductions corresponding to the *additional* CO_2 emissions that could be reduced by the four options. Biomass co-firing is the lowest cost option, estimated to be capable of reducing about 2.2 Mt of CO_2 (assuming 1,800 MW of coal-fired power plants were modified to accommodate biomass co-firing) at a marginal cost of about $10 per ton. Constructing new wind turbines and new CCGT units are predicted to cost about $38 per ton and $41 per ton, respectively, with the wind turbines cutting 12.0 Mt of CO_2 and the new CCGT cutting 4.2 Mt. Finally, modifying the current generation mix to use existing natural gas plants rather than coal units could be capable of reducing another 8.1 Mt of CO_2 at a cost of about $50 per ton.

Table 11. Summary of Assumptions Regarding Illustrative CO_2 Reduction Options

Option	Construction Time (years)	MW Replaced	CO_2 Emissions Reduction per Year (Mt CO_2)	Marginal Cost ($/ton CO_2)
Biomass Cofiring	1	1,800	2.2	10.0
New Wind Units	4	1,500	12.0	38.1
New CCGT	4	800	4.2	41.4
Modify Mix	0	2,000	8.1	49.8

Source: Illustrative calculations as explained in text.

Figure 13. Illustrative Marginal CO_2 Abatement Cost Curve for TXU



Source: Illustrative calculations as explained in text.

6.2. Financial Impacts to TXU Shareholders of Reducing TXU CO_2 Emissions Now

The illustrative TXU marginal abatement cost curve can be used to assess the implications to TXU of undertaking these various actions to reduce CO_2 emissions from its generating units. Since the shareholder resolutions emphasize TXU actions now, we develop empirical estimates assuming no mandatory CO_2 program is in place. We then consider various potential arguments for making such investments in anticipation of a mandatory program, concluding that the conditions under which it would be in TXU shareholders' interests for TXU to undertake costly actions are very limited.

6.2.1. Costs to TXU of Reducing CO_2 Now

Here, we consider the effects of TXU acting now to reduce its emissions in the absence of a mandatory program to control CO_2 emissions. The marginal cost curve developed above can be used to assess the implications of various unilateral reductions in TXU emissions. Table 12 summarizes our cost estimates for the four sets of actions identified above.[11] To provide a contrast to the situation in which a mandatory program is in effect, the table lists three other categories—change in revenues, CO_2 allocation "revenues" and CO_2 allowance "costs," all of which are zero in the absence of a mandatory program—and thus net profits are equal to the change in generation costs.

The annual costs of these CO_2 reduction actions range from about $22 million per year in the case of biomass co-fuelling to more than $450 million per year if TXU shifted generation from its low-price coal facilities to new wind facilities. Note that these annual figures can be translated into estimates of present values, i.e., the equivalent costs incurred now. Assuming a period of 15 years and a discount rate of 10 percent, the present values for the four CO_2 control options would be the following:

[11] The results in Table 12 assume each option is developed assuming the capacities listed in Table 11.

Table 12. Illustrative Annual Financial Effects if TXU Reduced CO_2 Emissions in the Absence of a Mandatory CO_2 Program (in Millions of 2003 Dollars)

	Biomass	New Wind	New CCGT	Modify Mix
Change in Annual Revenues				
Change in Generation Revenues	0	0	0	0
Allocation "Value"	0	0	0	0
Change in Annual Costs				
Change in Generation Costs	21.7	457.6	173.5	403.8
"Cost" of Emissions	0	0	0	0
Net Change in Annual Profits	–21.7	–457.6	–173.5	–403.8

Source: Illustrative calculations as explained in text.

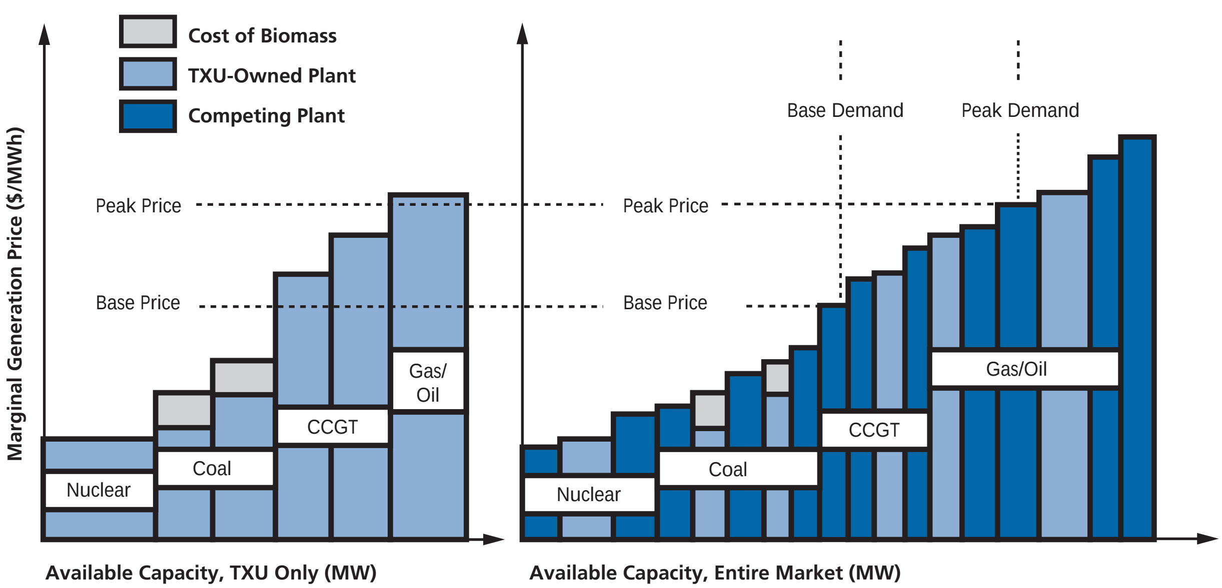
- Biomass co-firing: $165.1 million.
- New wind facilities: $3.5 billion.
- New CCGT: $1.3 billion.
- Modify generation mix: $3.1 billion.

To illustrate why TXU costs would increase without any corresponding increases in revenues from electricity generation, we consider the biomass example—the situation in which TXU modifies some of its existing coal plants to allow them to co-fire bio-fuels. As noted above, this alternative is relatively low-cost, estimated to reduce CO_2 emissions at a cost of about $10 per ton. Nevertheless, if TXU undertook such action, its costs would increase, and it could not expect any increase in revenues.[12] The market would not allow TXU to charge more for its power simply because it was produced with lower-CO_2 emitting fuels. As a consequence, TXU's profits would decline.

Figure 14 illustrates the losses that TXU shareholders would incur if TXU undertook the biomass co-firing alternative. The figure depicts the "merit order" of representative TXU plants in the left panel, and depicts a stylized merit order for generators supplying the entire ERCOT region in the right panel. The left panel illustrates the effects on costs of adding biomass capacity. Costs per kWh would increase for TXU's coal generation. Since ERCOT has a competitive wholesale electricity market, we assume that the marginal generating unit would set the electricity price in each time period. Since TXU's coal-fired units are not on the margin, they do not set the electricity price. Thus, electricity prices are not affected by this increase in TXU's costs. The second panel illustrates this—electricity wholesale prices are the same in ERCOT despite TXU's increased costs. Both the base price and the peak price are determined by market conditions, which do not change. Thus, TXU's profits would decrease by an amount equal to the shaded biomass areas in the left panel.

[12] TXU might receive some additional revenues from renewables generation, unrelated to a CO_2 program. The RPS in Texas requires retail electricity providers to generate a certain amount of energy from renewables or purchase renewable credits from other utilities. Thus, generation from renewables currently has a market value in addition to its value as energy.

Figure 14. Effects of Increased CO_2-Related Costs Incurred by an Electric Generator Assuming No Mandatory CO_2 Controls



Source: Illustrative calculations as explained in text.

Put another way, TXU shareholders would pay the added costs of switching to biomass in full because the added costs could not be offset by being "passed through" to wholesale customers in the form of higher electricity prices. In contrast, if a mandatory program were in effect for all ERCOT generators (or, indeed, for all US generators), wholesale market prices would increase to reflect the effects of the program. The precise increases in ERCOT electricity prices due to a mandatory CO_2 program would depend upon the specific effects on marginal generation in various time periods as well as "general equilibrium" effects of a mandatory CO_2 program on fuel prices. In addition, the net effects on TXU under a mandatory cap-and-trade program would depend upon the number of initial CO_2 allowances it received as well as its trading opportunities in the allowance market, which in turn would depend upon the marginal cost of its CO_2 reduction opportunities relative to the market price of CO_2 allowances.

Determining the impacts on TXU under various assumptions regarding any potential cap-and-trade program that might be established would involve substantial modeling. The important point here is that the presence of a mandatory program for all electricity generators would provide the opportunity for at least some of the CO_2 abatement costs that TXU incurred to be passed through to customers rather than absorbed by TXU shareholders. These options would not be possible under unilateral TXU action now.

6.2.2. Financial Effects to TXU of Reducing CO_2 Emissions Now in Light of Potential Future Mandatory Requirements and Other Complications

The set of cost impacts to TXU presented in Table 12 ignore some potential gains that TXU might accrue from taking actions to reduce its CO_2 emissions now. These include "co-benefits" due to reductions in non-CO_2 emissions, potential advantages gained from becoming familiar with CO_2-reducing technology—including the possibility of uncovering new or less expensive options or decreasing the uncertainty regarding the cost or effectiveness of a particular option—as well as the opportunity to make an investment now to reduce future liabilities under any mandatory program. These various potential gains raise the basic question—would TXU shareholders be well served by TXU making these costly investments in CO_2 reductions now even if they would not be immediately recouped in the ERCOT market?

This section addresses these potential gains from unilateral actions. Specifically, we consider the following potential rationales for taking expensive CO_2-reducing actions now:

- Take actions now as investments to reduce future CO_2 liabilities.
- Take actions now to reduce other emissions ("co-benefits").
- Take actions now to provide information on control alternatives or to provide greater future flexibility regarding control alternatives.

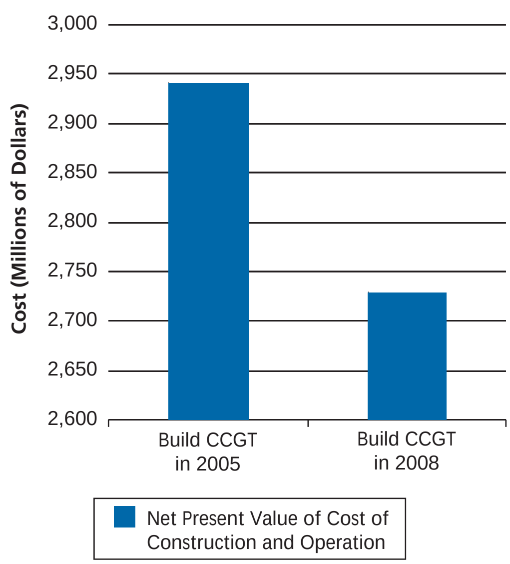
In addition, we consider one potential drawback of reducing TXU emissions now—the possibility that TXU's initial allocation would be reduced under a future CO_2 cap-and-trade program.

6.2.2.1. Taking Actions Now as Investments to Reduce Future CO_2 Liabilities

Voluntary unilateral actions to reduce CO_2 might be considered now on the presumption that mandatory CO_2 controls will apply at some point in the future. Indeed, as noted, many observers presume that the US will at some point adopt a cap-and-trade program for CO_2 similar to that being developed in the EU. This raises the question—under what conditions would unilateral actions to reduce CO_2 emissions now be justified as a means of preparing for a future mandatory CO_2 program?

Whether an investment now would be justified depends importantly on timing—the time it would take to implement control options as well as the likely timing of any mandatory program. Because of the time value of money—that is, the discount rate TXU or any other company would pay for funds spent now rather than in the future—the costs would be lower if expenditures were delayed, assuming there was enough time to implement the option before it were needed. Whether the investment would be justified now also depends upon other factors, including the likelihood of a binding cap-and-trade program and the likely CO_2 allowance prices.

Figure 15. Net Present Value of Constructing New CCGT in 2005 Versus 2008 and Operating Over the Life of the Plant



Source: Illustrative calculations as explained in text.

Figure 15 illustrates this time dimension by showing the added costs of implementing an option early. The figure shows the difference in costs to TXU of two alternatives, one in which construction of a CCGT unit were to start in 2005 and one in which the start were delayed until 2008. Both alternatives assume that a cap-and-trade program would go into effect in 2012 and that the expected CO_2 allowance price would be $50/ton—high enough to justify construction of a CCGT unit (since the marginal abatement cost of CCGT is less than $50 per ton). The figure shows that the net present value of constructing the CCGT in 2005 (and beginning operations upon completion in 2009) would be greater than delaying to 2008 (and beginning operations upon completion in 2012) because of the time value of money—i.e., expenditures made in 2005 are more costly because the firm would otherwise have the use of the money for additional three years. Based upon the illustrative costs we develop, the added cost of starting "too early" would be about $240 million. Thus, assuming TXU would have sufficient time to implement options after a mandatory program were decided upon, it would be cheaper to delay implementation.

Waiting to adopt costly controls until the details of the cap-and-trade program (or other requirements) are in place has other advantages beyond lowering the present value of the investment cost. Waiting until the specifics of the program were in place would allow TXU to make more informed judgments about the key factors that influence optimal investments, particularly the precise timing of the program and the likely CO_2 allowance prices.

With regard to the likely allowance price, the usefulness of TXU instituting controls to reduce its own emissions depends importantly on whether it would be cheaper for TXU to purchase CO_2 allowances or control its own emissions. This situation is identical to the choices TXU (and other electricity generators) have been evaluating over the last 5-10 years in connection with the SO_2 trading program. Indeed, the major inefficiency of the SO_2 trading program identified by Massachusetts Institute of Technology researchers in their exhaustive study of the acid rain trading program was the premature decisions on the part of some companies to add SO_2 scrubbers that turned out to be expensive relative to SO_2 allowance prices. Waiting until a specific program is in place—and the allowance prices can be predicted with more accuracy—would allow TXU to avoid this pitfall with a CO_2 trading program. Thus, for example, the scenario considered above, with allowances prices as high as $50 per ton in 2012, may represent a substantial overestimate of the likely allowance price in that year, even assuming a trading program were in place.

These considerations, however, leave open the possibility that there may be some circumstances in which it would be in TXU shareholders interests for TXU to reduce CO_2 emissions now. Specifically, actions now may be warranted *if* the cost per ton were less than the expected CO_2 allowance price (appropriately accounting for the time value of money and the uncertainty of regulatory requirements in the comparison), and *if* the time to implement the investment were longer than the likely time period before the mandatory program were to take effect.

6.2.2.2. Taking Actions Now to Provide "Co-Benefits"

Our illustrative costs of CO_2 control alternatives include the costs of the NO_x and SO_2 allowances. But as discussed in the previous section, TXU and other electricity generators seem likely to face additional restrictions on their emissions of NO_x and SO_2 emissions, as well as new controls on mercury emissions. Since some of the CO_2 control options also reduce these other emissions, the question is whether reducing CO_2 emissions now would be justified if the potential future costs of the other emissions were also considered.

The possibility of co-benefits from investments that reduce CO_2 could be incorporated in the analyses by modifying the costs of the various options relative to coal and thus revising the marginal cost curve. In the case of additional restrictions on other emissions, the analyses could incorporate estimates of expected future allowance prices (since most proposals call for cap-and-trade programs for these other emissions). The methodology for assessing co-benefits could be made more sophisticated by developing marginal abatement cost curves for all relevant emissions that consider interactions among the pollutants. Note, however, that any such calculations are inherently uncertain because of uncertainties regarding the various future potential regulatory requirements. Indeed, speculation over the nature of any co-benefits is another reason to delay costly CO_2 controls until more is known about regulatory requirements.

Here too there are some conditions under which taking into account the "co-benefits" would make CO_2 investments in TXU shareholders interest. Specifically, CO_2 reductions would be justified if the value of the co-benefits were sufficiently high that the CO_2 reductions "paid for themselves," i.e., the cost savings were sufficient to exceed the costs of the early implementation of abatement measures.

6.2.2.3. Taking Actions Now to Develop Better Information on CO_2 Reduction Opportunities

Another potential argument for TXU undertaking costly actions now to reduce CO_2 emissions now is that these actions could provide valuable information that would allow TXU to make better choices in the future. Pilot programs, for example, could be advantageous if they were to resolve uncertainties about the likely costs or effectiveness of emission control options and thus provide the basis for better future choices.[13] In the case of bio-fuel co-firing, for example, it could be desirable to undertake a pilot program to clarify its applicability to different types of plants (e.g., lignite versus coal) and its effectiveness.

The value of improved information is unlikely to justify costly CO_2 reduction options such as constructing CCGT or additional wind facilities or shifting generation from low-cost coal to expensive natural gas facilities. The likely costs of these technologies are generally well known and, moreover, technological advances are likely to require large government or pooled research efforts rather than efforts by a single generator, even a large one such as TXU. Indeed, the possibility of future technological progress to lower the cost or increase the CO_2-reducing capabilities of various technologies constitutes another argument for TXU delaying costly expenditures. Such future technological advances could render obsolete any experience gained from a (premature) demonstration program.

Uncertainties regarding any future US CO_2 program—including its stringency and the details of how it would be implemented—provide other reasons for questioning the value of the information that might be gained from costly controls now. As noted in the previous section, the CO_2 proposals that have been presented in Congress differ enormously. Moreover, the gains from TXU controlling its own CO_2 emissions rather than purchasing CO_2 allowances depend in large part on whether low-cost CO_2 allowances will be available from sources outside the US, including projects to reduce CO_2 and other greenhouse gas emissions in developing countries under the Clean Development Mechanism provided for in the Kyoto Protocol. It would not be useful for TXU to develop better information on

[13] Alternatives to develop information to improve future decisions can be evaluated using the tool of decision analysis and the related calculation of an "option value" to assess gains due to the information-collection alternatives. See, e.g., Breeley and Meyers. *Principles of Corporate Finance.* New York, 2004. McGraw-Hill, for discussions of these tools.

near term options that cost in the neighborhood of $40-$50 per ton of CO_2 if comparable allowances were available in national/international markets for much less.

All these considerations highlight the value to TXU and its shareholders of delaying costly programs to reduce TXU's CO_2 emissions until the specific elements of any mandatory program are evident. Put another way, information on actual regulatory requirements is likely to have much greater value to TXU than information it might acquire from taking costly actions now.

Here again, however, there may be some conditions in which the value of information from a pilot program or other CO_2-reducing program was sufficient to justify the program. Specifically, the program may be justified if the investment would provide "learning benefits" or expand the range of cost-effective CO_2 reduction alternatives, or if it would reduce cost uncertainty and therefore allow better direction of future TXU resources toward the most cost-effective approaches. Note, however, that these gains would have to be in addition to those that would accrue from other efforts (e.g., industry or government research and development programs).

6.2.2.4. Effects of Taking Actions Now on TXU's Potential Initial CO_2 Allocation Under any Future CO_2 Cap-and-Trade Program

The issue of waiting until the specific elements of any CO_2 cap-and-trade program are in place raises an additional disadvantage of TXU unilaterally reducing its emissions now—namely, that reductions now could reduce TXU's initial allocation of CO_2 allowances under a future cap-and-trade program. If a mandatory cap-and-trade program were put in place, the initial allocation that TXU (and other generators) receive may well be based on recent emissions levels. For example, a program going into effect in 2012 might base allocations on emissions during the period 2004-2008. If TXU were to reduce its emissions early, this could result in a *lower* allowance allocation under a future mandatory program. Moreover, if the initial allocation formula were similar to that developed for the SO_2 acid rain program—in which the formula used to calculate allowances in each year remained substantially unchanged over many years—the loss from acting now to reduce CO_2 emissions would be long-lasting.

This disadvantage of acting now can be illustrated with some simple estimates. As noted above, TXU generating units are projected to emit about 60 Mt of CO_2 per year. Suppose that TXU reduced its emissions by 10 Mt and initial allocations were set equal to 80 percent of baseline future emissions. The reduction by 10 Mt of CO_2 thus would reduce TXU's initial allocation by 8 Mt in this simple example. With a CO_2 allowance price of $20 per ton taking effect in 2012, that reduction would translate into a loss of $160 million per year, or a net present value (at a ten percent discount rate) of more than $600 million in 2012 for the five-year period from 2012-2016 that might be covered by an initial allocation period. With an allowance price of $50 per ton, the equivalent losses would be $400 million per year, with a net present value of more than $1.5 billion.

Of course, such reductions in the initial allocation could be tempered for several reasons. For one, it is possible that the baseline period that the allocations are based on could end before TXU's early emissions reductions took place. It is also possible that the initial allocation could be based on factors other than emissions, although if the allocation were based on heat input (the factor used for the SO_2 allowance cap-and-trade program as well as many of the NO_x trading programs) it might also be disadvantageous for TXU to take unilateral action. Finally, it might be argued that TXU could receive early credit for emissions reductions, either through explicit future regulatory recognition, or by selling emissions reductions in existing GHG markets. However, relying on such "early action" credits would be highly speculative because of the uncertainty that current investments would actually be recognized in the future. Existing GHG markets in the US, for example, offer very low prices (e.g., $1 per ton), but these low prices reflect not just low costs but also the high uncertainty associated with these commodities. For now, because of the uncertainty of future regulations in the US, such investments would be very high risk. Thus, although there are considerations that could mitigate against potential losses to future initial allowance allocations as a result of taking CO_2 abatement action, real concerns remain that TXU would actually be penalized if it reduced its CO_2 emissions now, and this provides another reason to question implementing controls early.

6.3. Conclusions Regarding TXU Actions in Light of Potential Mandatory US Climate Change Policy

The discussion in this section and the previous section suggests the following conclusions regarding the actions TXU should undertake now in the interests of their shareholders as well as those that should likely be postponed until mandatory requirements take a firmer shape.

6.3.1. Prudent TXU Actions Now

The following are actions that would be prudent for TXU to undertake now.

- Continue to monitor potential legislative developments and to encourage the development of cost-effective legislative and regulatory approaches.
- Continue to develop information on TXU's actual and projected CO_2 emissions and monitor the opportunities TXU would have to make reductions.
- Consider making CO_2 reducing investments now, but only if one or more of certain conditions hold:
- The cost per ton of CO_2 reduced is less than the risk-adjusted expected future CO_2 allowance price estimate (appropriately accounting for the time value of money), and the time to implement the investment would be longer than the likely time period before the mandatory program takes effect.
- The investment would provide learning benefits, reduce cost uncertainties, expand the range of cost-effective CO_2 reduction alternatives, or otherwise allow better direction of future resources toward the most cost-effective approaches (assuming also that such advances would not be made without TXU investments).
- The investment would yield other benefits (e.g., reductions in other emissions, improvements in facility efficiency) that make the alternative "pay for itself."

It is possible that other TXU actions could be desirable, including, for example, participation in government or privately funded research initiatives. Given the importance of future improvements in CO_2-reducing technology, TXU could support efforts to develop longer-term technologies that promise lower CO_2 emissions.

6.3.2. Reasons to Delay Costly Pre-Compliance CO_2 Investments That Do Not Meet These Criteria

The following are the major reasons to defer other CO_2 reducing investments from the perspective of TXU's shareholders.

- Given the time value of money, resources spent in advance of requirements would be greater (in present value) than the same money spent in a future year when CO_2 emissions would need to be restricted.
- Resources spent in advance of regulations might be less well targeted toward the specific regulatory requirements than those spent after the precise requirements were determined.
- Costs incurred by TXU before regulatory requirements are in place would be borne by TXU shareholders rather than (at least partially) passed on to customers in the form of higher prices, as could be the case under mandatory controls.
- Future improvements in CO_2 reduction technologies would make TXU's control alternatives less expensive in the future when mandatory requirements are imposed, making compliance less expensive.

In addition to these general considerations, there are several other reasons to defer costly CO_2 reduction because of the strong likelihood that any mandatory program would involve a CO_2 cap-and-trade program.

- Because a cap-and-trade program provides flexibility to purchase allowances rather than reduce emissions, TXU could wait to see what CO_2 price would emerge before it undertook costly programs of its own.
- TXU's cost-minimizing strategy is likely to depend upon the specifics of the cap-and-trade program (e.g., the availability of international CO_2 allowances), and thus it would be sensible to wait until the specifics were defined.

- Actions to reduce its CO_2 emissions in advance of determining the specifics may actually disadvantage TXU with regard to one of the major elements of the CO_2 cap-and-trade program—the allocation of initial allowances. If the allocation formula under the cap-and-trade program were based upon emissions around the time of the legislation, reducing its emissions would mean that TXU would receive fewer initial allowances.

7. Concluding Remarks

Shareholders at TXU and other companies are well served if management deals appropriately with environmental issues, taking care to evaluate alternatives and choose those that maximize shareholder value. Thus, it is important to have the internal capacity to analyze the effects of alternatives and integrate the results of these analyses into sound company decision making. Our evaluations of TXU's experience indicates that TXU has internal institutions in place to develop appropriate analyses and, indeed, that TXU has acted in the interests of its shareholders in its decisions regarding previous major environmental initiatives, notably those related to the federal acid rain trading program and the Texas ozone control program.

We have emphasized that the nature of the analyses as well as the nature of the response varies greatly over the course of legislative and regulatory development. In the early stages, when many options are possible, the analysis is relatively general and commitments to changes modest. As regulations become more specific and more certain, the analysis tends to focus on specifics and to evaluate specific control programs. After regulations are in place, there is an ongoing need for careful and detailed analyses and compliance programs to minimize the costs of meeting the environmental targets and policies that are set.

At present, there are enormous uncertainties about the nature of future air emissions and particularly climate change requirements that might be imposed on TXU and other electricity generators. One means of dealing with the uncertainty would be to guess the future regulatory requirements and take actions now to reduce emissions. Such activities, however, could be costly to shareholders.

Taking expensive actions now to reduce CO_2 emissions (or other air emissions) in advance of a clear regulatory mandate is not likely to be in the interests of TXU's shareholders except under very specific circumstances. Costs incurred by TXU before regulatory requirements were in place generally would be absorbed by TXU shareholders rather than passed forward to TXU wholesale customers in the form of higher prices. Because CO_2 emissions, for example, are not now regulated, there is no "shadow price" of carbon and thus no reason for electricity prices to go up.

In contrast, costs incurred by TXU after regulatory requirements were in place may well be passed on to customers in the form of higher prices. (The extent of pass through depends upon the details of market conditions.) Indeed, when carbon is regulated under a cap-and-trade plan, TXU profits for generation supplied by zero-carbon units (nuclear and renewable) might increase, which would work to reduce the potential negative effects for lignite and coal units. The appropriate extent (and timing) of investments to reduce TXU carbon emissions thus depends upon the details of when mandatory CO_2 requirements would be introduced as well as on the details of precisely how such requirements would be implemented.

Although we conclude that taking expensive actions to reduce CO_2 emissions is likely to be premature, we believe that TXU shareholders would be well served by some specific TXU actions related to potential future air emissions and climate change regulations. These actions include the following:

1. Take modest and prudent steps to reduce carbon emissions if the various conditions outlined in the previous section hold;
2. Keep abreast of research and development activities that might provide early options to reduce the costs or improve environmental effectiveness;
3. Continuously evaluate the financial implications to TXU of potential carbon dioxide policies and other air emissions policies as they are presented in various legislative and regulatory arenas;
4. Communicate the potential risks and opportunities regarding air emissions and climate change issues within the TXU organization;
5. Be prepared to take additional actions to respond effectively and efficiently to any future requirements; and
6. To the extent that competitive conditions permit, communicate the results of its various assessments of the impacts of air emissions and climate change policies to shareholders and other interested parties.

Appendix A. TXU Officials Interviewed

Table A- 1 lists the TXU officials interviewed as part of the study.

Table A- 1. TXU Officials Interviewed

Name	Title	Affiliation
David Duncan	Environmental Regulatory Manager	TXU Energy
Shawn Glacken	Vice President, Env. Policy Advocacy	TXU Business Services
John Hougland	Risk Manager	TXU Business Services
Rick Jeanes	Executive Assistant to President	TXU Energy
Mike Laney	Director Resource Analysis	TXU Energy
Bob Logue	Manager, Portfolio Management	TXU Energy
Michael J. McNally	Group President Corporate Services	TXU Corp.
Kim Mirales	Manager, Data Management	TXU Energy
Colin Moore	Lead Trader, Portfolio Management	TXU Energy
Paul Plunket	Executive Vice President	TXU Business Services
Ed Powell, Ph.D.	Manager, Env. Policy	TXU Business Services
Kenneth Price	Senior Director, Portfolio Management	TXU Energy
Thomas W. Rose	Director, Public Policy	TXU Business Services
Wade Stansell	Manager, Public Policy Strategy	TXU Business Services
Wes Taylor	President of Production	TXU Energy
Peter B. Tinkham	Corp. Secretary President, Corp.	TXU Business Services
Richard R. Wistrand	Senior Vice President	TXU Energy

Appendix B. TXU Generating Facilities

This appendix provides details on TXU's generating facilities. Table B-1 sets forth TXU's gas/oil facilities. Table B-2 presents TXU's coal/oil facilities and Table B-3 provides information on TXU's nuclear facilities.

Table B-1. TXU Generating Stations: Gas/Oil

Station	Unit Number	County	Date of Initial Commercial Operation	Net MW	Total MW
Collin	#1	Collin	6/22/1955	153	153
DeCordova	#1		5/1/1975	818	1,138
DeCordova	CTs-1-2-3-4		3/1/1990	320	
Eagle Mountain	#1	Tarrant	7/31/1954	115	655
Eagle Mountain	#2	Tarrant	12/29/1956	175	
Eagle Mountain	#3	Tarrant	6/30/1971	375	
Graham	#1	Young	12/19/1960	240	630
Graham	#2	Young	6/5/1969	390	
Lake Creek	#1	MeLennan	4/25/1953	87	323
Lake Creek	#2	MeLennan	7/9/1959	230	
Lake Creek	3-Diesels	MeLennan	8/20/1966	6	
Lake Hubbard	#1	Dallas	6/18/1970	393	921
Lake Hubbard	#2	Dallas	11/20/1973	528	
Morgan Creek	#2	Mitchell	7/30/1950	22	1,212
Morgan Creek	#3	Mitchell	7/1/1952	44	
Morgan Creek	#4	Mitchell	6/15/1954	70	
Morgan Creek	#5	Mitchell	6/15/1955	175	
Morgan Creek	#6	Mitchell	7/18/1966	511	
Morgan Creek	CTs-1-2-3-4-5-6	Mitchell	7/1/1988	325	
Morgan Creek	CT 3	Mitchell	8/1/1988	65	
North Lake	#1	Dallas	12/22/1959	175	715
North Lake	#2	Dallas	12/22/1961	175	
North Lake	#3	Dallas	7/2/1964	365	
North Main	#4	Tarrant	5/1/1952	80	80
Parkdale	#1	Dallas	6/19/1953	87	327

Table B-1. TXU Generating Stations: Gas/Oil (Continued)

Station	Unit Number	County	Date of Initial Commercial Operation	Net MW	Total MW
Parkdale	#2	Dallas	3/31/1955	115	
Parkdale	#3	Dallas	3/25/1957	125	
Pedricktown	#1 Steam Turbine + CT	New Jersey	3/14/2002	122	122
Pedricktown	HR Steam Generator	New Jersey	3/14/2002	0	
Permian Basin	#5	Ward	6/1/1959	115	980
Permian Basin	#6	Ward	12/20/1973	540	
Permian Basin	CTs 1-2-3	Ward	5/1/1988	195	
Permian Basin	CTs 4-5	Ward	2/1/1990	130	
River Crest	#1	Red River	6/30/1954	110	110
Stryker Creek	#1	Cherokee	6/26/1958	175	685
Stryker Creek	#2	Cherokee	12/21/1965	500	
Stryker Creek	5-Diesels	Cherokee	7/30/1966	10	
Sweetwater	#1 Steam Turbine	Nolan	6/8/2002	80	255
Sweetwater	CT1	Nolan	6/8/2002	35	
Sweetwater	CT1	Nolan	6/8/2002	70	
Sweetwater	CT1	Nolan	6/8/2002	70	
Sweetwater	HR Steam Gen.	Nolan		0	
Tradinghouse	#1	McLennan	4/4/1970	565	
Tradinghouse	#2	McLennan	6/1/1972	818	1,383
Trinidad	#6	Henderson	8/20/1966	240	
Trinidad	2-Diesels	Henderson		4	244
Valley	#1	Fannin	11/16/1962	175	
Valley	#2	Fannin	12/19/1967	550	
Valley	#3	Fannin	3/31/1971	390	1,115
				Total Oil/Gas MW	**10,998**

Source: TXU.

Table B-2. TXU Generating Stations: Lignite/Coal

Station	Unit Number	County	Date of Initial Commercial Operation	Net MW	Total MW
Big Brown	#1	Freestone	12/23/1971	575	
Big Brown	#2	Freestone	10/6/1972	575	1,150
Monticello	#1	Titus	12/23/1974	565	
Monticello	#2	Titus	12/8/1975	565	
Monticello	#3	Titus	8/1/1978	750	1,880
Martin Lake	#1	Rusk	5/16/1977	750	
Martin Lake	#2	Rusk	5/23/1978	750	
Martin Lake	#3	Rusk	4/1/1979	750	2,250
Sandow	#4	Milam	5/15/1981	545	545
			Total Lignite/Coal MW		**5825**

Source: TXU.

Table B-3. TXU Generating Stations: Nuclear

Station	Unit Number	County	Date of Initial Commercial Operation	Net MW	Total MW
Comanche Peak	#1	Somervell	8/13/1990	1,150	
Comanche Peak	#2	Somervell	8/3/1993	1,150	2,300
			Total Nuclear MW		**2,300**

Source: TXU.

Appendix C. Proposed Federal Multi-Pollutant Legislation and EPA Regulatory Proposals

The following tables, taken from the website of Resources for the Future, a nonpartisan organization conducting research on environmental and natural resource issues, summarize the elements of the three multi-pollutant bills that were introduced in Congress and the regulatory proposals put forth by EPA for SO_2 and NO_x as well as mercury. These tables are reproduced by permission from Resources for the Future.

Table C-1. Summary of Multipollutant Legislative Proposals

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Legislative Comparison of Multipollutant Proposals S. 366, S. 1844, and S. 843.[1] Version 01/22/04.

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
Affected Facilities	Electricity-generating facilities with a nameplate capacity of 15 MW or more.	Electricity-generating facilities with a nameplate capacity of 25 MW or more.	Electricity-generating facilities with a nameplate capacity greater than 25 MW.
National Annual Allowance Allocation Caps			
Sulfur Dioxide (SO_2)	2.25 million tons in 2009. Split into two regions.[3]	4.5 million tons in 2010. 3.0 million tons in 2018.	4.5 million tons in 2009. 3.5 million tons in 2013. 2.25 million tons in 2016.
Nitrogen Oxides (NO_x)	1.51 million tons in 2009.	2.19 million tons in 2008. 1.79 million tons in 2018. Split into two regions.[4]	1.87 million tons in 2009. 1.7 million tons in 2013.
Mercury	5 tons in 2008. Facility specific emissions limitations without trading.	34 tons in 2010. 15 tons in 2018.	24 tons in 2009. 10 tons in 2013. Facility-specific limitations apply.[5]
Carbon Dioxide (CO_2)	2.05 billion tons in 2009.[6]	No CO_2 policy.	2.57 + billion tons in 2009.[7] 2.47 + billion tons in 2013.[8] + additional tonnage through sequestration incentives.

[1] Prepared by David Lankton, Billy Pizer, Karen Palmer, and Dallas Burtraw. This document can be found at www.rff.org/multipollutant/.
[2] The Bush administration has proposed regulatory rules, similar to the policies in S. 1844, to be published in the Federal Register by early February of 2004.
[3] Under S. 366, the western region has a 0.275 million ton cap on SO_2 and the non-western region has a 1.975 million ton cap on SO_2.
[4] Under S. 1844, the western region has a 0.715 million ton cap on NO_x and the eastern region has a 1.475 million ton cap on NO_x. The eastern NO_x cap is reduced to 1.074 million tons in 2018.
[5] For S. 843, from 2009 to 2012, mercury emissions cannot exceed 50% of the total mercury present in delivered coal at each affected facility. After 2012, the percentage drops to 30%. Also, emissions may not exceed an output-based rate determined by the administrator.
[6] The CO_2 cap is specified in S. 366 and it approximates 1990 level CO_2 emissions from the electricity sector.
[7] The S. 843 2009 allowance cap is equal to 2006 electricity sector CO_2 emissions as projected by EIA in the most recent report as of date of enactment. The number we report is EIA's *AEO 2003* projection for 2006.
[8] The S. 843 2013 emissions cap is equal to actual 2001 electricity sector CO_2 emissions. The number we report is EIA's *AEO 2003* projection for 2001.

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Table C-2. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
Allowance Allocation Cap Changes and Additional Annual Allowance Availability			
High Costs "Safety Valve"	None except to exercise penalty provisions for excess emissions.	Units can purchase future allowances for current use: **SO_2**: \$2,000 (per ton). **NO_x**: \$4,000 (per ton). **Mercury**: \$2,187.50 (per ounce).[9]	None except to exercise penalty provisions for excess emissions.
Carryover from Title IV SO_2 and NO_x SIP Call programs	**SO_2, NO_x:** Banked pre-2008 Title IV NO_x and SO_2 allowances can be traded 4:1 for S. 366 NO_x and SO_2 allowances, respectively. **SO_2, NO_x:** SO_2 and NO_x allowances banked as a result of meeting new source performance standards between 2001 and 2008 are considered full value S. 366 allowances of the appropriate type.	**SO_2:** Banked pre-2010 Title IV SO_2 allowances can be traded 1:1 for S.1844 SO_2 allowances. **NO_x:** Banked allowances from the regional, seasonal SIP Call trading program can be traded 1:1 beginning in 2008.	**SO_2:** Banked pre-2009 Title IV SO_2 allowances carryover 1:1 for S.843 SO_2 allowances.
Additional Allocations for Out-of-Program Emission Reductions			**CO_2:** Additional CO_2 allowances for carbon sequestration are added to the annual CO_2 allowance cap. See "CO_2-Specific Allocation Methods" below. **CO_2:** Allowances from other international or U.S. CO_2 reduction programs may be used.[10]
Localized Reductions and National Ambient Air Quality Standards	The administrator may limit localized emissions to avoid significant adverse health impacts. **Non-Attainment:** Units contributing to non-attainment of	S. 1844 does not interfere with states continued authority over local compliance with NAAQS.	The federal or state government may limit emissions from a specific facility to address local air quality problems. **Non-Attainment:** After 2008,

[9] For S. 1844, purchased allowances reduce the allowances (of the purchased type) that would otherwise be allocated the next year. If these allowances are not used, they are taken by the administrator (without refund). Prices are adjusted for inflation based on the Consumer Price Index. If more allowances are sold than would otherwise be allocated in the next year, then the allocation in the second next year is reduced (continuing as necessary).

[10] S. 843 establishes an independent review board consisting of members from the EPA, DOE, state governments, the electricity sector, and environmental organizations that must certify additional CO_2 allowance allocations.

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Table C-3. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
(NAAQS)	the ozone standard must submit three NO_x allowances for each ton of NO_x emitted. Units contributing to non-attainment of the PM-2.5 standard must submit two SO_2 allowances for each ton of SO_2 emitted.		sources within non-attainment areas would no longer be required to obtain offsets for emissions.
Allowance Cap Reductions From Small Source Emissions	For 2009 and each following year, the allowance caps are reduced by the emissions from small electricity generators (< 15 MW) in the second preceding year.		
New Information "Re-opener"	Each year, any additional reductions the administrator finds necessary to protect public health and welfare may be made.		Within 15 years of enactment, the administrator must determine whether or not to adjust the annual allowance allocation caps. If it is determined that adjustments are required, they will take effect 20 years after enactment.
Allowance Banking and Trading Programs			
Banking Restrictions	**Mercury:** Cannot be banked.		
Trading Restrictions	**SO_2:** Allowances cannot be traded between regions. **Mercury:** Cannot be traded.	**NO_x:** Allowances cannot be traded between the two regions.	
Western Regional Air Partnership (WRAP)		Two measures trigger the start of the WRAP program: 1) After 2013, the third year after which the SO_2 emissions from WRAP states are *projected* to exceed 271,000 tons. **OR** 2) After 2018, beginning the third	Two measures trigger the start of the WRAP program: 1) Any year from 2016 or later that is the third year after *projected* WRAP SO_2 emissions exceed 271,000 tons **OR** 2) Any year 2021 or later that is

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Table C-4. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
		year after which *actual* SO_2 emissions from states in the WRAP exceed 271,000 tons. As of the start date, the administrator will allocate 271,000 SO_2 allowances to electricity-generating units (EGUs) in those states each year. Only these allowances may be used by EGUs in the WRAP states.	the third year after *actual* WRAP SO_2 emissions exceed 271,000 tons. As of the start date, SO_2 emissions from WRAP states may not exceed the number of SO_2 allowances allocated to units in WRAP states. The administrator will determine the method and number of these allocations by 2013.
Treatment of Pre-existing NO_x Programs	The regional summertime NO_x SIP Call trading program would exist separate from S. 366.	The regional summertime NO_x SIP Call trading program would terminate after 2007.	The regional summertime NO_x SIP Call trading program would exist separate from S. 843.
Potential for Trading Across Pollutants		By July 1, 2009, the administrator will submit a study to Congress regarding the environmental and economic effects of inter-pollutant trading of NO_x and SO_2.	
Allowance Allocation Methods			
In General	Auctions with revenues returned to consumers and allowances set aside for impacted sectors.	Grandfathering.	Grandfathering for SO_2 and output-based allocations for NO_x, mercury and CO_2.
Methods Applicable to Multiple Pollutants	**Existing Sources; SO_2, NO_x, CO_2**: 10% of all SO_2, NO_x, and CO_2 allowances in 2009 will be grandfathered to affected units based on their share of electricity generation in 2001. Allocations decrease by 1% until 2018. **Transition Assistance; SO_2, NO_x, CO_2**: 6% of all SO_2, NO_x, and CO_2 allowances in 2009 are allocated to non-electricity	**Baseline Heat Input; NO_x, Mercury:** Baseline heat input is the average annual heat input used by a unit during the 3 years in which the unit had the highest heat input for the period 1998 to 2002. See the NO_x and Mercury sections below for applicability. **Early Reduction Credits; SO_2, NO_x:** Additional allowances will	**New Unit Reserve; SO_2, NO_x, Mercury, CO_2**: The administrator and the Secretary of Energy will determine the size of the new unit reserve every five years for the next five-year period based on projections of electricity output from new units.

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Table C-5. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
	generating firms for transition assistance. This amount declines by 0.5% until 2018. Of these allowances, 80% go to dislocated workers and adversely impacted communities. The remaining 20% go to producers of electricity-intensive products. **Renewable Generation and Clean Product Incentives; SO_2, NO_x, CO_2:** Not more than 20% of all SO_2, NO_x, and CO_2 allowances will be allocated each year to renewable generation facilities and owners of energy-efficient buildings, producers of energy-efficient products, entities that carry out energy-efficient projects, owners of new clean fossil-fuel electricity generating units, and owners of combined heat / power generators.[11] **Household Allocations; SO_2, NO_x, CO_2:** Any allowances not allocated to other sectors are given to electricity consumers through an appointed trustee. Households receive allowances based on the	be allocated (1 allowance for each 1.05 ton reduction) for installation or modification of pollution control equipment or combustion technology improvements after the date of enactment but prior to 2010. No allowances will be allocated for equipment in operation or under construction prior to enactment, attributable to fuel switching, or required under federal regulation.	

[11] For S. 366, renewable electricity-generating units receive an allocation based on renewable electricity production and the national average emissions per MWh by all electricity-generating facilities. For energy efficiency, the allocation is based on electricity or natural gas saved and the national average emissions per MWh or cubic foot of natural gas. For new, clean fossil-fuel-fired electricity generating units, allocations are based on the previous year's MWhs produced by new, clean fossil-fuel-fired electricity generating units and one half of the national average emissions per MWh. For combined heat and power electricity generating facilities, allocations are the product of Btu produced and put to use by each facility and the previous year's national average quantity of emissions per pollutant per Btu.

Table C-6. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
	number of people in the household and their state's ratio of residential electricity consumption to national residential electricity consumption.		
SO_2 Specific Allocation Methods		**Grandfathering Rules; SO_2:** 93% of allowances are given to affected electricity-generating units proportional to Title IV SO_2 allowance allocations. **Non-Title IV Units and Additional Units; SO_2:** 7% of the SO_2 allowances are allocated (based on baseline heat input and SO_2 emission rates) to units that were non-Title IV units and additional units built after 2001. These allocations are made on a first construction basis. **Control Incentives; SO_2:** [12] A total of 250,000 allowances (out of the 4.5 million annual allocation) are allocated over the first three years of the program as incentives for SO_2 control technology.	**Existing Sources: SO_2:** Existing fossil-fuel-fired units (includes Title IV existing units and units built at least three years before the current year) receive allowances based on Title IV allowance allocation rules, pro-rated to comply with the difference between the S. 843 allowance cap and the new unit reserve for SO_2.[13] **New Sources: SO_2.** New units receive allowances based on future regulations promulgated by the administrator.
NO_x Specific Allocation Methods		**Grandfathering Rules; NO_x:** 95% of allowances (in each region) are given to affected electricity-generating units based on baseline heat input relative to total baseline heat input across all	**Existing Sources; NO_x:** Existing fossil-fuel-fired units receive allowances equal to the product of 1.5 pounds of NO_x per MWh times the quotient of the average quantity of electricity generated

[12] For S. 1844, in the first three years, the number of grandfathered SO_2 allowances is reduced by 0.083 million allowances. These allowances are offered via competitive bidding to coal-fired facilities that reduce their SO_2 emissions through improved technology.
[13] For S. 843, allocation to existing units that are not specifically mentioned in Title IV is determined by the administrator on a fair and equitable basis.

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Table C-7. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
		affected units. **Additional Units; NO_x:** 5% of the NO_x allowances (in each region) are allocated (based on baseline heat input) to units that commence operation after enactment of S. 1844. These allowances are allocated on a first construction basis.	during the most recent three-year period in MWh divided by 2,000 pounds of NO_x per ton. If this total is not equal to the difference between the allowance cap and the new unit reserve for NO_x, allowances are allocated on a pro-rata basis. **New Sources: NO_x:** New units receive allowances based on projected emissions.
Mercury Specific Allocation Methods	**Emissions Limitations;** **Mercury:** Mercury emissions are not to exceed 2.48 grams per 1,000 MWh. This is an emissions limitation, not an allocation of allowances, and may not be banked or traded.	**Grandfathering Rules;** **Mercury:** 95% of allowances are given to affected electricity-generating units based on baseline heat input relative to total baseline heat input across all affected units. **Additional Units; Mercury:** 5% of the Mercury allowances are allocated (based on baseline heat input) to units that commence operation after enactment of S. 1844. These allowances are allocated on a first construction basis.	**Existing Sources; Mercury:** Existing coal-fired units receive allowances equal to the product of 0.0000227 pounds of mercury per MWh multiplied by the average quantity of electricity generated during the most recent 3-year period in MWh. If this total is not equal to the difference between the allowance cap and the new unit reserve for mercury, allowances are allocated on a pro-rata basis. **New Sources; Mercury:** New units receive allowances based on projected emissions.
CO_2 Specific Allocation Methods	**Sequestration Incentives; CO_2:** Not more than 0.075% of total CO_2 allowances shall be allocated to encourage biological carbon sequestration and not more than 1.5% of total CO_2 allowances shall		**Sequestration Incentives; CO_2:** Additional CO_2 allowances are allocated for carbon sequestration and for programs to reduce greenhouse gas emissions. In 2009, allocations are made for

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Table C-8. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
	be allocated to encourage geological carbon sequestration.		projects from 1990 to 2008, and these allowances are limited to 10% of the CO_2 allowance cap for 2009. After 2009, allocations are made for current projects, and there is no limitation on the number of additional allowances. **Existing Sources; CO_2:** Existing fossil-fuel-fired, nuclear,[14] and renewable[15] units receive allowances equal to their average generation over the most recent three-year period divided by the total average generation over the same period by all such units multiplied by the difference between the allowance cap and the new unit reserve for CO_2. **New Sources; CO_2:** New fossil-fuel-fired and renewable units receive allowances based on their projected share of total generation.
Compliance With Legislation			
Penalties for Excess Emissions	**SO_2, NO_x, CO_2:** Three times the excess emissions in tons (or failed allowance submissions) multiplied by the average annual market price for the appropriate allowances. **Mercury**: Three times the excess emissions in grams multiplied by	**SO_2, NO_x, Mercury:** The excess emissions in tons (for NO_x, SO_2) or ounces (for Mercury) multiplied by the average sale price between holders of allowances. Excess emissions must also be offset the following year (a violator's	**SO_2, NO_x, CO_2, Mercury:** Excess emissions must be offset in a future year, as determined by the administrator. Also: **SO_2:** $2,000 (1990$) penalty for each ton of excess emissions. **NO_x:** $5,000 penalty for each ton

[14] For S. 843, nuclear units receive (and must submit) allowances based only on their incremental generation from 1990 levels.
[15] For S. 843, renewable units include wind, organic waste (excluding incinerated municipal solid waste), biomass, fuel cells, hydroelectric, geothermal, solar thermal, photovoltaic, and other non-fossil fuel, non-nuclear sources.

Table C-9. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
	the average cost of mercury controls.	allocation is reduced by the quantity of excess emissions).	of excess emissions. **CO_2:** \$100 penalty for each ton of excess emissions. **Mercury:** \$10,000 penalty for each pound of excess emissions. **SO_2, NO_x, CO_2, Mercury:** Fees are adjusted by the CPI.
Monitoring and Record Keeping Requirements	Each affected facility must install and operate a continuous emissions monitoring system. Facilities must provide the administrator with data on emissions and emissions per MWh for each covered pollutant. The administrator will keep an inventory of emissions from all small electricity-generating facilities (less than 15 MW). Coal-fired facilities with an aggregate generating capacity of 50 MW or more must monitor ambient air quality within a 30-mile radius of the facility.	Each affected facility must install and operate a continuous emissions monitoring system. Facilities must provide the administrator with data for opacity, volumetric flow, and emissions of SO_2, NO_x, and mercury.	The administrator will promulgate regulations for monitoring requirements. **SO_2:** Title IV reporting for SO_2 is required. **NO_x, CO_2, Mercury:** At least quarterly, facilities must submit to the administrator a report on the emissions of NO_x, CO_2, and mercury.
Modernization and the New Source Review Program (NSR) **Lowest Achievable Emissions Rate (LAER) and Best Available Control Technology**	Beginning on January 1, 2014, or 40 years after the beginning of generation at a facility (whichever date is later), the facility is subject to emissions limitations reflecting best available control technology (BACT) on a new source facility of the same generating capacity.	A unit whose hourly emissions of a pollutant increases at maximum capacity from modifications must either meet the national emissions standards for affected units or apply best available control technology. Facilities that are more than 50 kilometers from a Class I area can exempt themselves from new	**NSR:** Construction of a new unit (including existing boiler replacement) or any modification to an existing unit that increases the hourly emissions rate of an NSR covered pollutant will subject that facility to the NSR program. Beginning in 2020, each facility which began construction before August 17, 1971 must meet

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Table C-10. Summary of Multipollutant Legislative Proposals (continued)

Features	S. 366 – Jeffords (108th)	S. 1844 – Clear Skies (108th)[2]	S. 843 – Carper (108th)
(BACT)		source review and best available retrofit control technology if they commit within three years to meeting a limit for particulate matter (PM) of .03 lb/MMBtu, have begun to operate control technology to reduce PM emissions, or otherwise reduce PM emissions according to best operational practices.	performance standards of 4.5 lbs / MWh and 2.5 lbs / MWh for SO_2 and NO_x, respectively. **LAER and BACT:** Identified biennially. The cost of LAER may not exceed twice that of BACT. **Non-Attainment:** As noted above, sources within non-attainment areas would no longer be required to obtain offsets for emissions after 2008.
Non-NSR Regulatory Relief		The bill delays until 2011 EPA action on petitions by downwind states to reduce emissions in upwind states under section 126 of the Clean Air Act.	Some units would be exempt from mercury emissions standards under section 112 of the Clean Air Act (CAA) and visibility protection requirements (haze) under section 169 of the CAA.

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Table C-11. Summary of EPA Proposed SO_2 and NO_x Rule

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EPA Proposed SO_2 NO_x Rule: A Supplement to the RFF Legislative Comparison Table.[1] Version: 06/14/04.

EPA Proposed SO_2 NO_x Rule (Clean Air Interstate Rule CAIR) (Including June 10, 2004 Supplement)	
Federal Register Title (Date)	Part III Environmental Protection Agency 40 CFR Parts 51, 72, 75, 96 [Supplemental Proposal for the] Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone (Clean Air Interstate Rule); Proposed Rule (January 30, 2004) [Supplement: June 10, 2004]
Summary	EPA proposes implementing a cap and trade program for 28 eastern States[2] and the District of Columbia to reduce emissions of SO_2 and NO_x from electricity generating units. Participation in the regional trading program is optional for the 28 States and the District of Columbia. States that opt-out of the trading program must meet State-level emission caps.
Affected Facilities	Fossil fuel-fired[3] electricity generating units with a capacity greater than 25 MW, **AND** Fossil fuel-fired steam co-generation units with a capacity greater than 25 MW that sell more than 1/3 of their potential electric output.
Regional Annual Allowance Allocation Caps	**SO_2:** 3.86 million tons by 2010 and 2.70 million tons by 2015. **NO_x:** 1.60 million tons by 2010 and 1.33 million tons by 2015.

[1] Prepared by David Lankton. This document can be found at www.rff.org/multipollutant/.
[2] The 28 States are: Alabama, Arkansas, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.
[3] Fossil-fuel fired units are those that fire: natural gas, petroleum, coal, or any fuel derived from such materials, alone or in combination with any other fuel.

Table C-12. Summary of EPA Proposed SO_2 and NO_x Rule (continued)

EPA Proposed SO_2 NO_x Rule (Clean Air Interstate Rule CAIR) (Including June 10, 2004 Supplement)	
Allowance Allocation Method	**SO_2:** Allowances are allocated to States proportional to a State's share of total Title IV allowances. States that choose to participate in the regional trading program must grandfather their allowances to facilities in a manner consistent with Title IV. States have flexibility in allocating any allowances created using a 3:1 retirement ratio (see Carryover section below). **NO_x:** Allowances are allocated to States based on a State's historic annual heat input and a NO_x emission rate.[4] States have flexibility in allocating their allowances, including auction, updating, and grandfathering allocation. Connecticut is subject to an ozone-season-only NO_x cap beginning in 2010. Connecticut, New Hampshire, and Rhode Island may opt-in to the annual trading program. States are responsible for creation and maintenance of any allowance set-aside programs. **Both:** States choosing to participate in either the SO_2 or NO_x trading program must participate in both the SO_2 and NO_x trading programs.
Banking	Allowances for the proposed regional trading programs may be banked without restriction.
Carryover	**SO_2:** Pre-2010 Title IV allowances banked before the implementation date of the proposed rule may be used in the regional trading program. The proposed SO_2 program would allow: ▪ Pre-2010 Title IV allowances to be used at a 1:1 ratio, and ▪ 2010 to 2014 Title IV allowances to be used at a 2:1 ratio, and ▪ 2015 and later Title IV allowances to be used at a 2.86:1 ratio **OR** retired at a 3:1 ratio, creating CAIR allowances equal to the difference between the retirement ratio and the cap.[5] EPA proposes that these ratios for Title IV allowances will prevent States that are not included in the new regional trading program from abusing the abundance of inexpensive Title IV allowances that would be created without these ratios. All states must use the same ratios. **NO_x:** Banked NO_x SIP Call allowances may be carried forward for use in the proposed cap and trade program at a 1:1 ratio.
Penalties	EPA proposes that any facility emitting pollutants in excess of their permits must surrender future year allowances in an amount equal to their excess emissions. In addition, EPA suggests than an unspecified automatic penalty also be imposed.

[4] Historic annual heat input is a State's highest annual average heat input from 1999 to 2002. Historic annual heat input is multiplied by a NO_x emission rate (0.15 lb / mmBtu for phase 1 or 0.125 lb / mmBtu for phase 2) to determine a State's NO_x allocation.
[5] Because the proposed 2.86:1 trading ratio meets EPA's goals for SO_2 reduction, a 3:1 retirement ratio of Title IV allowances for CAIR allowances would result in reductions of SO_2 beyond these goals. If the retirement ratio method is used, CAIR allowances are created to close this gap.

Table C-13. Summary of EPA Proposed Mercury Rule

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EPA Proposed Mercury Rule: A Supplement to the RFF Legislative Comparison Table.[1] Version: 02/09/04.

EPA Proposed Mercury[2] (Hg) Rule	
Federal Register Title (Date)	Part IV Environmental Protection Agency 40 CFR Parts 60 and 63 Proposed National Emission Standards for Hazardous Air Pollutants; and, in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units; Proposed Rule (January 30, 2004)
Summary	The EPA proposes two options for reducing national Hg emissions from coal-fired utility units: 1. Maximum Available Control Technology (MACT), **OR** 2. National Mercury Cap and Trade Program. Choice of program will depend on legal interpretation of the Clean Air Act (CAA) and its amendments: ▪ EPA believes it has the authority, under section 111 of the CAA, to implement a national cap and trade program for mercury. ▪ However, some interpretations of sections 111 and 112 of the CAA and two (apparently contradictory) amendments passed in Congress may restrict EPA's authority. If this is the case, EPA suggests MACT.
Affected Facilities (Both Proposals)	Coal-fired electricity generating units with a capacity greater than 25 MW, **AND** Coal-fired steam co-generation units with a capacity greater than 25 MW that supply more than 1/3 of their potential electric output to an electricity generator.

[1] Prepared by David Lankton. This document can be found at www.rff.org/multipollutant/.
[2] The rule also proposes Nickel emission limitations on oil-fired generators, which are not discussed in this summary.

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Table C-14. Summary of EPA Proposed Mercury Rule (continued)

<table>
<tr><th colspan="2">EPA Proposed Mercury (Hg) Rule</th></tr>
<tr><th colspan="2">Option 1: Maximum Available Control Technology (MACT)[3]</th></tr>
<tr><td>Existing Units: Mercury Emission Limitations

Input or Output Based (Unit's Choice)</td><td>
<table>
<tr><th>Unit Type</th><th>Input Limitation (lb Hg / TBtu)</th><th>Output Limitation (10^{-6} lb Hg / MWh)</th></tr>
<tr><td>Bituminous-Fired[4]</td><td>2.0</td><td>21</td></tr>
<tr><td>Subbituminous-Fired</td><td>5.8</td><td>61</td></tr>
<tr><td>Lignite-Fired</td><td>9.2</td><td>98</td></tr>
<tr><td>IGCC Unit</td><td>19</td><td>200</td></tr>
<tr><td>Coal Refuse-Fired</td><td>0.38</td><td>4.1</td></tr>
</table>
</td></tr>
<tr><td>New Units: Mercury Emission Limitations

Output Based</td><td>
<table>
<tr><th>Unit Type</th><th>Output Limitation (10^{-6} lb Hg / MWh)</th></tr>
<tr><td>Bituminous-Fired</td><td>6.0</td></tr>
<tr><td>Subbituminous-Fired</td><td>20</td></tr>
<tr><td>Lignite-Fired</td><td>62</td></tr>
<tr><td>IGCC Unit</td><td>20</td></tr>
<tr><td>Coal Refuse-Fired</td><td>1.1</td></tr>
</table>
</td></tr>
<tr><td>Date of Compliance</td><td>Existing units must comply with the MACT standards within 3 years of the effective date of the final rule's publication in the Federal Register.
New[5] units must comply with the MACT standards upon initial startup or upon the effective date of the final rule's publication in the Federal Register, whichever is later.</td></tr>
<tr><td>Fuel Blending</td><td>Units that fire blended coals would have unit specific emission limitations. The emission limitations would be based on weighted average limitations over the different types of coal fired at that unit.</td></tr>
<tr><td>Emissions Averaging</td><td>The proposal would allow emissions averaging as a compliance option for existing coal-fired units located at a single contiguous plant.</td></tr>
</table>

[3] MACT is based on the average emission limitation achieved by the best-performing 12 percent of existing sources in each category or subcategory.
[4] The bituminous category includes anthracite.
[5] A new unit is a unit that commences construction, modification, or reconstruction after January 30, 2004.

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Table C-15. Summary of EPA Proposed Mercury Rule (continued)

EPA Proposed Mercury (Hg) Rule	
Option 2: National Mercury Cap and Trade Program	
National Annual Allowance Allocation Caps	34+ tons[6] beginning in 2010. 15 tons beginning in 2018.
Allowance Allocation Method	A State is allocated allowances based on its relative baseline heat input[7] to other States, which the State would then allocate to its utility units. Though States are free to choose an allocation method for utilities, EPA proposes a 'model rule': that allocations to existing sources be based on a unit's share of baseline heat input and adjusted according to coal type: ▪ Bituminous Unit: 1.0 times the share of heat input. ▪ Subbituminous Unit: 1.25 times the share of heat input. ▪ Lignite Unit: 3.0 times the share of heat input. A supplemental notice will address set-asides for new units and / or an updating allocation method.
New Source Performance Standards (NSPS)	New[8] coal-fired utility units will be subject to the following emission limitations for Hg (lb / GWh): ▪ Bituminous: 0.0060, ▪ Subbituminous: 0.020, ▪ Lignite: 0.062, ▪ Waste Coal: 0.0011, and ▪ IGCC: 0.020.
Re-Opener	After the implementation of requirements by 2010 and 2018, EPA will evaluate the Hg emission levels, control methods, and health impacts of the trading program and allowance allocation caps.
Safety Valve	Facilities may purchase Hg allowances for $2187.50 (per ounce and adjusted for inflation). Purchased allowances reduce the size of the allowance allocation in the following year.
Trading	States may choose not to participate in the national allowance-trading program. If a State ops out of the trading program, facility specific emission limitations apply (using 'model rule' calculations).
Banking	Current Hg allowances may be banked for future use.
State Authority	States may require Hg emission reductions in addition to those proposed by EPA.
Allowance Auctions	The EPA asks for comment on the possibility of auctioning a portion of the allowances each year.

[6] The 2010 Hg allowance cap is not specified. Instead, the 2010 allowance cap is equal to the Hg reductions that result as a co-benefit of SO_2 and NO_x emission reductions proposed in a separate rule in the Federal Register (Part III, EPA, 40 CFR Parts 51, 72, 75, and 96, Rule To Reduce Interstate Transport of Fine Particulate Matter and Ozone (Interstate Air Quality Rule); Proposed Rule). The 34-ton allowance cap is based on EPA's analysis, and it is also the 2010 Hg allowance cap in the most recent version of the proposed Clear Skies Act (108th Congress: S. 1844).
[7] Baseline heat input is based on the average heat input at a facility over the highest of the three years from 1998 to 2002.
[8] A new unit is a unit that commences construction, modification, or reconstruction after January 30, 2004.

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